A STUDY OF MATHEMATICS ANXIETY
WITH PARTICULAR ATTENTION TO
TREATMENT METHODS

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STATEMENT OF ORIGINALITY

This thesis is the original work of P.L. Hawkey. Extensive use has been made of material gathered in England, Canada and the United States of America but wherever this material has been used it has been clearly indicated in the text.

A STUDY OF MATHEMATICS ANXIETY WITH PARTICULAR ATTENTION TO TREATMENT METHODS

ABSTRACT

This thesis is the result of some extensive research in England, Canada and the United States of America. Prominent educationalists were interviewed and research institutions were visited. Ideas and projects have been investigated and used to provide a foundation for remedial suggestions in the South African context.

The nature of mathematics anxiety is fully discussed and provides a background to the complexities of the problem. The question of why mathematics is unique as a school subject is discussed and the manifestation of mathematics anxiety is described in terms of the interaction of socio-cultural, emotive, cognitive and educational influences.

The measurement of mathematics anxiety is an important aspect of remediation and various assessment techniques are reviewed. Mathematics anxiety scales have evolved from scales measuring general and test anxiety. For the assessment of large groups the Mathematics Anxiety Rating Scale (MARS) or an adapted version of this scale is recommended whilst individual assessment is seen as the ideal when small groups of mathematics anxious pupils have been identified. Two adaptations of the MARS test were used in an exploratory study in a

Durban primary school and a College of Education and the results of these tests are discussed.

Treatment methods are categorised in terms of socio-cultural, emotive, cognitive and educational factors. In each category the idea of creating an awareness of the problem of mathematics anxiety amongst pupils, teachers and parents is seen as an important aspect of the remedial process. For this reason, background research and ideas are discussed before treatment methods are suggested.

Intervention procedures involve general strategies as well as attention to individual difficulties. The importance of an early intervention programme is stressed but remedial methods are seen as flexible and adaptable to all education institutions. Proposed procedures are interrelated and overlapping in parts but provide a comprehensive answer to the complex problem of mathematics anxiety. The ultimate aim of a mathematics anxiety remediation programme should be to provide a better understanding of mathematics, a long-lasting improvement in mathematics ability and a greater enjoyment and appreciation of the subject.

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The ideas gathered in this work are taken from many sources but special mention should be made of the following people who I have personally interviewed.

I thank them for their time and advice.

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UNITED STATES OF AMERICA

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Interviews were conducted with each of the abovementioned people and those names indicated by an asterisk allowed tape recorded interviews.

P.L. HAWKEY (1986)

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OVERVIEW OF THE STUDY

CHAPTER I

OVERVIEW OF THE STUDY

PART 1: THE PROBLEM

The concept of mathematics anxiety has received increasing attention over the past number of years. The advent of the computer age and the widening array of vocations that require a theoretical and practical knowledge of mathematics have all contributed to the emphasis on mathematics achievement.

There is general agreement that mathematics is an important subject in a modern world and that the appearance of mathematics anxiety is as likely to cause inadequacy as any real lack of mathematical ability. Fears and self defeating attitudes of the mathematics anxious have been identified and ample evidence has been presented that emotions as well as intellect play a role in the learning of mathematics. (Lazarus 1974; Tobias 1976, 1978). This interest in mathematics anxiety has resulted in the publication of research findings on its nature and aetiology, suggested methods of approaching the problem and the establishment of programmes designed to combat the problem. The bulk of this research has been carried out in England, Canada and the United States of America. In the United States of America various colleges and private institutions have been offering remedial courses for the past few years.

The term "mathematics anxiety" has become a popular educational phrase and is often used in the popular press in the U.S.A. and Canada. It is associated with fear of mathematics, avoidance of mathematics and even poor attitude towards mathematics. One has to guard against disregarding this phenomena and assuming that it has little academic significance because of the publicity it receives. The mathematics educator must be concerned with any phenomena that could influence the efficiency of his or her teaching and mathematics anxiety is a most important issue which many educators are now recognising as a hindrance to learning mathematics.

From the psychologists point of view, "anxiety" has been a term which has been studied for many years and has caused some difficulty when it comes to a definition. For this reason psychologists started to look at more specific forms of anxiety and test anxiety and later mathematics anxiety evolved from their interest in establishing some clarity on the global term of anxiety.

Studies and research findings have now reached a stage where it is fairly safe to assume that many people learn far less mathematics than they otherwise might owing to mathematics anxiety (Dougherty 1981). Therefore it is crucial to investigate and determine where mathematics anxiety originates and how to alleviate the condition as it variously occurs.

PART 2: IMPORTANCE OF THE STUDY

"The importance of mathematics for understanding the social and natural sciences, and indeed much of daily life, hardly needs emphasis and the importance of good mathematics teaching, particularly in the primary schools, is widely recognised". (The Royal Society, 1976, p2)

This statement emphasises the widely recognised importance of mathematics and the growing concern for factors which may hinder one's progress in the subject. Good mathematics teaching is undoubtedly a crucial factor but emotional factors and lack of cognitive skills should also be of concern to the mathematics teacher. All these factors can cause fear or anxiety and Schonell and Schonell (1957, p70) came to the conclusion that "normal emotional reactions are more important than normal intellectual ones to progress in mathematics". For this reason mathematics teaching can only be good if the teacher is concerned about mathematics anxiety and the affective and cognitive variables that are connected to mathematics anxiety and hindering the progress of their pupils.

In their work with backward children Schonell and Schonell (1957, p70) found that "in many cases the confusion, the loss of self-esteem and self-confidence has been so great as almost to inhibit normal intellectual expression".

Good mathematics teaching necessarily involves consideration of both emotional and intellectual concerns as well as classroom strategies and school programmes which keep in mind both anxiety and performance.

There are several reasons why a study of the ways to effectively combat mathematics anxiety is a worthwhile task. The following are some of the most important reasons which have been expressed by leading authorities in this field.

1. Mathematics Anxiety is widespread

"A majority of individuals probably suffer from some form of mathematical anxiety" (Crumpton 1977, p11). Some people may not feel anxious until they reach university level while others may panic at primary school. Zacharias (1976, p22) stated that mathematics anxiety "afflicts almost everyone" and Lazarus (1974, p17) felt that "the children and adults who should be judged mathophobic outnumber by far those who are comfortable with mathematics."

2. Mathematics Anxiety affects performance.

Research concerning mathematics anxiety and learning seems to indicate that high levels of anxiety hinder academic progress. Negative correlations have been found between Mathematics Anxiety Ratings and performance on the mathematics component of the Differential Aptitude Test (DAT) (Richardson and Suinn 1972; Suinn et al 1972).

3. Mathematics anxiety causes mathematics avoidance.

Children and adults who are anxious about mathematics tend to avoid mathematics altogether or take an easy option. Tobias (1976, p56) noticed that "some of her students were even contemplating changing their majors to avoid mathematics prerequisites". This problem appears to be universal as even students in Natal schools appear to select courses which provide an "easy way out". Boys are generally encouraged to take mathematics but in fact are too quick to resort to the standard grade level. Girls may give up mathematics altogether or opt for a standard grade course which is far below their capabilities. Mathematics avoidance leads to a limited choice of courses at university as even fields that are thought of as non-mathematical have become more mathematized. This course restriction subsequently limits the career development of the student.

4. Vicious circle effect.

People who feel highly anxious about mathematics often rationalise that it is unimportant and the fact that they are incompetent in various areas of mathematics is of no consequence. These people tend to pass on these feelings of anxiety. Parents who are convinced that mathematics is inessential and unimportant are likely to pass on these feelings to their children. Likewise, a teacher with anxiety towards mathematics could drastically affect the attitude of the children he or she teaches. If this "vicious circle" effect is not stopped, mathematics anxious children will continuously be emerging from our schools and finding themselves as parents and teachers ready to perpetuate a similar syndrome.

PART 3: INTENTION OF THE STUDY

During the past 30 years extensive research has been conducted concerning mathematics anxiety. Included in such research have been studies dealing with the relationship between anxiety and educational achievement and the relationship between anxiety and certain learner characteristics. The question of whether or not mathematics anxiety is more predominant in females than males has received a significant volume of attention whilst the development of programmes to combat the problem has received relatively little attention.

Whilst much of the information and many of the theories have been considered, a complete survey of all this literature is beyond the scope of this study. It is necessary to consider all factors and significant research findings but the emphasis will be on literature involving the programmatic development of ways to alleviate the problem and ensure that its perpetuation is stemmed.

The intention of this study is to review the research and literature on mathematics anxiety and to emphasise the most important issues which must be included in remediation. For an adequate background to the problem it is necessary to explore the nature and aetiology of mathematics anxiety; to investigate how it is measured; to analyse and categorise research and theoretical ideas and to review and assess the effectiveness of various treatment procedures. The three chapters that follow will deal with three issues and are entitled:

1. The nature of mathematics anxiety,
2. The assessment of mathematics anxiety, and
3. The treatment of mathematics anxiety.

Throughout these chapters it will become evident that mathematics anxiety cannot be studied in isolation. There are many factors directly or indirectly linked to mathematics anxiety and without an investigation of some important related aspects this study would not be complete. Mathematics anxiety is complex in nature and its causes and effects are multifaceted. Treatment processes cannot be simple and short-termed but must necessarily be diverse and with long-term goals.

The following three aims should form the basis of one's approach to the treatment of mathematics anxiety.

1. Remediation of socio-cultural, emotive, cognitive and educational factors that influence mathematics anxiety.
2. Intervention procedures should be suitable for school level and particularly the primary school.
3. Long-term improvement of mathematics anxiety, attitude and ability.

In addition every attempt will be made to relate remedial ideas to the South African context.

It is intended to illustrate in this study that the answer to a solution to mathematics anxiety is to create an awareness amongst parents, pupils and teachers of the multitude of factors that affect mathematics performance and to counter-act these factors in as many situations as possible.

CHAPTER II

THE NATURE OF MATHEMATICS ANXIETY

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THE NATURE OF MATHEMATICS ANXIETY

PART I : DEFINITION

Aiken (1976, p95) referred to mathematics anxiety simply as "anxiety in the presence of mathematics". Zacharias (1976, p22) coined the word "mathophobia" for the condition of disliking or fearing mathematics. Lazarus (1974, p16) further identified mathophobia as "an unnatural and impeditive dread of mathematics" and goes on to say that "a student can develop this emotional and intellectual block, making further progress in mathematics and closely related fields very difficult". Such a student "rapidly develops a fatalistic attitude about his problems with mathematics, fully expecting to do badly". The individual develops a self-sustaining syndrome whereby his low level of functioning leads to difficulty and failure which in turn leads to further anxiety which itself reinforces negative attitudes.

Dougherty (1981), a consultant to the mathematics anxiety programme at Wesleyan University, warns against confusing mathematics anxiety with an attitude of "disdain" for mathematics, technology and science. "Mathematics anxiety is an unspecific fear based on a projected feeling of indadequacy vis-a-vis some contemplated experience with mathematics" (Dougherty 1981, p5).

Auslander (1979 Pg 17) says that "mathematics anxiety can be defined as the experience of mental disorganisation, panic, and fear that prevents a person from learning mathematics". She goes on to say that a lack of enthusiasm for mathematics, technology and science "may actually be partially attributable to mathematics anxiety".

Buxton (Personal Interview 1984) prefers to use the term "panic". He feels that the word "panic" is a more specific description because it means a "total blackout" whereas anxiety is a more general form.

Kogelman (Personal Interview 1984) also uses the word "panic" but he describes it as a manifestation of intense anxiety. He says that "once panic begins to take hold, normal functioning is impaired and the skills necessary for learning and performing become inaccessible".

It is significant to note that there is a tendency amongst theorists to not only describe the feelings of mathematics anxiety but to also give some indication of either the sources or the consequences. The aetiology and the possible consequences of mathematics anxiety are impossible to condense into some short definition.

The obvious general consequence of mathematics anxiety is one's performance in mathematics. Richardson and Suinn's definition is widely used in the United States of America and is generally accepted as a good description of the condition. Richardson and Suinn (1972, p551) stated that "mathematics anxiety involves feelings of tension and anxiety that interfere with the manipulations of numbers and the solving of mathematical problems in a wide variety of ordinary life and academic situations". They clearly see the problem as more than just scholar orientated but rather an impediment in general life.

The consequences of mathematics anxiety are far-reaching and are more likely to affect a person in general life because although it may be easy to avoid mathematics courses at school or university it is difficult to get through life being fearful of numbers.

Furthermore, Richardson and Suinn (1972, p551) contended that "mathematics anxiety exists among many individuals who do not ordinarily suffer from other tensions". Dreger (1957, p350) supported this view in an earlier study on college aged students which led him to conclude that "number anxiety does appear to be a separate (composite) factor from general anxiety". Mathematics anxiety has become a functional psychological term to represent a specific anxiety state and although people who are generally anxious may also suffer from the anxiety state of mathematics anxiety, it also includes people who do not generally feel anxious. In addition it should be mentioned that mathematics anxiety is not merely connected with test anxiety in a mathematical setting but specifically described feelings of anxiety that interfere with the utilization of mathematics skills in "many daily life and academic situations" (Ricardson and Suinn 1972, p551).

There are many theories which help to explain this uniqueness of mathematics anxiety and it is perhaps appropriate to now consider how they relate to the sources of mathematics anxiety.

PART 2: SOURCES OF MATHEMATICS ANXIETY

Few studies clarify the source of mathematics anxiety. It is often associated with fear, avoidance, dislike and the psychological construct is taken as well-defined and measureable. The general term of "anxiety" has yielded little agreement from psychologists in that theories vary from those emphasising that anxiety has biochemical origins to others which say that anxiety is a learned response. With mathematics anxiety the sources tend to relate to a more psycho-social point of view and although related to general anxiety most of the sources are unique to mathematics anxiety.

Susan Bregman (1978, p41) says that "no-one knows precisely why mathematics anxiety occurs - whether the reasons be within the individual, the classroom, or the society at large - but answers are gradually emerging". For the purpose of clarity it may be beneficial to attempt to structure the sources of mathematics anxiety under certain headings. This is a difficult task because all factors involved in causing anxiety must necessarily be closely linked and any categorisation will lead to a certain amount of overlapping. However, the following four aspects could provide a clearer view of the sources of mathematics anxiety.

1. Socio-cultural factors
2. Emotive factors
3. Cognitive factors
4. Educational factors

2.1 Socio-cultural Factors

Sheila Tobias cautions against the use of the term "mathematics anxiety" which reflects only the psychological aspect. She makes the point that the use of this term could further stereotype women in that it might become a sociably acceptable fact that women suffer from "mathematics anxiety". Sociologists hold that the factors that cause mathematics anxiety are more "political and social" and not wholly "psychological and educational". For this reason remediation should seek to focus not so much on curing the individual as on rectifying the conditions which foster these feelings (Tobias, 1978, [2], p7).

It is becoming socially acceptable to "not be able to do mathematics". Many professional men who are otherwise proud of their achievements will shamelessly admit to being "no good at mathematics". Parents who may find themselves unable to cope with the "new maths" or are very committed to old methods and ideas may express negative feelings to their children.There is often quite a strong conflict between homes and schools because parents do not understand the logical progress of their child's mathematics course.

Parents often influence their children by revealing their expectations. Studies have shown that fathers do not expect their daughters to do particularly well in mathematics and that they consider "being good at mathematics" a masculine trait (Jacobs, 1978). Mothers also are reluctant to motivate daughters to do well at mathematics because more often than not the mothers were not successful in mathematics. In general, many parents are more concerned with their son's academic progress and more concerned that the son is well catered for academically. The daughter may feel anxious if she does not live up to this subordinate role, whilst the son may become anxious under the pressure being put to bear on him to do well (Jacobs, 1978).

2.2 Emotive Factors

The socio-cultural factors described above are often the cause of certain emotive reactions by individuals as mentioned in the concluding sentence of the previous section. The individual may develop psychological blockages which will seriously impair his or her mathematics performance. It is important to realise that mathematics anxiety can afflict people suffering from general anxiety but may also afflict an individual who does not normally feel anxious. In addition, mathematics anxiety is not necessarily related to general intelligence as it often afflicts people who are highly successful in other subjects. Several convincing arguments have been put forward which attempt to clarify the issue of emotive interference in the mathematics progress of each individual.

2.2.1 Connotative meanings

Richardson and Woolfolk (Sarason, 1980, p271) emphasise the fact that mathematics has a unique and important component which appears to be its connotative meanings for many people. They say that "being good at" or "liking" mathematics connotes:-

Certainty
Perfection
High intelligence
Genius
Some arcane wisdom
Highly specialised knowledge remote from common sense
The essence of practicality
A characteristically masculine activity

These connotations cause people to develop certain emotive reactions to the subject and each individual may be affected in a different way by the various connotative meanings connected with mathematics. Certain pupils may assume that doing mathematics is beyond them and only a subject for the gifted few. The fact that an individual who is good at mathematics is set apart from others and that being good at mathematics is seen as a characteristically masculine activity can lead to several emotive reactions. Males who are not good at mathematics may feel inadequate whilst those that excel may feel out of place. Certainly there has been evidence of girls who do well at mathematics and are not eager to reveal their aptitude for fear of being regarded as strange (Jacobs, 1978).

2.2.2 the Myths of Mathematics

Kogelman and Warren (1978, p30) believe that people develop certain emotive reactions towards mathematics because of 12 myths which have gradually become entrenched in our society. These myths are:-

1. Men are better in mathematics than women.
2. Mathematics requires logic, not intuition.
3. In doing mathematics you must always know how you got the answer.
4. Mathematics is not creative.
5. There is a best way to do a math problem.
6. It's always important to get an answer exactly right.
7. It's bad to count on your fingers.
8. Mathematicians do problems quickly in their heads.
9. Mathematics requires a good memory.
10. Mathematics is done by working intensely until the problem is solved.

11. Some people have a "math mind" and some don't.
12. There is a magic key to doing mathematics.

Kogelman and Warren emphasise the mystification that surrounds mathematics and see this as a major cause of the manifestation of anxiety. Many of these myths are formed at an early age at school and are often because of misguided attitudes of both parents and teachers. More detailed discussion will follow in Chapter IV in connection with treatment.

2.2.3 Sex-differences

When considering emotive issues one cannot ignore the vast amount of literature on sex-related factors influencing mathematics anxiety. Many people are obviously concerned about the sources of mathematics anxiety which may lead to inequality between the sexes in later life. Hill (Jacobs, 1978, p7) says that "perhaps the most serious influences, the subtle messages society conveys in a myriad, difficult-to-pin-point ways, represent the area in which we in education must concentrate our greatest efforts. The attitudes and conditioning related to the individual female's role and the perceived need and appropriateness of mathematical study to that role, are developed early and are the result of innumerable interrelated experiences, both in school and out. Thus the critical character of the elementary school in middle or junior high school experiences and the influence of teachers, counsellors and parents becomes apparent".

Many girls tend to have more difficulty with mathematics as they progress. However, this is also true for boys and the teacher should be careful not to be over concerned and thus emphasise the problem of sex-differences. Society, in general, regards women and men differently when it comes to role expectations and this often influences how the individual reacts to mathematics. Whilst acknowledging this, it is not the main concern of this study.

2.3 Cognitive Factors

There is no doubt that emotive factors play an important role in the manifestation of mathematics anxiety. However, there are certain cognitive factors unique to mathematics which often cause a setback in mathematics progress. These factors are related to the content and nature of the subject which does actually cause some difficulty as pupils progress through school.

2.3.1 Mathematics progression

Brush (1981) found that there are many features of mathematics that students observe, dislike and find increasingly anxiety provoking as they grow older. She compared the natural progression in the subject English with that of mathematics and points out the following four aspects where mathematics is at a disadvantage:

(a) Maths gets more difficult (more abstract) as one progresses at school.

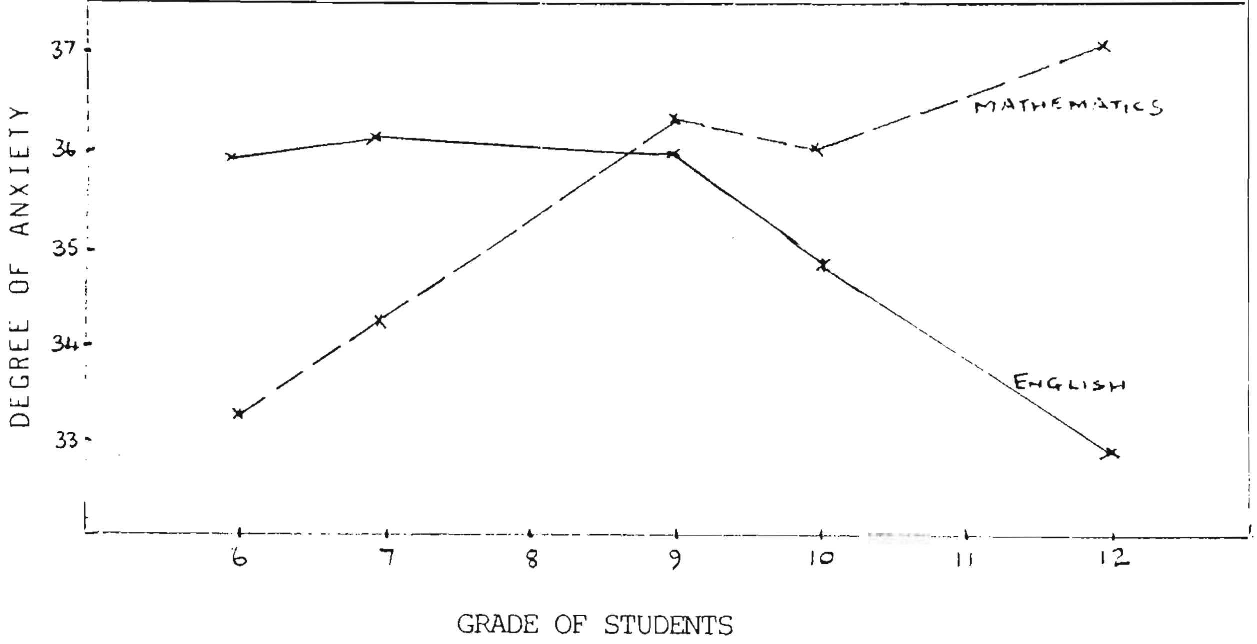
(b) Students spend more and more time learning what is already known and less and less time contributing their own ideas.

(c) After arithmetic the everyday uses of the material learned in class seems limited.

(d) Working with numbers does not seem to contribute to a better understanding of oneself or of society; the subject seems very impersonal.

If one considers these aspects in regards to English as a subject it is not surprising that students find mathematics more anxiety provoking.

SELF RATINGS OF AMOUNT OF ANXIETY EXPERIENCED BY STUDENTS IN SITUATIONS INVOLVING MATHEMATICS AND ENGLISH



(Brush, 1981)

The graph illustrates the ratings of pupil's anxiety in English and Mathematics from 6th to 12th grade of about 1500 students from three New England School systems. With a range of 12 to 60 (a high number represents greater anxiety), Brush was able to illustrate the 'interesting trend' evident in the graph. It appears that there are features of mathematics that students find increasingly anxiety provoking as they get older.

2.3.2 Measurability and Evaluation

Brush (1981) claims that one of the main reasons for increased anxiety in mathematics is the evaluation aspect. English is more evaluative in the early years when spelling tests, grammar exercises and comprehension tests play an important part. In later years English increasingly becomes a study of literature and there are many opportunities for students to express their own ideas. Mathematics on the other hand, becomes more and more tied to a lecture model of course presentation, with frequent graded assignments and regular tests.

Ability in mathematics is more measurable than ability in most other subjects and this often leads to mathematics anxiety because of a fear of exposure. Many students will not ask questions in class because of their fear of being found out. They feel that "everyone knows I do not understand this. The teacher knows. Friends know. I'd better not make it worse by asking a question" (Tobias, 1978, [1] p45). This type of reaction is particularly disabling because the fear of exposure keeps the pupil from constructive action. Questions in subjects such as English and History do not require such precise and measurable answers and pupils are encouraged to express different points of view.

2.2.3 Continuity

The continuity aspect of mathematics is also a factor which makes it unique. Most other subjects are relatively easy to grasp at any level. Learning about the 2nd World War in History does not need too much reference to earlier events. However, mathematics is constantly building upon itself and absence from school, a move to a new school, a misunderstood topic or a badly taught section of the work can all have a profound effect on a pupil's progression. Until the missing topic is learned there is a feeling of helplessness and uncertainty which inevitably leads to anxiety. This anxiety, although at first confined to a certin section of the work, often develops into a general anxiety whenever one is confronted with mathematics.

2.3.4 Avoidance

Related to the continuity aspect is the tendency to avoid mathematics. Dr Judith Jacobs (Personal Interview, 1982) refuses to accept the term mathematics anxiety and prefers to refer to the anxious type of student as mathematics avoiders. Mathematics anxiety may be viewed as a cause or an effect of mathematics avoidance. Negative and self-defeating feelings generated by mathematics anxiety could lead to mathematics avoidance while on the other hand, students who have not actively used mathematics for some time may find that the unfamiliarity, awkwardness and forgetfulness they experience could lead to mathematics anxiety.

Because they have avoided mathematics over long periods of time, those who are affected with mathematics anxiety typically exhibit below average ability. This lowered ability in turn compounds the anxiety associated with mathematics. A spiralling effect is created - anxiety results in avoidance - which results in reduced ability to perform mathematical operations - which generates increased anxiety and so on.

An important distinction to make is that mathematics avoiders are not necessarily mathematics anxious, but may have chosen to avoid mathematics because of such factors as ignorance of its importance in careers or the stereotyped view of mathematics as a male domain. The potential cause and effect relationships of mathematics anxiety and mathematics avoidance suggests some overlap in their origins which stems from social and cultural attitudinal variables.

2.3.5 Language and Notation

The language and notations used in mathematics is undoubtedly a cause for concern amongst many pupils. One could argue that the language of mathematics is unique in itself and the need to learn this new language before one can understand mathematics is a source of anxiety.

The following aspects relating to mathematics language and notation should be noted.

1. Mathematics is a complex language which is not easily related to the "real" world.
2. Mathematics language is not used as frequently as the home language of the individual.
3. Mathematics language uses fewer symbols and hence requires a certain expertise in the spatial relationship between symbols and their meaning.
4. Mathematics teachers often neglect teaching the language and notation or they do not realise that pupils find the language difficult.

Other factors could be mentioned here but this is not the main purpose of the study. As a result of the problems listed above the student is not familiar or confident with the language of mathematics and this can lead to anxiety.

2.3.6 Rote-Learning

Elementary mathematics may be presented as a series of routines which can be fairly easily memorised. However, the number of routines to be learnt eventually becomes overbearing and these routines are difficult to adapt to other problems based on the same mathematical ideas.

In addition, rote-learning enables the pupil to reach an answer without being able to interpret his methods and without understanding what is happening in mathematics. With this lack of inducement to interpret his actions a general attitude of cognitive passivity will develop. This attitude will perpetuate itself as failure to interpret methods will lead to increasing difficulties as mathematics progresses. The apparent success which rote-learning had provided during the early years is no longer evident and the pupil becomes increasingly anxious as his methods become less effective.

2.4 Educational Factors

Many aspects discussed under the previous three headings may be termed "educational". However, for the purpose of this study educational factors will be those relating more specifically to the school. The school has an obligation to society and to the individual to present mathematics in such a way that each individual can develop an understanding of and an enjoyment of the subject. When considering the sources of mathematics anxiety, educational factors within the school is the obvious place to start one's investigation.

Sources of anxiety may be traced directly to the teacher and his or her classroom strategies. However, there are many factors involved in education at school level which can influence the teacher's approach. The teaching of mathematics is influenced through the hierarchical structures of:-

(a) The education department

(b) The headmaster

(c) The head of the mathematics department within the school

(d) The teacher.

These structures need to be investigated if remediation is to be effective. However, it is the teacher who is seen as the main source of anxiety within this hierarchy. Kogelman and Warren (1980, p18) say that "traumatic experiences with teachers are frequently recalled. Long lasting negative effects seem to result from being called to the blackboard and feeling humiliated". These authors complain that mathematics is often seen as rigid and authoritarian because mathematics books are too formal and emphasis is on communication of a specific body of knowledge. They believe that individuality and invention are not encouraged.

Johnson (1981, p2) points out that "research shows that the attitude of the teacher is a prime determinant of the attitude of the child". She goes on to describe what is obviously a universal problem.

> "Research regarding the attitude of prospective elementary school teachers towards maths indicates that there exists a great many negative feelings towards the subject. It has been found that these negative feelings towards maths are a

> consequence of the primary school experiences of the prospective teachers. These teachers enter the academic programme for training to become a teacher with negative feelings towards maths and if no changes occur they will begin their career with negative attitudes towards a subject which they must effectively and positively present to elementary students in order to not continue to perpetuate these negative feelings through another generation of students" (Johnson, 1981, p3).

Dr Lynn Joffe (Personal Interview, 1984) echoes these sentiments when she says that "our study suggests that Primary School teachers are not very confident about their own performance in mathematics" and hence they are passing on negative views to their students. She also makes the point that secondary school teachers are often "mathematics graduates first and teachers second" and that they often find it extremely difficult to understand why children are having difficulties. If they haven't the patience or teaching skills they often create anxiety.

For this reason one of the main concerns of this study will be to outline methods which combat this emergence of inadequate mathematics teachers. Teachers who are suffering from mathematics anxiety themselves will pass this on to their pupils. Teachers who may not be anxious themselves may also cause anxiety in their pupils if they use faulty teaching methods and create a negative attitude towards mathematics. Obviously the teaching methods and content of the courses of prospective teachers for both primary and high school have to be carefully considered to effect a change in attitude. Unless prospective teachers are receiving some help with their anxieties it is unlikely that they will be able to help the future generations.

Discussions of classroom procedures and routines that can be used to prevent negative experiences and create more enjoyment with mathematics are essential. Learning how to alleviate the anxiety of their future pupils will help the student teachers eliminate the fear that he or she personally feels. Teaching to avoid mahematics anxiety should become a matter of concern for all those involved in education.

PART 3: OVERVIEW OF THE CHAPTER

Whilst considering socio-cultural, emotive, cognitive and educational sources of anxiety it should once again be emphasised that these four areas are closely interrelated. The sources of mathematics anxiety are both varied and complex and hence alleviation of the problem is no easy task. Experiments which have tended to show that mathematics anxiety can be reduced by short-term methods have not successfully revealed long-term success and enjoyment in mathematics. The purpose of categorising the sources of mathematics anxiety is to focus attention on the areas which must necessarily receive remediation. The very complexity of this problem suggests that the only approach to remediation must involve several factors and that the programme must include as many people as possible who can influence the course of the individual's mathematics progress.

Two aspects of causation are clear. Firstly, there is no single cause of mathematics anxiety and secondly, causes differ for each individual.

CHAPTER III

THE ASSESSMENT OF MATHEMATICS ANXIETY

CHAPTER III

THE ASSESSMENT OF MATHEMATICS ANXIETY

PART 1: INTRODUCTION

If treatment of mathematics anxiety is to be effective it is necessary to identify those people suffering from mathematics anxiety. Several scales have been developed to measure mathematics anxiety and most of these scales have evolved from general anxiety and test anxiety scales.

In many instances mathematics anxiety scales are associated with measures of mathematics performance and conclusions are reached according to the correllations revealed. In some cases researchers may use a battery of tests in their studies whereby certain links between mathematics anxiety and attitudes or personality traits may be investigated.

In this chapter some of the more popular mathematics anxiety scales will be discussed and the testing methods used in certain research projects will be investigated. Finally, ideas developed from research in England and the U.S.A. have been used to experiment with tests in a Durban primary school and a College of Education

PART 2: MEASUREMENTS OF MATHEMATICS ANXIETY

As mentioned earlier mathematics anxiety scales have evolved from general anxiety and test anxiety scales. Mathematics anxiety scales themselves have developed from fairly simple questionnaires to much more sophisticated instruments. The following provides a brief description of how mathematics anxiety scales developed.

2.1 The Three Number-anxiety Items from the Taylor Scale

The Taylor Scale is a manifest anxiety scale consisting of 46 items. One of the earliest mathematics specifications was developed by Dreger and Aiken (1957) who used three items from the Taylor scale which are related to mathematics. The three items asked the subject to respond to the questions:-

(a) whether or not arithmetic made him nervous

(b) whether or not he would "freeze up" whenever he saw a mathematics problem, and

(c) whether or not he was as good in mathematics as in other subjects.

This early development in mathematics anxiety scales was fairly brief but it did indicate a move from more general studies of anxiety to an investigation of a specific anxiety trait.

2.2 The National Longitudinal Study of Mathematics Abilities

Wilson and Begle (1972) describe two mathematical scales which were developed for use in the National Longitudinal Study of Mathematics Ability which was carried out in the United States of America. These scales are an example of how test anxiety measures were used to develop mathematics anxiety scales. More specifically, the Achievement Anxiety Test (AAT) developed by Alpert and Haber (1960) was modified. The AAT is said to measure "the facilitating and debilitating effects of anxiety on achievement performance." These tests were modified to relate more specifically to mathematics anxiety. The result was two scales; one which measures facilitating mathematics anxiety or the degree to which a students' mathematics achievemnt is facilitated by stressful conditions; and a second scale which measures debilitating anxiety or the degree to which students' mathematics achievement is harmed by stressful conditions. However, there is no information about reliability or validity data for any of these scales and they are not widely used.

2.3 Fennema and Sherman Scales

Fennema and Sherman (1976) have developed nine 12 item scales designed to measure a number of different attitudes and feelings about the learning of mathematics by female and male High School students. These scales assess the student's confidence in learning mathematics; the view of mathematics as a male domain; usefulness of mathematics; attitudes of mother, father and teachers towards the student's learning of mathematics; and several other factors. One of the scales measures mathematics anxiety. Students respond to a five point likert-type scale in order to indicate the extent to which they agree or disagree with 12 statements that express feeling anxious, tense, or at ease with mathematics problems and tests. Six items are scored positively and six negatively. Male and female norms based on two large High School samples are presented, and a split-half reliability co-efficient of 0,89 is reported for the scale. The battery of nine scales are highly respected and widely used in America and deserve close study by anyone interested in mathematics anxiety treatment or research.

However, Richardson and Woolfolk (Sarason, 1980, p273) point out that "no information is given concerning test-retest stability or validity of the scale, and it would be desirable to have more precise information than given about internal consistency reliability to ensure that each item of this very brief scale correlated substantially with total scores on the instrument".

2.4 Mathematics Anxiety Rating Scale (MARS)

Suinn (Richardson and Suinn, 1972, p551), constructed the MARS in order to "provide a measure of anxiety associated with the single area of the manipulation of numbers and the use of mathematical concepts". The MARS is undoubtedly the best known scale for measuring mathematics anxiety and it is frequently referred to in the literature on the subject.

Two forms of MARS have been used in research: A 98 item scale and a 94 item scale. The items include brief descriptions of ordinary life and academic situations involving the manipulations of numbers or solving of mathematical problems that may arouse anxiety. A total mathematics anxiety score is calculated by assigning a value of 1 to 5 corresponding to the level of anxiety checked (1 for "not at all" anxious to 5 for "very much" anxious), and then summing all the values.

A copy of MARS has been included in the Appendix because of its popularity amongst researchers in the U.S.A.(see appendix, p39). The main reason for its widespread use is the normative data which Richardson and Suinn (1972) and Suinn, Edie, Nicoletti and Spinelli (1972) have provided. Three studies have been conducted to collect normative data on the MARS. Richardson and Suinn (1972) reported that on the 98 item form, data on a sample of 397 students enrolled in a large state university in Missouri, had been collected. The mean score for this sample was 215,38 (possible high score of 490, low score 98), the standard deviation was 65,38; the test-retest reliability co-efficient was 0,85 and the internal reliability co-efficient was 0,97. A separate sample of 30 junior and senior students were administered the MARS and then the Differential Aptitude Test (DAT). The Pearson product-moment correlation co-efficient between subjects' scores was -0,64. Richardson and Suinn (1972, p551) contended that "since high anxiety interferes with performance and poor performance produces anxiety, this result provides evidence that the MARS does measure mathematics anxiety".

Suinn et al (1972) reported that normative data had been collected on a sample of 119 students enrolled in a large state university. The mean and standard deviations were 197,3 and 55,5 respectively, on the first testing and 179,9 and 55,9 respectively on the second testing. The test-retest reliability co-efficient was 0,78 after 2 weeks. Correlations between MARS and DAT were -0,35 and -0,32 indicating that "high anxiety as measured by MARS is associated with low performance on DAT tasks " (Suinn et al, 1972, p303). The mean score of students who sought therapy for mathematics anxiety was 256,9 indicating a high level of mathematics anxiety and providing evidence of the validity of MARS.

Richardson and Woolfolk (Sarason, 1980) recently performed a principle components factor analysis with a varimax rotation of the factors on the 397 students' MARS scores from the Richardson and Suinn (1972) study and also determined the item-total correlation for each MARS item. They found that "almost all MARS items correlate with total scores above 0,40 and that all the items describing evaluative academic and problem solving situations correlate more highly with total MARS scores than do items concerning everyday, non-evaluative number manipulations". (Sarason, 1980, p274).

Richardson and Woolfolk (Sarason, 1980) selected 40 MARS items with the highest item-total correlations (from 0,74 to 0,56). They claim that this 40 item scale is "presumably at least as reliable, stable and valid as the original MARS and is almost certainly dominated by a single homogeneous factor of anxiety concerning evaluative test taking and problem solving mathematics situations". (Sarason, 1980, p274). The normative data associated with the MARS test makes it a most reliable instrument to use in research and more detail will be discussed later. First let us briefly discuss some more diverse testing and the use of multidimensional scales.

PART 3: MULTIDIMENSIONAL SCALES

It is often found that researchers are interested in various attitudes to mathematics and in many cases most of these dimensions have some bearing on mathematics anxiety. When considering treatment procedures for mathematics anxiety it can be valuable to know if mathematics is regarded as useful and enjoyable, as well as if one is confident dealing with mathematics and motivated to become involved in mathematics. The question of stereotyping of mathematics as a male domain is also one which needs clarification.

The Fennema and Sherman scales offer this type of multidimensional measurement. However, Visser (1983, p8) contends that existing scales for measuring attitudes to mathematics "are either unidimensional and thus fail to measure complex aspects of attitudes to mathematics, or they consist of several scales, some of which are highly correlated and therefore measure essentially the same attitude".

She developed two original semantic differential scales and four Likert-scales adapted from existing scales. One of the dimensions in the Likert-scales was labelled the "confidence scale" and included items measuring "anxiety when confronted with mathematics".

It was found that the semantic differential is more suited for measuring general attitudes to mathematics while Likert-type scales may "easily be constructed for measuring more specific attitudes to mathematics" (Visser, 1983, p8). The four Likert-scales she developed measuring confidence, motivation, male domain and usefulness proved to be "relatively independent". However, confidence, motivation and anxiety do seem to be related and it appears to be difficult to separate these three aspects on a Likert-type scale.
Whilst multidimensional type studies on mathematics attitudes can be interesting, the aspects which one could consider are unlimited and could lead to a rather complicated study. There is, however, no doubt that attitude to various aspects regarding mathematics will have a profound influence on anxiety when dealing with mathematics.

3.1 National Foundation for Educational Research (NFER) Questionnaires

The NFER have undertaken a continuous study of mathematics on behalf of the Assessment of Performance Unit (APU) of the Department of Education and Science (England, Wales and Northern Ireland). Since 1978, four attitude questionnaires have been administered to 11 and 15 year olds in England, Wales and Northern Ireland. The questionnaires are designed to measure various dimensions of attitude (see Appendix, p47) but the authors point out that "since mathematical concepts are highly interrelated, the boundaries between sub-categories are not seen as impermeable for reporting purposes".

It will be noted that although anxiety was not a specific section of the questionnaire the inferences permeate throughout the four sections. Part A is composed of statements expressing feelings about how useful, enjoyable and difficult mathematics is, as a school subject. Pupils are asked to rate the degree to which they agree with each statement. Part B is designed to indicate opinions about particular aspects of the mathematics curriculum when just a topic name is given. Pupils are asked to use seperate three-point scales to rate how useful and difficult they find the given topics. Part C attempts to ellicit more specific information about how pupils view a particular topic, having just completed a representative item. Pupils are asked to work through examples drawn from the APU written test bank. After each one, they are asked to say how difficult they found that item and how useful they consider it might be, both now and in the future. Finally, Part D was designed to gain information about how pupils see mathematics in relation to other school subjcts; whether pupils regard the mathematical performance of girls and boys respectively as similar or different; and other issues that pupils regard as relevant to their views of mathematics.

These questionnaires are unique in that they include various scales (from Likert-type scales to open-ended questions) and divide some of the questions according to a particular mathematics topic. The implications are that certain sections of the mathematics curriculum are more anxiety provoking than others. This type of questionnaire can be most elucidating as it not only provides information on attitudes towards mathematics but also provides information on topics which cause difficulty and anxiety.

It is important not to isolate anxiety and attitudes from what is essentially the crux of the problem, i.e. being able to perform well at mathematics and enjoy the subject. For this reason it is essential that any remedial programme includes some investigation into the topics or section of the curriculum that are causing problems and may add to anxiety.

3.2 Brunel University, Department of Education

Researchers Dr R Rees, G Barr and J Curnyn, at Brunel University in England have made a study of "the nature and development of mathematical ability from late primary to early secondary". Their findings on mathematics performance suggest that one needs to take a much closer look at performance testing. This team headed by Professor Furneaux have developed their investigations based on

Spearman's theory of intelligence. They are particularly interested in investigating what they have described as two distinct types of mathematical ability, viz. general intellectual ability (g) and a capacity for "mathematical inference". Their defining characteristic of "mathematical inference" is its apparent independence of g. More will be said about this interesting development at a later stage. For the purpose of testing it was interesting to note that mathematics anxiety again played an integral part in this study. A comprehensive battery of tests was used and included the following:

(a) Mathematics Test - Primary and Secondary (see Appendix, p18)
(b) AHI (From NFER) - measures "g" (aptitude test)
(c) Eysenck Personality Questionnaire (EPQ)
(d) Children's Manifest Anxiety Scale (CMAS) (see Appendix, p29)
(e) Test Anxiety Questionnaire (see Appendix, p30)
(f) Semantic differential measures of attitudes towards school and mathematics (see Appendix, p27).

In both the NFER and the Brunel testing a much more individualistic approach to assessment was evident. Problems invoking emotive issues were discussed on an individual basis and the cognitive approaches to problem solving were carefully assessed by listening to pupils describe their path to the solution.

PART 4: ASSESSMENT BY INTERVIEW

The mathematics anxiety tests described earlier are obviously convenient measures when dealing with large numbers of students. However, one should always consider the possibility of assessing students individually. In schools, mathematics teachers should work closely with the school counsellor and in teacher training colleges tutors who exercise a pastoral care should be able to assess if mathematics anxiety exists.

4.1 Emotive Assessment

Buxton (1981, p22) chooses to investigate the emotions of a selected few adults for his book "Do you panic about mathematics?". He is critical of researchers in the United States of America who emphasise the statistical approach and points out that Krutetski of the Soviet Union has been more concerned with the individual. He says that it "is amusing that a society that claims to emphasise the individual should resort to heavy statistical work while one that extols the collective examines individuals". In the case of mathematics anxiety the treatment methods should involve some classroom group remediation as well as individual attention when considered necessary. General assessment at group level by using written tests can indicate a general need for remediation. However, much important information can be found from the individual on a person to person basis. In this way anxiety problems as well as problem solving strategies can be more easily recognised. It is essential that a mathematics educator as well as a psychologist work in conjunction for individual assessments because not only will emotions be exposed but also faulty beliefs and methods concerning mathematics. By interviewing his subjects Buxton (1981) was able to not only categorise them as evidently mathematics anxious, but also identify the most important sources of their anxiety.

Kogelman and Warren (1978, p18) adopt a similar approach in their course "Mind over Math" and they describe some of the responses of their clients which reveal the sources of anxieties.

"Gloria: I remember my seventh grade teacher. She didn't care. She couldn't be bothered with me because I was too slow".

"Mary: Math was fun in the beginning of school. In the fourth grade the teacher announced to the class that she hated math and was going to have a special teacher come in to teach it".

These two examples are indicative of the type of fears that can develop and the source of these fears. The value of the interview situation is the fact that the client can reveal the problem and it's source in a very explicit manner. This allows for precise planning of remedial action. It is also obviously a much more individual approach to the problem.

4.2 Performance Assessment

In the interview situation the mathematics instructor will also be able to ask questions of a more specific nature pertaining to the contents of mathematics. Topics which have caused blockages or are so poorly understood that they are causing future progress to be slow, can be revealed in the interview. The method of doing problems will often reveal whether or not the student has truly understood the topic or just learnt a how-to-do method.

Rees and Barr (1984, p188) say that "finding out what went on in a learner's mind is crucial to effective diagnosis". At Brunel University they decided to record students' "routes to solution" in two ways. The "interview-free" situation allows the student to talk through a solution without interference whilst in the interview situation there is dialogue between interviewer and student. For research purposes the first method allows for effective initial diagnosis. When there is a need to probe further the interview situation is used.

Rees and Barr (1984, p152) suggest that the only way to really know what a child is thinking is to ask them to think aloud and listen to their routes to the solution. This approach could be useful in indicating if the child is simply using rote-learning methods which are often a source of anxiety. An example of a 9 year old child doing a question on equivalent fractions is given.

Task : What numbers must go in the box to make the following true? $\frac{2}{\square} = \frac{1}{3}$

Student : 2 is double one -----so six is double 3.

Task : What number must go in the box to make the following true? $\frac{\square}{8} = \frac{3}{12}$

Student : Well it goes into ----- that ---- well ----(Coughs) sorry ---- you times that by ---- you've added 4 so that ---- oh ---- hold it I'm stuck ---- ah (laughs) right so ---- that ---- you've added 4, 'cause eight goes ---- four and eight ---- I mean four goes into eight and twelve so ---- so ---- so ---- it goes ---- mmmmmmmm ---- so four goes three times into that ---- ooooh!

Instructor : Your'e doing well. Keep trying.

Student : So it goes two into eight so I think it will be two.

This type of interview situation is invaluable for assessing what may cause anxieties. The first example can easily be completed using several rote-learned methods. The one used by the student is probably the method that is most common. However, the second example requires a clear understanding of equivalent fractions and ratios. The "thinking aloud" of the student appears to be rather jumbled but is in fact the type of thinking that he might be involved in more frequently once he reached High School. The laughs are often an indication of anxiety and for many students would mean giving up. In this example the interviewer listens carefully and is able to encourage the pupil to continue. Although it is not practical to deal with each child's problems individually the teacher can gain invaluable insight into methods that children use which are often not thought of by the teacher and which may be related to the pupil's anxiety. Faulty learning methods as well as a lack of understanding of what the pupils find difficult are ingredients for developing anxiety. The interview situation reveals these problems and gives the teacher a greater insight into the requirements and anxieties of his pupils.

In similar interviews with trainee teachers, Rees and Barr (1984, p194) were also able to reveal anxieties about mathematics.

The following comments were recorded:

"I have never been able to do mathematics".

"I like mathematics but cannot do it".

"I now tolerate mathematics but hated it at school".

"I have done quite a lot of mathematics at college but I am scared of teaching numbers to young children".

The National Foundation for Educational Research were also able to include individual assessment in their surveys. A number of the students who completed the attitude questionnaire were also given a practical test which was administered individually by an instructor. This tester then was asked to assess the student on different scales i.e. Attitude to topic, Confidence mode of response, Willingness to handle apparatus,, Verbal expression. However, the data gathered for this survey was dealt with statistically to reveal the percentages of, for instance, confidence on a 5 point scale from assured to anxious about success. Here one must agree with Buxton and Skemp that this type of analysis seems, futile. It would be far better to assess each individual and so form a diagnostic chart of his or her particular responses.

For practical purposes the interview situation is obviously too time-consuming to be used for all students. However, it is important to remember that the remedy to mathematics anxiety is complex and will involve not only a reaction to the emotive problems but also a reaction to faulty cognitive processes and attention to educational techniques of classroom organisation and teaching methods. Thus information gained in an interview situation will benefit the teacher when he or she considers remediation.

PART 5: LOCAL TESTS

In order to emulate the research done by the NFER and the Brunel University team this study would need to be very extensive and beyond the capabilities of one person. The purpose of this study is to investigate mathematics anxiety and to suggest remediation. Measuring levels of anxiety and relating these to performance levels forms an important part of this study.

The mathematics anxiety rating scale (MARS) which was developed by Richardson and Suinn is highly respected and widely used in the U.S.A. The reasons for this are, firstly, the fact that the normative data is most impressive and, secondly, that the MARS test is a sophisticated development of earlier attempts to measure test and/or maths anxiety. These facts have been presented earlier in this chapter.

It was also mentioned earlier in this chapter that Richardson and Woolfolk (1984) claim that their modified version of MARS is reliable, stable and valid. It was therefore decided to begin with these 40 items which they found to have the highest item/total correlations. These items were carefully studied and 22 were selected to form a primary school test (see Appendix, p9), whilst 30 were selected for a student teachers' test (see Appendix, p1). The items which were discarded were those not related to the age group being tested or not particularly relevant to the South African situation. In addition, certain wording had to be adapted to suit the age group concerned. It was also decided not to use a very lengthy test for the primary school pupils because of their limited attention span and the fact that they might lose interest.

Hence, two tests were designed to be administered to

(a) primary school pupils, and

(b) College of Education students.

The fact that these tests were modified limits the strength of the conclusions that can be drawn. Nevertheless, the purpose of administering these tests was to indicate general trends in research procedure rather than to reach any specific conclusions.

5.1 Research Concerning Standard 5 Pupils

A. Intention of this Study

1. To gain information on the suitability of administering a maths anxiety questionnaire to primary school pupils.
2. To investigate the mathematics performance of the pupils in Standard 5.
3. To investigate the childrens' perception of the degree of difficulty of various mathematics topics.
4. To investigate teachers' perception of the degree of difficulty of various mathematics topics.
5. To investigate whether or not there would be a significant negative correlation between scores on the mathematics test and scores on the mathematics anxiety rating scale.

This study is by no means comprehensive and conclusive and no special recommendations can be made. However, the results and research material should be of interest to people intending to investigate mathematics anxiety and/or mathematics performance. The survey used for this report is merely to emphasise some of the important factors, related to mathematics anxiety, which have already been considered by overseas researchers. A description of the testing procedure is outlined below.

B. The Tests

1. A mathematics anxiety rating scale was constructed for this survey (see Appendix, p9). This scale consisted of 22 items relating to mathematical incidents and was adapted from the MARS test according to the criteria described earlier in this section.
2. A primary mathematics test was constructed and consisted of 25 questions (see Appendix p6). These questions were designed to include "g type" and "inferential type" of problems which were described by the Brunel researchers. The intention here was to differentiate between a general intelligence and the more mathematically inferred ability described earlier by the Brunel researchers.
3. A Rating Scale (on a five point system ranging from very easy to very difficult) was attached to the Primary Mathematics Test (see Appendix p9). Pupils could indicate the perceived degree of difficulty of each of the 25 questions they had just answered.

C. The Sample

56 girls and 53 boys in Standard 5 at a Durban Primary School. The pupils had been streamed in an A, B, C and D class and the mathematics teachers of these classes assisted in the experiment.

All 109 of the pupils completed the Primary Mathematics Test and the Degree of Difficulty Scale. However, 9 of the Mathematics Anxiety Scales were spoilt and not used in the results.

D. The Method

1. The 4 mathematics teachers of the classes at this primary school were asked to complete the "degree of difficulty" rating scale to indicate how their pupils would cope with the questions.
2. The teachers then asked their pupils to complete the mathematics anxiety rating scale. No time limit was set.
3. The pupils were then required to complete the Primary Mathematics Test. No time limit was set.
4. Finally the pupils were asked to assess the degree of difficulty of each of the questions they had just completed.

E. The Results

1. It was clear from the mathematics anxiety scale that many of the pupils were highly anxious about certain situations.
   The following items were rated most anxiety provoking by the pupils:-
   1. Waiting to get a mathematics test returned in which you expected to do badly.
   2. Thinking about a mathematics test one hour before writing.
   3. Writing a mathematics test.
   4. Thinking about a mathematics test one day before.
   5. Studying for a mathematics test.

   The least anxiety provoking situations were as follows:-
   1. Watching a teacher doing mathematics on the board.

2. Playing cards where numbers are involved.
3. Sitting in your mathematics class.
4. Checking your change after buying several items at a shop.
5. Watching someone work with a calculator.

These results indicate that anxiety at this early age is probably strongly test-related. Active classroom issues (i.e. answering questions or explaining a problem) were next in line whilst passive classroom issues (i.e. sitting in class, watching a teacher do mathematics) and every-day life events revealed little anxiety.

After discussion of these issues with the students it was evident that many of the items normally included on the MARS questionnaire are not suitable for pupils of 11 and 12 years of age. Some of the reasons for this are:

(a) Calculators and computors are not a necessity or a threat at this early age. They are not expected to be competent with these instruments at this time in their life.

(b) Shopping problems are not of great consequence because they do not do the shopping and are hardly ever involved in purchasing many articles at a time.

(c) Calculating G.S.T. is not anxiety provoking because they do not buy expensive articles and when spending money on a 30 cent sweet approximate value of G.S.T. is all that is necessary.

(d) Adults who are not confident of their arithmetical ability feel more threatened in public situations (such as shops) where their mathematical inadequacies may be detected.

2. From a possible high score (on the mathematics anxiety scale)

of 110 and low score of 22 (22 items rated 1 to 5) the mean score was 49 and the Standard Deviation 15,9. The correlation between mathematics anxiety and performance on the Primary Mathematics Test was -0,39. (level of significance 0,05%). The results are similar to the normative data published by Suinn et al (1972). On a sample of 119 state University students the mean was 187,3 and the Standard Deviation 55,5. (Using the 98 item MARS with possible high score of 490 and low of 98) whilst the correlation between MARS and Performance was recorded as -0,35.

However, contrary to the findings of researchers with university students this primary school survey revealed a similar level of anxiety pattern amongst girls and boys:

48 boys Mean 48 Standard Deviation 12,1) level of significance
52 girls Mean 50 Stnadard Deviation 11,1) 0,05%

The Pearson Product Moment Correlations between anxiety ratings and Performance on the Primary Test were -0,32 for girls and -0,49 for boys. It would appear that in this group the boys' anxiety affected their performance more than girls. However, in both groups a significant negative correlation was found between anxiety and performance.

3. The primary mathematics test revealed some interesting facts which support the work done by the Brunel University team in England. Questions 8 and 11 appear to be the same and yet proved to distinguish between those who have learnt rules and those who understand decimals fully. Question 8 was 0,4 x 0,4 and this yielded 41% success rate. Question 11 was 0,3 x 0,3

and the success rate here was only 3%.

Another interesting factor which was revealed by these questions was the fact that 40% of the pupils who rated question 8 easy or very easy got it wrong. Whilst 77% of the pupils who rated question 11 easy or very easy got it wrong. In addition, of the 4 teachers asked to complete the degree of difficulty scale, one teacher rated both question 8 and 11 very easy whilst two teachers rated them as easy .

Similar results were revealed by other questions such as $\frac{2}{\square} = \frac{1}{3}$ (79% correct) and $\frac{\square}{8} = \frac{3}{12}$ (45% correct).
The idea of ratios has to be understood to do the second question whilst the first one could be arrived at by doubling 3 or by knowing equivalent fractions.

Adding decimals is not necessarily understood by pupils who can add 298,78 72,36 and 13,89 (77% correct). Question 17 requires adding decimals with a different number of digits after the comma, 16,36 1,9 and 243,075. This question yielded only a 59% success rate, whilst all 4 teachers regarded it as either easy or very easy and 33% of the pupils who regarded it as easy or very easy got it wrong.
The questions which were related to problems which may be encountered in everyday life revealed interesting results. Questions 4, 16, 20 and 22 were particularly badly done and this appears to indicate that the link between classroom

mathematics and everyday use or its practical application is often lost.

Discussion

A full set of the results of this survey together with copies of the survey material are provided in the appendix. After studying these results the following answers are given to the questions posed at the beginning of this research.

1. The mathematics anxiety questionnaire could possibly be adapted to suit primary school children. The results indicate that items relating more to test situations are the most anxiety provoking at this age.
2. The "inferential-type" of question does identify those pupils who do not fully understand a topic.
3. The pupils have difficulty assessing the degree of difficulty of an "inferential-type" of question.
4. The teachers have difficulty assessing the degree of difficulty of an "inferential-type" of question.
5. The results reveal a negative correlation between mathematics anxiety rating scores and mathematics performance of the primary test.

Other intersting findings were as follows:

1. Marks obtained on the primary mathematics test differed considerably from those that the pupils had recently received in an end-of-tem test (see Appendix, p13). This suggests that the added element of "inferential-type" questions is a distinguishing feature when mathematics performance is assessed at this level of schooling.

2. Pupils show signs of anxiety at an early age and this anxiety has a negative effect on their performance.

In closing the discussion it should be mentioned that these findings may not be taken as conclusive evidence nor should they be generalised. However, three observations may be made:-

1. The tests reveal similar findings to research projects in England and America.
2. Manthematics anxiety measures can be adapted to suit younger pupils.
3. Mathematics performance testing needs to probe the more "inferential-type" of thinking involved in mathematics.

The ideas incorporated in this small survey may serve as a stimulus for a larger more longitudinal type of study which would be of more use to long term remediation of mathematics anxiety.

5.2 College of Education Survey

Mr Mike Keeley (Personal Interview 1985), acting Head of the Mathematics Department of Edgewood College is concerned about the general standard of mathematics of all students and recognises the fact that many of the teachers who will be teaching primary school children their first mathematics lessons are in fact uncertain of their own mathematical ability. With the grateful help of the Edgewood staff, a small survey was carried out involving all first year students. As all first year students are required to do some mathematics, a short questionnaire was submitted to them. These first year trainee teachers consisted of two main groups:

1. Those specialising in mathematics.

2. Those doing a general course in mathematics.

The special course in mathematics is by far the more advanced and is aimed at training teachers who may eventually teach mathematics to Phase 3 in a High School (i.e. to Standard 7). The general course is taken over three years allowing students to gain some general mathematics background before specialising in subjects of their choice in their final year. These students would probably teach some mathematics in the primary school. It is worth noting that students who had obtained the best matriculation mathematics results were not necessarily those enrolled in the special major mathematics course.

The aims of the Survey

1. To construct and use a mathematics anxiety scale which may provide a basis from which to develop a maths anxiety scale suitable for college students in South Africa.
2. To discover the level of mathematics anxiety amongst first year trainee teachers at a College of Education.
3. To investigate the level of personal school mathematics achievement amongst trainee teachers at a College of Eduacation.
4. To investigate the highest level to which each student is confident to teach.

The Questionnaire

This was designed to indicate firstly some general information about each student and secondly to measure their degree of mathematics anxiety (see Appendix p1). The students were not required to provide their names but there were five questions in the first section requiring some details of mathematics achievement and other personal details. The second section consisted of 30 items on a mathematics anxiety rating scale. Once again the full MARS test was considered to be too long and items which were considered relevant to this population were chosen (see earlier explanation).

The Sample

The questionnaire was administered to 148 first year students at Edgewood College of Education. Details of these 148 students are given below:

31 Males
117 Females
33 Special Major Course (17 Males, 16 Females)
115 General Course (14 Males, 101 Females)

16 Did not take mathematics to Standard 10.
91 obtained a standard grade mathematics pass.
41 obtained a higher grade mathematics pass.

The Results

1. The first part of the questionnaire revealed that 37 students felt competent to teach only to Standard 4 whilst 111 students felt competent to teach to a level higher than Standard 4. So 75% of the students regard themselves as being competent to teach to Standard 5 and higher.
   A complete breakdown of this data reveals the following:

Highest Standard that student felt confident to teach	No. of Students
None	5
1	11
2	3
3	7
4	11
5	39
6	7
7	31
8	22
9	3
10	9

Considering the mathematics results of many of these students it is rather surprising that so many students feel confident enough to teach to high school pupils. There was no relationship between this perceived level of confidence and the students matriculation mathematics results. In fact some students who had not done well at school felt they could teach a higher level than many who had done well at school.

2. With the confidence indicated in the first set of data, one would expect the mathematics anxiety levels to be relatively low. However, contrary to this, the anxiety levels were high. The 30 item test yielded a mean of 70,66 and a standard deviation of 17,64. (Possible high score 150 and low score 30). These figures appear to reveal a higher level of mathematics anxiety

than that reported by Suinn et al (1972) on the 98 item MARS Test i.e. 187,3 mean and 55,5 standard deviation. (Possible high score 490 and low score 98).

3. The five items which were most anxiety provoking were found to be in this order:-
   (a) Waiting to get the results of a mathematics test in which you expected to do badly.
   (b) Receiving your final mathematics results in the post.
   (c) Studying for a mathematics examination.
   (d) Not having the formula needed to solve a particular problem.
   (e) Being called upon unexpectedly to recite in a mathematics class.

   The five items which measured the least anxiety were found to be in this order:
   (a) Entering a mathematics class.
   (b) Listening to a lecture in a mathematics class.
   (c) Working with a calculator.
   (d) Watching a lecturer do mathematics on the board.
   (e) Discussing a mathematics problem with someone in your class who does well at mathematics.

   Once again the test situation is evident as a high anxiety provoking factor. However, for these students it appears that the results of the testing and the studying for the test cause more anxiety than the test itself. Although the classroom situation and the lecturer are not rated high anxiety provoking items, it is obvious that the judgement of the lecturer or fellow students is a crucial factor influencing anxiety.

4. Using the student's past matriculation mathematics result as

a guide to the level of mathematics competence, the following analysis of anxiety scores was obtained:

	No. of Students	Mean Anxiety Score	Standard Deviation
Students who had not taken mathematics to Standard 10	16	91,75	17,88
Students with a standard grade mathematics pass of D symbol or below	44	73,25	14,5
Students with a standard grade mathematics pass of C symbol or above	46	69,06	15,31
Students with a higher grade mathematics pass of D symbol or below	30	65,53	13,9
Students with a higher grade mathematics pass of C symbol or higher	12	49,25	10,05

The pattern of results here is much as would be expected and although a true statistical test of correlation cannot be performed, these results indicate that the level of anxiety is higher for those students whose mathematics perfomance is poorer.

Discussion

1. The reason that perceived teaching competence level does not relate to the mathematics anxiety rating could be because students tended to write down the level they were intending to teach rather than what they truly felt competent to teach. It should be noted here that many of the students who were enrolled for the special major course of mathematics were not the top mathematics matriculants in the first year group.
2. The level of mathematics anxiety does appear to relate to past mathematics achievement with the non-matriculant mathematics students proving to be the most anxious and the top mathematics matriculants showing least anxiety. This would seem to confirm that the anxiety questionnaire did indeed measure anxiety although more data would need to be gathered to confirm this.
3. The points raised at the beginning of this small survey may be answered as follows:
   (a) Mathematics anxiety scales can be constructed by adopting the MARS items to suit students at a South African College of Education.
   (b) The level of mathematics anxiety of first year trainee teachers at Edgewood College of Education is generally very high.
   (c) The present level of mathematics anxiety appears to be negatively correlated with past mathematics achievements,

(i.e. higher anxiety levels correlated with lower mathematical achievement).

(d) The level of perceived teaching competence is related more to the course selection (i.e. Junior Primary, Senior Primary, Specialising) than to any anxiety rating or mathematics achievement.

4. Once again one must be warned against generalising from these results. The intention of this survey was not to obtain any type of concrete evidence but more to illustrate general trends in mathematics anxiety measurement and to use these ideas in the South African situation. This type of testing could form the basis of a more comprehensive study which could indicate long-term requirements in a solution to mathematics anxiety. A full set of results of this study can be found in the appendix.

PART 6: OVERVIEW OF THE CHAPTER

Mathematics anxiety scales have evolved from general and test anxiety scales and are now sophisticated instruments with normative data provided. In addition, individual interviews and listening to pupils methods has become an important part of pupil asessment. It is difficult to recommend one particular approach as this would depend on the requirements of the researchers. In the U.S.A. mathematics anxiety has received considerable attention and is a topic which is studied in its own right. The trend in England, Canada and South Africa is to concentrate more on several aspects of attitude and performance and to administer a battery of tests or multidimensional attitude scales.

For large groups in school or college it is often necessary to assess a large number of students and for this reason a suitable mathematics anxiety rating scale is important. On the evidence presented in the literature it appears clear that the MARS test, or a modified version of MARS would best satisfy this requirement. Modification of this test is necessary because the test is rather lengthy and was mainly developed for tertiary institutions. Some items are not relevant to school children and others cannot be related to the South African situation.

For smaller groups and in instances where pupils have been identified as particularly highly anxious, individual assessment is always more beneficial. Individual assessment will not only serve to gain some insight into the sources of the problem but also provide information on what remedial processes would best assist that particular pupil.

CHAPTER IV

THE TREATMENT OF MATHEMATICS ANXIETY

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PART 1: INTRODUCTION

Dr Lynne Joffe (Personal Interview 1984) says that "with any study of mathematics one should always consider mathematics anxiety because it is a very emotive type of subject and the most common reaction that you get when asking questions about mathematics - to the exclusion of all other subjects - is that they panic about mathematics". With this type of approach by researchers it is not surprising that the literature on mathematics anxiety has escalated over the last decade. However, Duchesneau (1980, p28) makes the observation that mathematics anxiety is like the weather in that, "everybody talks about it but no one does anything about it".

The two observations quoted above highlight some of the important aspects of this study of treatment methods. Three issues need to be clarified at the outset of this chapter. These are:-

(a) The complex nature of mathematics anxiety means that almost any aspect pertaining to mathematics can involve some form of mathematics anxiety. A discussion of all these aspects is not possible. Hence, only those factors which recur throughout the literature and which are considered central to mathematics anxiety, will be discussed in this chapter on treatment.

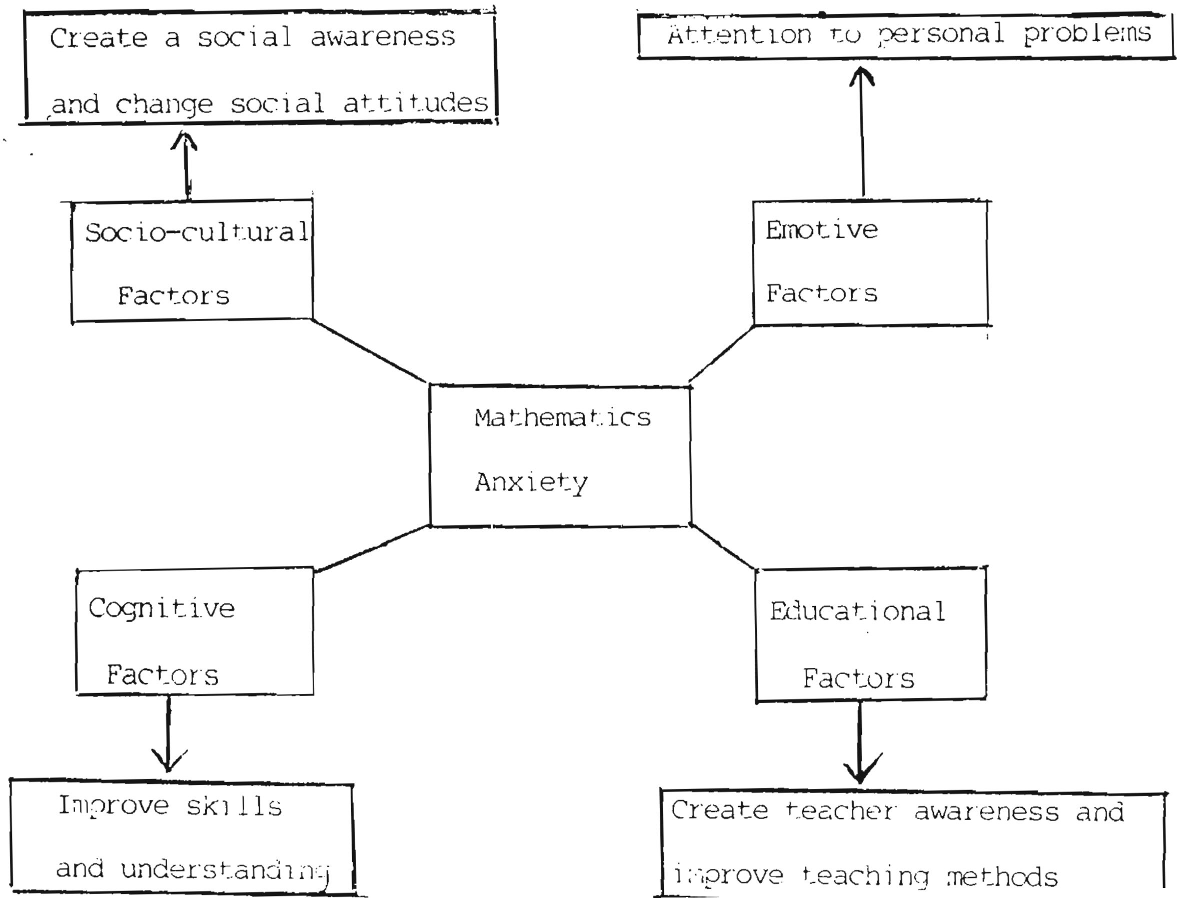
(b) Many aspects of mathematics anxiety have been studied but projects involving treatment have not received the attention they deserve. Hence, many of the ideas that have been suggested for remediation have not been tested adequately.

(c) The treatment of mathematics anxiety must be multifaceted and should be aimed at long-term improvement in mathematics attitudes and performance.

In chapter 2 the sources of mathematics anxiety were identified and categorised in terms of:-

socio-cultural factors
emotive factors
cognitive factors, and
educational factors.

However, it must once again be stressed that these four areas are closely related and whilst treatment methods will be divided into these few categories, some overlap is unavoidable. The categorisation of treatment methods is merely to provide a more organised and coherent approach to the problem of mathematics anxiety. Planned below is a diagnostic idea of how mathematics anxiety may be approached through these four closely interrelated areas:



The diagram provides a brief description of how treatment methods will be planned in this chapter. In each of the four categories, background research and ideas will be discussed before treatment strategies are suggested. However, in many instances the background provided in each section is a treatment ingredient in that the reader will be made aware of the problems involved in the manifestation of mathematics anxiety creating an awareness of the problem is an important aspect of an overall treatment strategy.

PART 2: SOCIO-CULTURAL FACTORS

Sheila Tobias (1976) points out that there is a school of thought that holds that remediation of mathematics anxiety should seek to focus not so much on curing the individual but on rectifying the conditions which foster these feelings. Many of these conditons are evident in socio-cultural attitudes towards mathematics and any remediation programme seeking long-term improvement in mathematics performance and attitudes must necessarily involve some methods of creating a greater social awareness of the problem of mathematics anxiety. In this section socio-cultural factors which influence mathematics anxiety will be discussed and remediation will involve a description of methods aimed at changing social attitudes which have a restrictive influence on mathematics progress.

2.1 Background

In dealing with social attitudes one is faced with a difficult situation of two seemingly contradictory factors.

1. The importance of mathematics and the need for a good mathematics schooling is essential for later university choices and career choices.
2. Mathematics anxiety needs to be alleviated by changing attitudes of society and encouraging parents not to create stress and pass on their anxieties to their children.

It is important that in creating a social awareness of the problem of mathematics anxiety, one does not create further anxiety by overemphasising the importance of doing well at mathematics. Both aspects are important and it is essential that at the outset, parents are aware that although encouragement in mathematics progress is important it should be provided in a way that does not increase the child's anxiety.

Parents and other significant adults in a child's life often relate past experiences and bad encounters with mathematics. Poor performance in mathematics is often rationalised by describing success in other fields or claiming that mathematics ability is "a gift of only a selected few". These are the type of social attitudes which can only be detrimental to a child's progress.

Two projects, one in England and one in Canada, provide some information on how remediation may be aimed at informing the public, creating a social awareness and changing social attitudes.

2.1.1 Maths with meaning

Dr Ruth Rees of Brunel university (Personal Interview 1984) conducted a radio programme of the B.B.C. entitled "Maths with Meaning". In this series she addresses the student, the teacher and parents in an attempt to inform them of the problems connected to mathematics progress and the need to develop a sense of responsibility amongst the public.

Dr Rees says that "the challenge is with us the teachers to teach mathematics with meaning, to teach our pupils in such a way that their feelings will progress continuously into the further stages of education, training and life". She thus stresses the importance of developing feelings or attitudes which will continue through to parenthood. The support that teachers need from society is ultimately created by themselves and their teaching.

Dr Rees goes on to say that "what we need is a lot of people who enjoy mathematics at a fairly elementary level and are not frightened of it, and have confidence in their ability to adapt this knowledge to new requirements as the world moves on". Thus the main thrust of the programme was to inform the public of the need for healthy attitudes towards mathematics and to create a sense of responsibility amongst the public which will enable mathematics to progress in a non-anxiety provoking atmosphere.

2.1.2 Mathematics: The invisible filter

The Toronto Board of Education has made a concerted effort to rectify the problem of social misinformation by publishing a booklet and pamphlets which are distributed to parents through the schools.

This interraction project has concentrated on informing teachers, students and parents about the problems surrounding mathematics avoidance and anxiety. The approach has been through information brochures provided in a folder (The Invisible Filter Kit). Unfortunately these are made available to schools and tertiary institutions at a cost and therefore it is only presumed that all institutions would actively participate in the campaign. The folder consists of:

1 The Invisible Filter Booklet

This book is a 50 page report on all aspects of the problems related to mathematics avoidance and anxiety. The main emphasis is on women in mathematics and sex-related differences. The booklet includes a statistical report on mathematics participation in school in Toronto followed by recommendations on how this can be improved. A second section reviews research pertaining to sex-related differences in mathematics participation and achievement. These findings are reported later under the heading of "Emotive factors".

On preventing mathematics anxiety and mathematics avoidance the essential recommendations made in the booklet are:

(a) Build confidence in a supportive environment

(b) Emphasise problem solving

(c) Develop awareness of the usefuleness of mathematics in careers and real-life situations

(d) Discourage the attitude that mathematics is a male domain

It is suggested that in-service training be given to teachers, that films or video tapes be produced to illustrate the problems and that grades 6 to 8 (Standards 4 to 6) become the target grades for interventions. The intervention procedures are seen as a combined effort between mathematics teachers and guidance counsellors, whilst parental support is emphasised and seen as an essential ingredient in alleviating anxiety and encouraging progress.

The final section of this booklet deals with the implication of mathematics avoidance with specific attention to career choice.

2. Pamphlets for Distribution

The second half of the Invisible Filter Kit consists of 5 pamphlets for distribution to teachers, students and parents. The information in the pamphlets is basically the same as that in the booklet but it is presented in a more attractive and eye-catching format (see Appendix p37 and 38). The pamphlets are:

(a) Mathematics: A key to the future - a diagramatic presentation of career opportunities.

(b) Mathematics and the teacher - hints to teachers based on four main concerns, viz. encouraging girls to take mathematics; provide parents with information concerning the necessity of mathematics; provide role models; teach creatively.

(c) Your Child and Mathematics - aimed at the parents this pamphlet summarizes the important issues discussed in the main booklet.

(d) Mathematics: Who needs it ?- an extremely eye-catching, comic and graphic presentation of the issues students must contemplate before disregarding mathematics as a course.

(e) Survive and Succeed in Mathematics - another interesting and attractive layout which enables the student to see illustrations of how people feel about mathematics and how they should try to react.

These brochures are obviously aimed at educating the prospective student and his or her parents as well as being a source of guidance to the teacher. Many of these ideas will be used in this chapter on treatment methods.

2.2 Treatment

To change social attitudes one needs to create an awareness of the problems relating to mathematics anxiety. Teachers and pupils need the support of parents in their attempt to remedy the problem. This awareness and support will serve to alleviate the immediate anxieties and ensure that future generations are more informed about the consequences of mathematics anxiety.

2.2.1 The media

In England, Canada and the Unites States of America articles have been published in the newspapers and popular periodicals. Important issues which have been researched and published in educational journals have been adapted to provide information for the general public. This procedure could be duplicated in South Africa as many of the issues involved in mathematics anxiety are of general interest to most families. The radio programme "Maths with Meaning" proved to be most popular when it was broadcast on B.B.C. in England. A similar type of programme could be adapted for television. Panel discussion programmes are popular with television viewers. Prominent educationalists could be given the opportunity to discuss the problem of mathematics anxiety with specific attention to those issues which are a matter of concern to parents and pupils.

Such a television programme should have wide appeal and will provide a powerful medium in the attempt to influence social attitudes. The main thrust of the programme should be to discuss the factors which influence the manifestation of mathematics anxiety so that parents become aware of the problem and are able to recognise the symptoms of mathematics anxiety and the dangers of perpetuating the problem through revealing these anxieties consciously or unconsciously to their children.

2.2.2 Parents evenings

Parents evenings have become an integral part of education in schools in South Africa. Parents are becoming more involved in the education of their children and the mathematics teacher is often the most sought after at these affairs. This opportunity to talk to parents should be used to its full advantage.

There is no doubt that mathematics and mathematics teaching is a source of bewilderment to many parents. The aims of the curriculum, the approach to teaching and the importance of mathematics are all factors which need to be clarified. In addition, the unique nature of mathematics when compared to other subjects is a crucial aspect which can help parents understand the problems that may arise or have already arisen. The head of the mathematics department and/or the school counsellor should be called upon to prepare a talk which would serve to inform parents of aspects in which they have a part to play in affecting their child's performance. These aspects could then be listed on brochures and distributed to parents.

2.2.3 Brochures

The publication of information brochures, similar to those distributed by the Toronto Board of Education, is suggested. These brochures need to be eye-catching as well as informative and should be available to all parents.

The information literature envisaged would be the best formal way that the Education Departments can reach the people concerned. Brochures should include the following elements:

1. What is mathematics anxiety?
2. The need for a mathematics education
3. Parental guidelines

The overall aim and purpose of these brochures is to educate people on the irrationality of mathematics anxiety and how this could lead to mathematics avoidance and limited career choice.

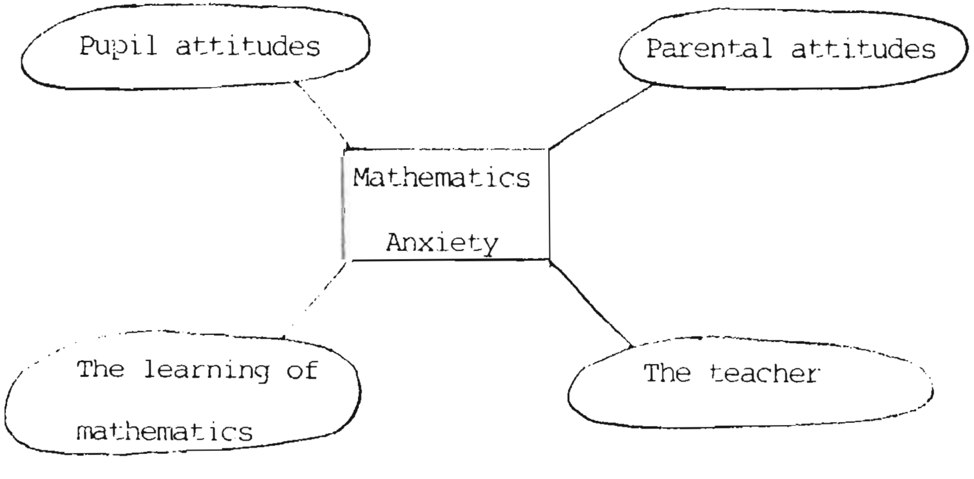
A brief outline of what should be contained in these brochures follows.

1. What is Mathematics Anxiety?

This brochure should aim to provide general information about mathematics anxiety that will give parents an insight into the problem. Without being too lengthy it should make brief mention of as many related problem areas as possible. Parents may then discuss these problems with the mathematics teacher. It will be necessary to briefly mention many factors which will be discussed in length under the headings, the Individual, the Subject and the School in later sections of this chapter.

This brochure would include a diagram with some brief explanations of factors influencing mathematics anxiety.

mathematics anxiety



Mathematics anxiety is a problem which is receiving universal attention at the moment. It is clearly defined as "feelings of tension and anxiety that interfere with the manipulation of numbers and the solving of mathematical problems in a wide variety of ordinary life and academic situations" (Richardson and Suinn, 1972). This type of problem is clearly detrimental to the development of a child and factors which contribute to the manifestation of mathematics anxiety should be prevented.

Parental attitudes towards mathematics often cause the perpetuation of the problem. Bad experiences and fears involving mathematics should not be consciously or unconsciously passed on to the child. Mathematics is a subject which is within the grasp of all children, male or female, and parents should encourage this point of view. Mathematics should be projected by parents as interesting, exciting and extremely useful as this will develop a positive attitude to the subject. The child needs to be given a positive view of the subject and encouraged to develop understanding through working and learning.

Parents should be particularly careful not to discourage their children by perpetuating certain socially held beliefs or myths. It is most important that girls are not discriminated against by any sex-role stereotyping. Girls should not be led to believe that mathematics is solely the domain of the male and that they are trespassing on unfeminine ground. Parents tend to encourage their sons to do well and feel that it is not important or expected that their daughters be mathematically minded. Statements such as "you've either got it or you haven't" and "I was never any good at mathematics" are extremely detrimental to the child's correct perception of the learning of mathematics.

Pupil attitudes are influenced by the factors mentioned under parental attitudes as well as many other myths which have become firmly entrenched in our society. The 12 myths listed by Kogelman and Warren (1978) in Chapter 2 of this dissertation could be included here with the explanation that parents need to be aware of these beliefs and try to counteract the effect they can have on their child's attitude towards mathematics.

The child's perception of the teacher will also have a profound affect on his/her attitude. Parents should try to be supportive and understand the point of view of the teacher. Parents should not easily accept the view that the teacher is to blame for the child's lack of understanding. If parents support negative views of the teacher then they will undermine the teaching process and seriously affect the child's progress in mathematics. Learning mathematics requires as much hard work as learning History or Geography and should not be simply dismissed by saying "I don't understand this".

The learning of mathematics is unique and requires a conscientious effort by the pupil. Pupils should be encouraged by their parents to ask more questions in class and to organise notes and probe for understanding. Being absent from school and missing sections of the work will seriously jeopardise the mathematics progress of the child. Mathematics builds upon itself and prior sections of the work need to be fully understood before one can progress. Avoiding sections of mathematics can contribute to this lack of continuity and eventually lead to a general avoidance. The pupil must realise that all aspects of the mathematics curriculum are important and that any avoidance will inevitably lead to anxiety when further topics need to be understood.

The teacher needs the support of the parents in his or her efforts to build confidence in mathematics. Through testing the teacher can provide the parent with information on what sections of the work the child needs remediation. Remedial lessons can be provided at school and any emotional problems pertaining to mathematics can be discussed with the school counsellor. The teacher can also provide ideas on how best each child can learn to cope with mathematics. This often requires considerable effort from the child and it is important to emphasise that any pupil who indicates a willingness to work and improve will always receive sympathy and encouragement from the teacher.

The information provided in this section is brief and is intended to only highlight certain important factors which will encourage parents to think about the problems facing their children and then provide the necessary support and encouragement.

2. The need for a mathematics education

Whilst being aware that mathematics anxiety exists many people may still not be convinced that a mathematics education is necessary. The aim of this brochure should be to convince people that the highest possible attainment in mathematics is desirable. The following points should be stressed:

1. A mathematics background allows the widest possible educational and career choices.
2. The future is not as certain as the past and the need for career

change is more likely to happen in the future. These changes would be limited without mathematics.

3. Even social science careers (Psychology, Sociology, etc.) are now increasingly requiring mathematics.
4. Without mathematics, advancement in a career is limited.
5. Entrance examinations for many careers include a type of mathematical test.

This brochure should again be designed to be eye-catching and interesting whilst conveying the message that avoiding mathematics is detrimental to one's future.

This brochure should also include some diagramatic charts which clearly reveal some of the more important aspects of a good mathematics education. For example:

1. A chart listing the mathematics requirements for entering the study of each vocation.
2. A salary chart indicating the remuneration for each job according to its mathematics requirements.

Whilst not dealing specifically with mathematics anxiety this brochure does emphasise the need for mathematics in a modern world. There is the danger that providing this type of information may lead to increased anxiety and one needs to be extremely careful when promoting the need for a mathematics education. It should be stressed that the most important reason for providing this information is because many pupils or parents who are anxious about their mathemtaics ability will rationalise that it is unimportant. It is essential that this type of unrealistic rationalisation is recognised.

3. Parental guidelines

This brochure could provide a summary of many of the ideas and suggestions mentioned earlier. It is important that parents receive some literature on the problems caused by mathematics anxiety. The following guidelines could be provided.

1. Mathematics anxiety is detrimental to a child's mathematics progress.
2. Parents who have experienced mathematics anxiety often pass their feelings on to their children.
3. People often defend their inadequacies in mathematics by rationalising that mathematics is unimportant.
4. There is no evidence that males should be better at mathematics than females. Daughters and sons should receive equal concern for their mathematics.
5. Pupils often decide to opt for a mathematics education below their capabilities. It is important to investigate the reasons and consequences of any lowering of levels or mathematics avoidance.
6. There is no truth in the myth of a "maths brain". In many cases pupils struggle with mathematics because of some minor setback in earlier years. If this setback can be rectified early, the child will be able to resume a normal mathematics course. Achievement in mathematics is the result of an individual's aptitude, ability and skills acquired through practice, experience and hard work.
7. Encouragement to do well and a positive attitude towards mathematics will provide the child with an incentive to improve.
8. Pupils need to be encouraged to be attentive in class, to ask

questions and to organise their books and notes.

9. Changing schools and absence from school can be detrimental to a child's progress. When this is unavoidable, work which has been missed should be covered as soon as possible.
10. Improvement in mathematics requires a greater effort from the child. It is important that parents support the teacher in encouraging the child to produce this greater effort.

2.3 Summary

The influence of socio-cultural factors on mathematics anxiety is gradually gaining more recognition. Efforts to counteract socially held misconceptions are evident in England and Canada, and the concept of mathematics anxiety has received increasing coverage in the popular media. Whilst this progress should be beneficial and encourage parents to assist their children it may also add to the stress if parents label their children as mathematics anxious. For this reason, the parent evening together with the distribution of well constructed information brochures is recommended as the most sensible way of informing the public of the problems related to mathematics anxiety.

Parents are concerned about their child's progress and their help should be enlisted in any effort to encourage the child to overcome his anxieties and hence improve his performance.

This final brochure summarises points that need to be highlighted in the media and during parent evenings. The intention of this section is not to provide remediation for all members of society but rather to create an awareness of the problem and to influence a change in social attitudes regarding mathematics. A social awareness programme must deal with a cross-section of the problems which will be tackled in the remainder of this chapter.

PART 3:EMOTIVE FACTORS

Having considered methods to combat the socio-cultural elements which affect mathematics anxiety, attention needs to be paid to individual manifestations of mathematics anxiety. It is important to realise that although there are many social factors influencing mathematics anxiety, each individual is affected differently by these factors and the manifestation of anxiety can be found in many forms. There will understandably be some overlap with broad social issues but of central concern here is the individual's feelings towards mathematics.

3.1 Background

There is some argument as to whether or not treatment procedures should be aimed at emotive factors influencing mathematics anxiety. Some researchers have stressed this aspect whilst others suggest that remediation should involve a more content orientated approach and concentrate on improving cognitive skills. In this study both affective and cognitive issues have been considered. However, in this section attention is given to the emotive issues related to mathmatics anxiety. Individual manifestations of mathematics anxiety are often associated with negative attitudes, feelings of uneasiness, nervousness, confusion, fear and mental disorganisation. The way that each individual perceives mathematics will have a profound influence on his or her feelings and may result in a defeatist attitude about future performance and eventually a decision to avoid mathematics in all sitations.

3.1.1 The myths of mathematics

The 12 myths suggested by Kogelman and Warren (1978) were listed in chapter 2 and have been mentioned as a societal factor influencing mathematics anxiety. Kogelman and Warren believe that these myths have become entrenched in our society and that the individual needs to be made aware of the unrealistic fear that may be created if these myths are held to be true. Although these myths are formed in society it is the individual who interprets them and forms anxieties which are unique to his or her experiences. These generalised cultural beliefs convey the impresson that mathematics is cold, logical and rigid and have a serious affect on personal attitudes towards mathematics. It is important that individuals are assisted in dispelling these myths.

3.1.2 Sex-related factors

Sex-related factors is an emotive issue that requires special attention. There have been many studies on sex-related factors and one cannot ignore the evidence that there is a marked difference between girls and boys in the development of mathematics ability. As this is important when studying individual performance and because many of the primary school teachers are women, it is necessary to consider these sex-related factors that may influence these two areas, viz. performance and teaching.

Shirley Hill (In Jacobs, 1978, p7) says that "the attitudes and conditioning related to the individual female's role and the perceived need and appropriateness of mathematical study to that role, are developed early and are the result of innumerable interrelated experiences, both in school and out. Thus the critical character of the elementary school in middle or junior high school experiences and the influence of teachers, cousellors and parents becomes apparent".

Shirley Hill is obviously concerned about social attitudes and the role of the school in promoting anxiety. In addition to these concerns, a consistent finding in the literature is girls' relative lack of self-confidence in their mathematical ability and their tendency to withdraw from mathematics activities. These issues indicate a more emotional response to the subject by females.

Efforts to alleviate individual anxiety in girls should take cognisance of the following summary of sex-related findings.

1. Fennema (In Jacobs, 1978, p15) points out that teachers often encourage girls to take the easier courses in mathematics which will eventually lead to their preclusion from higher study. She stresses the need for intervention at school level to encourage female participation in mathematics. This is important as it will prevent anxiety at a later stage when a mathematics course is necessary as part of their tertiary education.
2. The Toronto Board of Education has focused on the problem of girls studying mathematics. After carefully surveying the theoretical material on this subject, the following factors have been stressed in a booklet entitled Mathematics: The Invisible Filter (1982).
    (1) Factors which contribute to female participation in mathematics are:
        (a) their perception of the need for and usefulness of mathematics in further study and in careers
        (b) their attitude towards mathematics
        (c) teacher encouragement and the quality of teaching
        (d) the influence of important persons such as

parents, teachers and counsellors

(e) their individual perception of mathematics as a male domain.

(2) The most important factors influencing mathematics anxiety in girls are:-

(a) the quality of the classroom learning experiences

(b) their cultural beliefs held about mathematics

(c) the difficulties arising from language and symbolism

(d) the accumulative nature of the discipline.

3. Schonberger (1978, p21) suggests that boys become better at problem solving because the context of most problems have a male bias. She questions the feasibility of separate texts and sex role stereotype questions in which "girls cook, sew and lose weight while boys build, fish and buy cars" (Schonberger, 1978, p21). However, she does suggest that as many items as possible should be made as neutral as possible and then the remaining items balanced with respect to masculine and feminine context.

4. Fennema (1977) is convinced that it is only certain areas in the study of mathematics that cause sex-related differences. She points out that general intelligence (as measured by intelligence tests) is a major factor related to mathematics learning and that there are no sex-related differences apparent in these tests. She claims that a simple conclusion is that there must be other factors influencing mathematics learning. Fennema outlines what she considers to be the most important elements of cognitive, affective and educational variables associated with sex-related differences in

mathematics lerning.

(1) Cognitive variable. Girls are more likely to have difficulty in coping with the areas of mathematics that require spatial visualization skills

(2) Affective variable. Girls are influenced by the stereotyping of mathematics as a male domain and they reveal less confidence and more anxiety in learning mathematics.

(3) Educational variable. The quality of the teaching and the general organisation will have a profound influence on a girl's attitude towards the subject.

It is interesting to note that Fennema suggests that remediation should concentrate on the education variable and that mathematics instruction and school organisation should provide the basis of remediation which will not only improve cognitive skills but will also alleviate affective variables which are detrimental to the girls' progress in mathematics.

In this study cognitive, affective and educational variables are considered and remediation in all three areas is suggested.

5. In South Africa the question of "Mathematics and the sexes" is currently being researched by Delene Visser of UNISA and the HSRC is making a comprehensive study in Transvaal schools to look at the factors which influence mathematics achievement and participation. The questions that she seeks to answer form a good summary of the direction of international, mainly United States of America, concerns. Some of the questions being investigated are:

(a) Why do a large proportion of girls elect to terminate their mathematics studies?

(b) Do boys perform better than girls at mathematics?

(c) At what age do possible sex differences in achievement become evident?

(d) What are the causes of possible sex differences in ability?

(e) Which factors are good predictors of achievement in mathematics?

(f) Do attitudes to mathematics affect performance?

(g) To what extent do socialization experiences affect girls mathematics achievement and participation?

(h) How important are peers, parents and teachers in influencing pupils' attitudes to mathematics?

(i) May adolescence be regarded as the "critical period" with regard to the forming of attitudes towards mathematics?

(j) Which cognitive factors are important for achievement in mathematics?

(k) Is a boys mathematical achievement more dependent on cognitive factors and achievement motivation while girls achievement relates more to socialization influences?

(l) Are boys more confident about their mathematical ability than girls and in what way does this effect performances? (Visser, 1982, p8).

The findings of this survey have not yet been published. However, the questions themselves describe the many concerns related to sex differences in mathematics performance.

The knowledge of sex-related anxieties is important in the individual assessment and remediation of mathematics anxiety. Without placing too much emphasis on this phenomena because it is not the main concern of this study, it still remains essential that one is aware of how different individuals develop anxieties. The female faces some unique problems which could be alleviated through a greater awareness by the individual of the pressures that emanate from society.

3.1.3 Attitudes

There is often a conflict of opinions when considering the importance of attitudes towards the learning of mathematics. The main argument is again related to the promotion of either affective or cognitive outcomes in pupils. If the ultimate aim in alleviating mathematics anxiety is to improve performance and provide a life-long enjoyment of the subject then both cognitive and affective outcomes are important. In this section we will concentrate on the question of why the promotion of positive attitudes is important when considering the treatment of mathematics anxiety. The following studies provide some relevant background on the importance of attitudes.

1 . The Cockcroft Report (1982, p81) is concerned about the developing of attitudes at an early age. In every mathematics lesson the teacher is conveying a message about mathematics which will influence the students' attitude to the subject. "Once attitudes are formed they can be persistent and difficult to change. Positive attitudes assist the learning of mathematics, negative attitudes not only inhibit learning but ... very often persist into adult life".

   A brief summary of some of the findings of the Cockcroft Committee are:

   (a) The development of good attitudes among pupils is an essential part of teaching

(b) Attitudes are derived from teachers' attitudes and to an extent from parents' attitudes

(c) Attitude to mathematics is correlated with attitude to school as a whole and with the peer group's attitude

(d) These factors do not seem related to type of school or size of school or to subject content.

(e) Throughout school a more negative attitude develops as the child reaches a higher standard.

The obvious conclusions from the Cockcroft Report are that attitudes play an important role in promoting a life-long enjoyment of mathematics and that positive attitudes need to be developed at an early age.

2. Schofield (1981) is concerned about the fact that some studies reveal that favourable teacher attitudes are not an important determinant of achievement. He claims that this observation is based on short term studies and short-sighted outcomes such as success in current examinations. Schofield is critical of those teachers who believe that promoting academic skills is held to entail adherence to a well-organised curriculum and the exertion of pressure on children to apply themselves continually during class periods to tasks leading to content mastery.

Schofield supports the contention that teachers should show concern for the pupils' enjoyment of classroom activities and develop an interest in learning as well as developing feelings of self esteem. Pupils who enjoy a subject are inclined to invest more than energy in acquiring competence in that subject, and the positive reinforcement received from success is likely to generate continuing or renewed effort. By administering mathematical attitude and achievement tests to final year student teachers and to fourth through to sixth grade pupils (N=850) of 48 of these student teachers twice during the following year, Schofield (1981) was able to support the positive correlation between teachers' attitude and pupils' mathematics achievement.

3. The National Foundation for Education Research (NFER) has carried out a series of surveys monitoring the performance of a large sample of 11 and 15 year olds since 1978 (see p35). One of the survey forms is concerned with attitudes and Dr. Lynne Joffe (Personal Interview 1984) explains that the collection of information about pupils' attitude to mathematics is important because:

   (a) the thoughts and feelings of pupils are an important feature of their learning, and

   (b) a positive approach to any school subject is an educational goal in itself.

   The final report on the findings of these surveys has not yet been published but is in draft form at the NFER offices (1984). The most relevant findings on attitudes were:-

   (1) at both ages there are three predominant factors influencing pupils' attitudes to mathematics viz. enjoyment, perceived utility and perceived difficulty

   (2) most pupils recognise mathematics as a useful subject

   (3) 15 year olds have more strongly developed attitudes and can articulate their feelings and opinions more clearly

   (4) there are marked sex differences at 15 - girls found

mathematics less enjoyable and more difficult

(5) girls at 15 show a marked lack of confidence whilst boys are over-confident.

It is not the intention to study attitudes to mathematics in detail. However, it is necessary to recognise the important role that they play in the development of mathematics anxiety and subsequently mathematics performance. In view of the evidence presented above, it would appear desirable to promote the desired affective outcomes in pupils and to be aware of the fact that positive attitudes towards mathematics will contribute to better performance.

3.2 Treatment

Having discussed important issues which contribute to the emotive-reactions of individuals it is now important to consider the practical aspect of treatment. It is not advisable to label children as "mathematics anxious" as this may only compound the problem. Pupils need help in knowing and understanding themselves as mathematics learners. For this reason it is necessary to approach remediation by building confidence and by developing a positive self-concept and a positive attitude to learning mathematics.

Primary school pupils may have preconceived perceptions of mathematics which have been developed through socio-cultural processes which portray the negative aspects of mathematics learning. High school pupils and students in tertiary institutions may have developed anxieties and negative attitudes through bad experiences in the classroom. In addition, girls may need to be specially motivated because of certain sex-related problems mentioned earlier in this chapter.

Individual remediation is time-consuming and it would be impractical to suggest that each pupil receives individual attention. What is practical is that pupils are made aware of problems that may be associated with mathematics anxiety and they may then consult the counsellor or mathematics teacher if they feel that they are unable to cope. Pupils will then be provided with certain techniques to deal with their problem.

The following approach to remediation could form part of an awareness programme which would provide individuals with information on mathematics anxiety, whilst improving attitudes and providing techniques to cope with the problem.

1. Demystifying mathematics.
2. Anxiety-coping techniques.

These ideas can be used at any level of education and would be an invaluable ingredient in the training of teachers as well as helping pupils at school.

3.2.1 Demystifying mathematics

Mathematics myths should be discussed and the consequences of believing in them should be made clear. It is true that these myths have become firmly entrenched in our society but each individual needs to tackle his or her anxieties as they see them. However, every pupil should have the following aims in mind:

1. Try to develop a realistic view of mathematics and how it is

studied and used.

2. Try to understand the consequences of believing certain mathematical myths.
3. Be able to explore and analyse one's own experiences and attitudes.
4. Begin to develop a better attitude towards mathematics and become less anxious when faced with a mathematics problem.

The 12 myths listed by Kogelman and Warren (1978) in an earlier chapter could be dealt with in discussions in class. The following information could form the basis for discussion.

(1) Men are better in mathematics than women

Discussion of Famous Women Mathematicians (see Appendix p70). These women have often gone unheralded. This is intended to raise curiosity and stimulate interest.

A discussion could then be started on the things that are likely to hinder a woman in mathematics or even beginning to pursue mathematics at school. One would need to discuss background features that might have helped to stimulate mathematical interests. These would include family and friends' responses to intellectual interests as well as socio-economic variables such as financial support for intellectual pursuits and availability of educational opportunity.

Research has shown that there is no significant inherent difference between men and women in mathematical ability. The differences lie in the socialization process and the forming of the self-concept. Being good at mathematics is related to masculinity in that it is regarded as detached and objective. Men attribute difficulties with mathematics to the fact that they did not really try hard enough whilst women are quick to blame their intellect and claim to have no ability to do mathematics.

The consequences of believing this myth should be made clear. Women tend to accept the fact that they cannot do mathematics because it is part of their femininity. This leads to a general avoidance of mathematics which could severely limit future career options and lead to the women becoming more dependent on men to do mathematics and handle their finances. Men learn to adopt the attitude that not much is expected from women when it comes to mathematically related activities.

(2) <u>Mathematics requires logic not intuition</u>

(a) Students need to be convinced that intuition is as important in mathematics as logic. Students need to recognise the fact that when their mathematics teacher or lecturer presents a problem on the blackboard it has taken years of experience and has probably been well prepared before hand so that it can be presented in the most concise and logical way. This is, however, not the way most mathematics is done. Just like an artist uses several sketches before producing a final painting so the mathematician may use his intuition to maybe make several false starts before struggling towards a solution.

(b) The consequences of someone believing this myth are that they develop a false expectation that there is an automatic, logical solution to every problem. When the solution does not come to them, they conclude that they do not have the ability to do mathematics. Students do not allow themselves to use intuition, which is one of the best tools for getting started on mathematical problems, and as a result they put too much pressure on themselves and are unable to relax and try to understand the problem.

(3) You must always know how you got the answer

Teachers must guard from being too stereotyped in their approach. Too often they prepare their lesson with one method in mind and when a student describes how he got an answer the teacher is not prepared to accept this method. This type of teaching severely hampers the use of intuition. If a student consistently gets the answer right then he obviously understands the problem. However, if the student consistently gets a wrong answer we then require an explanation of the method so that we can discover the error.

The consequences of believing this myth is self-doubt. If the answer cannot be explained then the validity is questioned. The pupil is then less inclined to discover how the problem is done.

(4) Mathematics is not creative

The discussion here should involve the ingredients of the act of creation. Creativity is not simply a "flash in the pan" or a "bolt from the blue". It invloves diametrical opposites such as working intensely and relaxing, the frustration of failure and elation of discovery, the disappointment at realizing you've been on the wrong track and the satisfaction of seeing all the pieces fit together. "It requires imagination, intellect, intuition and an aesthetic feeling about the rightness of things" (Kogelman and Warren, 1978, p35).

If the pupil believes that mathematics is not creative and he sees himself as a creative person he will not want to be involved in the subject. If a student is involved in the subject they tend not to use their imagination and creativity when dealing with mathematical problems.

(5) There is a best way to do a mathematical problem

Teachers may be inclined to show pupils the solution to a problem and offer this as the best method. They should, however, make it clear that this method or the one in the text book is not necessarily the best method. The value of various methods can also be expounded during a mathematics lesson by working in groups and allowing pupils to discuss the different methods they are using to solve a problem. Most teachers have experienced a situation where having thought they have discovered the neatest and most elegant solution to a problem, a pupil presents them with a unique and equally elegant method.

The consequences of believing this myth are vast. Students will not be able to develop their own methods of solving a problem and when they do, they will not feel successful because the method was not the the "best" one. Students will try to remember how to do problems rather than just trusting their intuitive approach and if they cannot remember they will often hesitate to start the problem for fear that they are doing it the wrong way. Confidence can be badly affected if a pupil is lead to believe that other methods are superior to his own.

(6) It is always important to get the answer exactly right

Since the advent of the calculator it is often more important to intuitively approximate answers before finding the exact answer. The approximation serves as a check and is invaluable. There are many instances when one may feel that it is not necessary to have an exact answer. For example, approximating the cost of a supply of groceries or estimating a 10% tip at a restaurant. Pupils tend to be more comfortable when working with mathematics if they feel that mathematics is not a rigid, authoritarian subject. By practising approximation and estimation the pupil will be able to show flexibility and insight and not be too rigid in his approach. By believing that the exact answer is all important one tends to focus on the negative aspect of getting an answer wrong and not on the one careless mistake in a solution that is correct in terms of method.

(7) It is bad to count on your fingers

Finger counting is ofen seen as "cheating" and is banned by parents and/or teachers. People then do it secretly and feel guilty or inadequate when they have to use their fingers.

There is no reason to prohibit their use. The abacus is really a sophisticated finger-counting machine and many people develop some ingenious use of their fingers. This myth once again adds to the rigid, authoritarian image of mathematics and leads to people feeling anxious about the methods that they feel comfortable using.

(8) Mathematicians do problems quickly in their heads

The only problem that mathematicians do quickly are those they have done before. Pupils at school are often in awe of the teacher who takes delight in demonstrating how quickly a problem can be done and never admitting that they too might need some time to figure out a new problem. Time-limited tests and arithmetic drills also add to the impression that mathematical competence and speed are the same thing. Teachers need to explain to their pupils that the reason they seem to be able to find the solutions quickly is because they have had many years experience with similar problems.

The key to students improving is to do similar problems, develop an intuitive mind and have a little luck when trying different solution approaches. The concert pianist, the magician or the gymnast all make a performance look easy but it is only because of years of practice.

Believing this myth leads students to try to do problems faster than they are ready to do them. This can cause panic and carelessness because the attention is on speed and not mastery. Speed only comes from practice and it is impossible to become quick at mathematics without a gradual progression.

(9) Mathematics requires a good memory

"Knowing mathematics means that concepts make sense to you and the rules and formulaes seem natural" (Kogelman and Warren, 1978, p39). Rote-memorizing cannot aid this type of understanding. Rote-learning of procedures in mathematics is a particularly successful (as far as test results are concerned) method of teaching in the primary school. Pupils often do extremely well at primary school if they have just managed to train themselves to do mathematics by memorizing rules and processes. However, mathematics anxiety is often brought on by pupils whose marks tend to deteriorate at high school because their methods are no longer effectual on problems which are more diverse and complex.

It takes longer to teach a child to really understand a concept and it is often too easy for the teacher to resort to memorized rules and for the pupil to accept these rules. However, if a person understands a concept they are much more likely to experience less difficulty with that topic and future related topics.

Belief in this myth leads to tension from trying to memorize too many things, and an increasingly confused mind. Memorizing also makes the subject unpleasant and meaningless.

(10) Mathematics is done by working intensely until the problem is solved .

There is no disgrace in leaving a problem and then coming back with a fresh approach. Perseverance is not the ability to work intensely at one given time but rather to be able to try various approaches to problems until one hits on the right one. Working too long on a specific problem only leads to frustration, a dislike of mathematics, wasting time and finally giving up. Taking breaks helps one gain more insight into a problem.

(11) Some people have a "mathematics mind" and some do not .

There is no concrete proof that a "mathematics mind" is a biological attribute. However, the environmental influence does appear to start at an early age and it is the confidence of children that is normally affected. Belief in this myth leads to a complete lack of self-confidence and is one of the most important determining factors in mathematical performance (Kogelman and Warren, 1978). Believing that a "mathematics mind" is biological rather than learned, causes students to become discouraged when mathematics does not come easily. Any failure will confirm one's belief and one will be reluctant to put in the time, effort and concentration it takes to learn mathematics. Most important is the fact that students who believe this myth will tend not to accept help from others because they believe that a mathematical mind cannot be developed.

(12) There is a magic key to doing mathematics

There is no magic key to doing mathematics. It is more important that one believes that mathematics is a subject similar to others and to everyday life and requires the same skills that you use to do everything else.

Students must use their own initiative to do problems and not rely on formulas to provide the magic key. Using imagination and insight is more important than remembering magic memorized methods.

3.2.2 Anxiety-coping techniques

It has been mentioned earlier that the mathematics anxious person is not necessarily a person who suffers from general anxiety. It is likely, however, that those pupils suffering from general anxiety require special attention to cope with their emotive reactions.

The following three anxiety-coping techniques are often used by psychologists.

3.2.2.1 Relaxation techniques

The basic idea behind this strategy is to teach the child to cope with the physical unpleasantness of anxiety. Methods include breathing exercises and muscle relaxation. These are usually linked with a self-induced one word such as RELAX or CALM and pupils are encouraged to practice these relaxation techniques whenever they find themselves in an anxiety-provoking setting.

3.2.2.2 Systematic desensitization

This technique involves a hierarchical list of distributing stimuli. For example, the psychologist will arrange a list of mathematics situations which the client finds anxiety-provoking. These situations are arranged from those regarded as least disturbing to those which are considered to be the most disturbing. The client is then encouraged to consider each one systematically, starting with the least anxiety-provoking situation, and to learn to cope with each situation. This procedure is often used in conjunction with relaxation techniques.

3.2.2.3 Anxiety-management training

This would involve a more structured coping strategy with pupils involved in some self-analysis, self-remediation and discussion in support groups. Components of this programme would include:

(a) Writing a mathematics autobiography, where students recall past experiences with mathematical situations.

(b) Keeping a diary of mathematics experiences.

(c) Writing out their goals relevant to studying mathematics.

(d) Discussing mathematics study skills.

(e) Learning assertiveness techniques to help deal with lack of confidence in the classroom.

(f) Developing a personal support system which could be used outside of the class. For example, becoming friends with others in a mathematics class (Chapline and Newman, 1984).

The above techniques have been used in many situation-specific anxiety remedial programmes. These programmes are time-consuming and require the expertise of a qualified psychologist. Whilst these methods would undoubtdedly benefit the chronic anxiety sufferer, it would be more practical to develop a self-help type of remediation to alleviate mathematics anxiety.

The booklet, Mathematics: The Invisible Filter (1983) contains information which could be summarised to provide mathematics anxious pupils with a profile of:

(1) Feelings of anxiety

(2) Negative reactions to anxiety

(3) Positive reactions to anxiety

By becoming familiar with himself as a mathematics learner the pupil will be able to identify his anxieties and learn to cope with them as they arise.

(1) Feelings of anxiety

Many pupils suffer from mathematics anxiety. A little anxiety can be beneficial but too much anxiety will interfere with one's progress. The pupils must learn to cope with the following feelings:

(a) Physical reactions, such as faster heart beat, shallow breathing, blanking out, etc.
(b) Anger.
(c) Embarrasment.
(d) Fear of ridicule.
(e) Feeling that he is "dumb".
(f) Feeling that he is the only one who does not understand.
(g) Disappointment.
(h) Loss of confidence.

(2) Negative reactions to anxiety

The following sequence of events describes how not to react to mathematics anxiety:

(a) Have bad encounter in mathematics.
(b) Become tense, anxious.
(c) Feel inadequate.
(d) Lose confidence.
(e) Become discouraged and give up.
(f) Avoid mathematics homework and classwork by being absent from school.
(g) Have more bad encounters with mathematics.
(h) Becomes more difficult.
(i) Fail.

(3) Positive reactions to anxiety

A more positive approach to anxiety would be:

(a) Have bad encounters with mathematics.

(b) Become tense, anxious.

(c) Practice relaxing (breathing easily, telling oneself to relax etc.).

(d) Seek help from teacher, counsellor, friends, parents.

(e) Talk about problems and ask questions.

(f) Study, improve skills and try again.

(g) Things begin to fall into place.

(h) Perseverance.

(i) Begin to enjoy some success.

(j) Believe that you can do mathematics.

(k) You can do mathematics.

(Adapted from: Mathematics: The Invisible Filter, 1983)

3.3 SUMMARY

Emotive issues must receive attention by alleviating personal psychological problems affecting mathematics performance. These problems develop through negative attitudes and through certain socially held myths and connotations associated with mathematics. Negative attitudes and faulty beliefs are often reinforced by bad experiences throughout one's mathematics progress.

Bad experiences may include instances where;

the teacher humiliated the pupil in the class;

the pupil felt slower than the rest of the class;

other pupils ridiculed the pupil when he or she gave an answer.

The longer the pupil has been at school the more chance there is that he or she may have experienced some setback and hence reinforced some of the negative attitudes and myths.

An early intervention programme is essential to the remediation of mathematics anxiety. It is important that young pupils are aware of the myths that have been formulated through the socialization process. By providing information on these myths and by allowing the pupils to explore their own experiences with mathematics they are likely to realise that their dislike for mathematics is not entirely rational.

PART 4: COGNITIVE FACTORS

The connotations and myths associated with mathematics contribute to the uniqueness of this subject. However, the contents of mathematics and some of the tasks involved in mathematics actually do present some difficulties to the learner. In addition to developing competence in the content material other skills such as test-taking skills, organisational skills and attention skills all contribute to the cognitive progress of the pupil. Whilst this is true for all subjects, it is often in mathematics that pupils display inadequate cognitive skills. One of the reasons for this is that cognitive factors are often linked with emotive factors and in this way contribute to the overall manifestations of mathematics anxiety.

4.1 Background

The ultimate reason for a study in mathematics anxiety must be to inmprove long-term performance. For this reason certain cognitive aspects influencing performance should be studied. Two studies in England have attempted to clarify the mathematics performance progress of school children and provide important insight into the mathematics abilities of these children. Although these are by no means the only studies on mathematics performance they are most comprehensive and attempt to explain some cognitive factors which may influence performance and cause anxiety as well as providing some indication of how treatment should be developed.

4.1.1 National Foundation for Educational Research (NFER)

This series of surveys was mentioned in the previous section because one of the modes of the survey concentrated on attitudes.

However, the three other modes of this survey were concerned with cognitive factors and were entitled:

1. Concepts and Skills.
2. A Practical Test.
3. Problem Solving Strategies.

Approximately 13000 pupils in each age group (11 and 15) completed the concepts and skills test, whilst sub-groups of 1100 to 1500 were asked to undertake the other three tests.

1. Concepts and skills

The testing of certain concepts and skills was unique in that pupils were asked to assess their enjoyment of each topic together with assessing the perceived usefulness and difficulty of the topic. They were then asked to complete a task on each section being tested. This aspect proved most revealing, not only because certain sections of mathematics are more anxiety provoking than others, but also because pupils' feelings may differ according to the type of problem they are concerned with at the time. Although this study was not directed at anxiety it does indicate that anxiety is related to the type of mathematics question asked and that research can reveal which topics of mathematics are most anxiety provoking.

2. The practical test

The practical mode of this survey also indicates a useful method of revealing faulty performance methods as well as feelings. On a video tape (demonstrating the practical test) produced by the A.P.U. (1980) what is most clearly revealed is that pupils who may be doing quite well at multiplication and division in a mechanical sense are quite

unable to adapt this knowledge to a practical problem, as the following example illustrates.
A problem with a balance, a 20 gram mass and a number of plastic chips leads to the child establishing fairly easily that 21 chips has the equivalent mass as 20 grams. However, to establish the mass of 1 chip the common error of dividing 21 by 20 was made by many pupils. On being prompted by the tester to consider the answer to the problem again, the pupils are able to confidently predict that 1 chip should weigh less than 1 gram and hence $\frac{20}{21}$ gram should be the correct calculation. Talking about methods is an essential ingredient in discovering where faulty beliefs and procedures have developed.

3. Problem solving strategies

The NFER surveys since 1981 began to pay more attention to general mathematical processes. Ideas provided by teachers formed a basis for some written tests called "problems and patterns" (Foxman et al, 1982, p120).

The test on concepts and skills and the practical mode of the surveys provided descriptive information on problem solving strategy and as yet the separate components on problems, applications and investigations have not been fully reported on. Current research in learning and teaching is extending the original formulations of these approaches and also providing new ideas for assessmnet.

It is important to note that the current trend in research is to include items on tests which will reveal methods of problem solving. Foxman et al (1982) describe the type of problem that will reveal problem solving methods. By using a set of 2cm square tiles, which may be illustrated in a drawing or used physically, they investigated the following types of problems.

(a) Relatively open form - e.g. "Investigate the perimeters of different arrangements of tiles". This would require the pupil to formulate the problem and decide what aspects of the solution to investigate.

(b) Less open form - e.g. "Find the maximum and minimum perimeters of tiles which can be placed corner to corner or edge to edge". This form of presentation is less open but provides options as far as method is concerned. The NFER investigations have included a more structured type of presentation in their written tests whilst exploring patterns and roles in their practical mode of survey.

Although not much information is yet provided on the results of the problem solving component of the NFER survey the researchers have recognised the importance of a more detailed look at methods and have concluded that faulty cognitions and methods are often a cause of anxiety and poor performance and these methods are best detected through individual assessment (unpublished draft, 1984).

4.1.2 Brunel University: Department of Education

The Education Department at Brunel Unversity in Berkshire, England has also been concerned about the current standard of basic mathematical competence in schools and colleges. The Brunel team are concerned with the cognitive processes in mathematics performance. Since 1970 the Mathematics Education Group (MEG) have carried out studies which have dealt with craft and technician students in further education, primary and secondary school pupils, trainee teachers and some university engineering undergraduates. The recent studies in the research programme have succeeded in confirming the existence of two distinct types of "difficulty in learning Mathematics" which reflect two different modes of strategies of mathematical thinking (Furneaux and Curnyn, 1982).

In their research they have adopted Spearman's ideas on intelligence to distinguish between two specific types of mathematics ability. The first type of ability they found to relate to a general intellectual ability as measured by some intelligence tests. This dimension of mathematical ability was termed the 'g' factor and the related problems 'g' type problems. The second type of ability appears to relate to a fairly specific ability to make valid inferences within a mathematical context. These problems they found created more difficulty for the pupils than was predicted by their teachers and it was demonstrated that in working out aloud, the solution paths involved in solving these "inference type" problems are of a qualitatively different nature from those utilized in solving 'g' factor problems (Furneaux and Curnyn, 1982). When a student tackles a "'g'-type" problem the solution is elicited fairly rapidly via well learned techniques. The "inference-type" problems are not so easily done and would elicit a characteristic fumbling towards a solution and often involved a restructuring of the problem. A good example of this fumbling towards a solution was quoted on page 40 of this study.

The following examples illustrate the difference between "'g'-type" problems and "inference-type" problems. Tasks such as:-

a) $\frac{2}{\square} = \frac{1}{3}$

b) $0,4 \times o,4 =$

c) $24,34 + 61,42 + 38,53 =$

do not fully test the understanding of the topics they should be testing, i.e.

a) ratios

b) multiplication of decimals

c) addition of decimals.

The testing of these topics would be served better by examples such as:

a) $\frac{\square}{8} = \frac{3}{12}$

b) $0,3 \times 0,3 =$

c) $251,6 + 37,325 + 6,47 =$

(Rees and Barr, 1984)

The reason why the first set of examples are termed "'g'-type" problems is because they are considered to merely test a general type of ability similar to the non-verbal section of an intelligence test. The second set of examples requires the pupil to make certain inferences within the context of mathematics. Whilst these are fairly simple examples of "inference-type" questions it is stressed that as the pupil progresses with mathematics he will find it more and more necessary to make valid inferences. For this reason, the Brunel team feel that some measurement of a pupil's "inferential" mathematical ability is necessary.

In addition to assessing the mathematics ability of pupils this type of distinction in questioning can also reveal faulty learning techniques. The first set of examples may be done using rote-learned methods and do not necessarily require a good understanding of mathematics. However, the second type of examples requires greater understanding by the pupil as the principles of ratio, multiplication of decimals and addition of decimals are tested.

The findings of the Brunel team have been most interesting and their dividing of mathematics ability into two distinct avenues explains many of the problems which pupils have with mathematics. Again, the main concern is mathematics performance but the anxiety factor is of central importance. This issue is raised by Curnyn (1980) when he outlines the relevant questions that the study of primary and secondary school pupils addressed.

1. During which stages of education do the 'g' factor and "inference" factor emerge?
2. Is this development regular and progressive or are there certain crucial periods during which they develop relatively suddenly?
3. Is this development associated with corresponding failures in the development of pupils intellectual abilities, with defective teaching or with other factors such as lack of interest, dislike and <u>anxiety</u> ?

Curnyn (1980) goes on to say that this final issue is of particular interest because of the major difficulties faced by many of the pupils when attempting to learn mathematics is that they rapidly develop negative attitudes to the subject and become so anxious when faced with mathematical tasks that they cannot function at their normal level of cognitive ability. This emphasises an important point made earlier. It is necessary to cultivate positive attitudes at an early age to help ease anxiety when mathematics becomes more abstract. Of particular interest in the Brunel study is the primary and secondary pupils' survey. At primary school level it was found that mathematical performance proved to be determined mainly by 'g'-type ability i.e. it correlated mainly with general intellectual ability. The 'inferential'-type of ability was more evident at the early secondary level and the data provided evidence for the developmental emergence of this mode of thinking within the age range studied (Furneaux and Curnyn, 1982). These findings have serious implications for the compilation of a mathematics curriculum. One of the principal aims of the "modern approach" to mathematics teaching is that pupils should have conceptual grasp of the material rather than an accumulation of rote-learned rules. However, if pupils in primary schools have mainly 'g'-type thinking capacities then many of the expectations of a more conceptualized approach may be unrealistic. What is realistic and warrants attention is the possibility of stimulating and accelerating the development and acquisition of a capacity for inferential thinking.

The importance of developing a capacity for inferential thinking is an essential ingredient in alleviating mathematics anxiety. Teachers at primary school level must be aware of the ability of their pupils and ensure that they equip them well for the more abstract type of thinking which will be required during the high school years. Mathematics anxiety often develops because pupils who have coped adequately with mainly 'g' type thinking at primary school level are shocked when their performance level drops as they are required to adapt to a more inferential type of thinking.

The Brunel survey also monitored attitudes of students at various ages. By talking to school children and students at tertiary level it was clear that many attitudes are developed at an early age and that negative attitudes contribute to anxiety feelings as mathematics becomes more abstract. Like the NFER survey, the Brunel survey covered a wide spectrum of students. Both surveys are concerned with the development of mathematics performance and factors which may hinder this development. One must conclude that although combating mathematics anxiety should be an ongoing process, the main effort should be concentrated on the primary schools. It is most important that teachers at this level are developing healthy attitudes towards mathematics and teaching a deeper understanding of the subject. These two aspects are essential to the success of developing an anxious-free student who is able to cope with the changing form of mathematics as he or she progresses through high school.

4.1.3 Cognitive-attentional Theory

J. Wine (Sarason, 1980, p376) feels that mathematics anxious students tend to divide attention between self-preoccupied worry and task cues whilst the less anxious person focuses more fully on task-relevant variables. This cognitive-attentional theory is gaining support mainly because it suggests the necessity for a more multifaceted approach to the treatment of mathematics anxiety. Whilst the emotive factors are not ignored this theory does emphasise the fact that the cognitively demanding nature of mathematics must suggest that cognitively based treatment strategies must be considered.

Wine (Sarason, 1980) lists the following differences between high-anxious and low-anxious individuals

LOW ANXIOUS	HIGH ANXIOUS
1. Current concerns are relevant.	1. Current concerns are evaluation of others and anticipation of negative evaluation.
2. Focused on task of situation.	2. Focused on self and social evaluative cues.
3. Task orientated.	3. Task avoidant.
4. Situationally specific cognition; problem-solving cognition.	4. Static, global, stereotypic cognition, self-preoccupation and social concerns.
5. Active.	5. Inactive.
6. High belief in self-efficiency.	6. Low belief in self-efficiency
7. In the present; concentrates on present problem.	7. Out of situation, preoccupied with past failures or future negative consequences.

Mathematics clinics dealing specifically with mathematics anxiety in the United States of America, have been quick to take cognisance of the above differences and their multifaceted approach to treatment includes programmes on cognition restructuring and highly specific task-orientated information on mathematics-related activites. Pupils often reveal their anxiety by the way they approach a mathematics problem. Geometric figures are meticulously drawn but interpreting the problem is neglected. Attention is often given to words or details which are not central to the problem at hand. Experiments by Dusek et al (1975 and 1976) have supported these observations. Low-anxious pupils were found to react as expected when irrelevant or relevant cues were added to the task material. Irrelevant cues debilitated their performance whilst relevant cues facilitated their performance. With high-anxious pupils it was found that they would simply use less and less of the task relevant cues as their anxiety level rises. In another experiment by Dusek et al (1976) children were shown cards with pictures of animals in certain situations which they were told to learn. Each card also had other drawings which the children were told not to learn. The fact that the high-anxious pupils performed poorly on the central task and yet were better able to recall the other drawings demonstrated their concern for peripheral cues.

Teachers often note that a pupil is not giving his full attention to a lesson or a problem. This may be because he is lazy and/or disinterested but in many cases it is often found that high-anxious pupils tend to be generally negatively self-preoccupied and will reveal this preoccupation in self-devaluing terms (Sarason, 1980).

4.1.4 Attribution Theory

As in cognitive-attentional theory, attribution theorists are concerned with factors such as self-evaluation and attention to task-relevant cues. Low-anxious pupils are likely to cope better with success or failure feedback because it is likely to be interpreted as task-relevant information and because of their resultant achievement motivaton. Failure informs them that they must pay more attention and work harder. Success confirms the low-anxious pupil's ability and allows him or her to relax.

For the high-anxious pupil failure and success feedback is interpreted as more social-evaluative and bearing upon his or her generally negative self-evaluation. The high-anxious pupil is likely to attribute failure to a stable internal factor, lack of ability, and assume that the person evaluating them considers them to be stupid. They subsequently give up and disengage from the task. In response to success the high-anxious pupil is likely to feel reassured although they do tend to attribute success to external factors such as luck, fate etc. The implications of this theory are twofold.

1. Positive reinforcement is a more desirable and successful technique in mathematics teaching.
2. Self-confidence in a pupils' ability to do mathematics is essential to continued success.

Setting tests and examinations that continually fail pupils and then using this failure to motivate them to work harder does not give the high-anxious pupil a fair chance to reach his potential. These pupils need to experience success and to learn to attribute this success to their own hard work. When they do inevitably fail certain tests they should be encouraged and assured that they can improve.

4.1.5 Cognitive Skills

Many theories on reducing anxiety have centred around improving skills. Study skills, cognitive skills, confidence skills, social skills are all seen as areas that could be improved. In contrast to emotionally based theories, these involve operant techniques which attempt to modify overt behaviour while assuming that a reduction in anxiety will follow.

The obvious skill of doing mathematics can be remedied through extra lessons, covering topics which had been missed due to absence or change of school and reteaching sections of the work that may have been poorly taught. However, other skills may have some influence on mathematics performance. The following studies should be considered.

Desiderato and Koskinen (1969) and Wittmaier (1972) found that anxious students had less effective study skills than those lower in anxiety. Kirkland and Hollandsworth (1979) found that study habits and achievement anxiety measures were the major predictors of performance results and they raised the important question "whether anxiety interferes with effective test-taking behaviour or whether lack of effective study skills result in anxiety". Culler and Hollahan (1980) reported that "high anxious students who have developed and exercise better study skills did better academically than those with poor study habits".

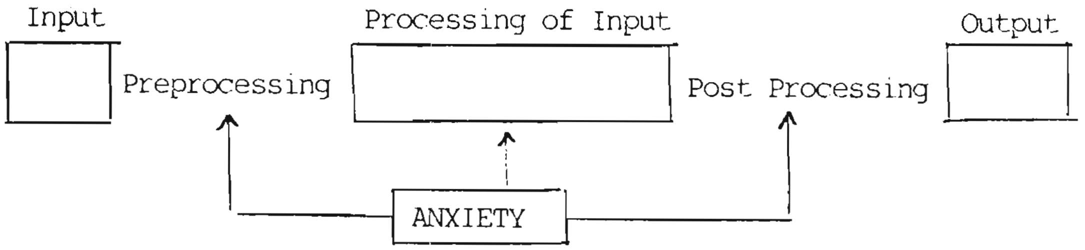
These studies and questions seem to indicate that anxiety reduction requires a two-pronged remedial programme. Anxiety reduction programmes should be conducted in conjunction with skills training procedures. On test-taking skills, Kirkland and Hollandsworth (1980) compared the effect of anxiety reduction treatments and training in test-taking skills and their results indicated that the skills acquisition group reported less attentional interference and had a higher performance. Bruch (1981) and Bruch, Juster and Kaflowitz (1983) also found that test-taking skills significantly related to differences in College achievements. However, Bruch, Juster and Kaflowitz (1983) did note that test-taking strategies had a less important effect on performance on a mathematics test than on an essay or a multiple choice test. This seems to suggest that whilst improving test-taking skills is important, mathematics may have an added component which causes anxiety and as such needs a more multifaceted approach.

Frye (1983) was able to show that mathematics anxiety, (as measured on the MARS), could be significantly reduced by concentrating solely on mathematics skills. By careful diagnosis of deficiencies in mathematics skills in the individual, she was able to prescribe remediation by mathematics skill interventions. Crumpton (1977) also showed that by concentrating on improving mathematics competency one could reduce mathematics anxiety effectively. Themes (1982) compared mathematics skill training with Ellis' Rational Emotive Therapy and Michenbaum's cognitive behaviour modification and found that the mathematics skills intervention was no better than the other two remediations as an effective method of reducing mathematics anxiety.

The efficiency of a combination of mathematical and non-mathematical treatments as compared to a no treatment and mathematical treatment only group was investigated by Handler (1982). She found that the instruction/anxiety treatment group experienced a decrease in mathematics anxiety and an increase in mathematics competency and that in fact the average final mathematics course grade for this group was

one better grade above those of the instruction group.
The above studies have some contradictory findings but do appear to indicate that some form of skill training can improve performance and as such will contribute to the lowering of anxiety. It should be mentioned however, that all these studies were based on short term results and therefore have very little value in long-term planning of remediation. Handler's view that a combination of mathematics instruction plus some form of anxiety treatment should be the best approach to a multifaceted problem.

Sigmund Tobias (In Sarason, 1980, p293) feels that there are three levels where cognitive skills training can help to alleviate mathematics anxiety. He sees anxiety interfering with performance "indirectly by impacting on the cognitive processes utilized in the instructional sequence". His model for the effects of anxiety on learning from instruction indicates the three places that anxiety can have a debilitating effect.



At the preprocessing stage high anxious students may not be giving their full attention to the problem at hand and Tobias suggests that a solution to this is some type of instructional training that will assist the pupil in concentrating on the task-relevant cues provided in the problem. The processing stage invokes three types of manipulations that are likely to have the largest effect on learning. (1) Difficulty; (2) Reliance on memory; (3) Organisation of the task. At this stage instruction must consider easing the burden of perceived difficulty by developing an approach which is not reliant on memorized methods but more on understanding of the content. In addition, Tobias advocates a training of organization of the instructional material as he feels that this is often a weakness in high-anxious students.

The postprocessing effect occurs when students appear to have mastered the content yet experience some difficulty reproducing it. At this level test taking skills need to be developed.

Although Professor Tobias is primarily concerned with test anxiety, the implications of his work is that any programme designed to alleviate anxiety should be viewed at three levels and should offer remediation at these three levels. Anxiety can be caused by inadequate attention in the correct direction (before processing facts), i.e. the pupil is unable to organise his or her attention to the relative facts. Secondly, during processing the anxious person may find that perceiving the problem as difficult or having to rely on rote-memorized rules or a lack of being able to organise the input material will all cause a debilitating effect. Thirdly, the need for test-taking skills is often necessary, (even in solving a single mathematics problem).

4.2 Treatment

Research in mathematics performance has shown that there are many factors influencing the cognitive processes of the pupil. There are certain aspects of mathematics which pupils do find difficult as they progress in mathematics and the subject becomes more abstract. A recurring factor in most research on the subject of mathematics anxiety is that it is during the early years that pupils encounter "bad experiences" and learn "bad habits". Lack of a sound, basic knowledge and inadequate learning skills at an early age will lead to anxiety as the pupil progresses through school, whereas more enjoyment through understanding and an organised approach will enable the pupil to cope with mathematics as it becomes more difficult. A treatment strategy which is aimed at developing the cognitive processes should take account of the theory of three levels of cognitive processing which was expounded by Sigmund Tobias. In essence Tobias' approach requires attention to three important areas.

1. Helping the pupil to become more organised.
2. Providing a better understanding.
3. Alleviating test anxiety.

4.2.1 Helping Pupils to Become More Organised

From the literature reviewed in this study it is evident that the mathematics anxious child needs help in organising not only the content material but also in eliminating faulty or misguided cognitions. The following guidelines will assist pupils in adopting a more systematic approach to mathematics through organisation of their thoughts and the content material.

1. Be aware of misguided cognitions

(a) Do not be concerned with how other people evaluate you and do not always anticipate negative evaluation.

(b) Try not to be too self-critical and feel that you are not adequately endowed with intelligence.

(c) Be more flexible with your cognition, i.e. do not always feel that you are being judged or socially evaluated.

(d) Learn to become <u>active</u> immediately you are faced with a problem.

(e) Learn to concentrate on the task at hand and not just observe the problem.

(f) Learn methods to become involved in doing a problem. It is important to get pen to paper and start doing something.

2. Become more organised in your approach to mathematics:

(a) Keep tests and exercises well corrected and filed in an orderly fashion.

(b) Be sure to ask questions if you do not understand. Remember: There are no "stupid" questions.

(c) Highlight the points your teacher stresses.

(d) Note formulas, symbols, new words and definitions and be sure you understand their meaning before you proceed.

(e) Note where you made errors because these errors will help you learn.

(f) Learn to become independent to try to start problems without asking for assistance and to use your own initiataive to try various methods before seeking help.

(g) Make a note of things you do not understand and ask for help.

(h) Ask your teacher to help you organise methods of problem solving, i.e. read the question slowly, draw pictures, charts and organise information and talk the problem through.

(i) Be alert and pay attention in class.

3. Learn to approach the teacher. Teachers are often blamed for not being sympathetic or being too busy to help or not being bothered with a pupil. In many cases it is the pupil who did not pay attention in class. The following ideas should ensure that problems receive a sympathetic hearing from teachers:
   (a) Pay attention in class and ask questions.
   (b) Show an interest in your work.
   (c) Try to understand what the teacher expects from his pupils.
   (d) Be co-operative, and avoid doing things which will annoy your teacher.
   (e) If you need to ask your teacher for extra help try to do this at a time of his or her convenience, not your own.
   (f) Be prepared to give up your free time, e.g. lunch break etc. to seek help.
   (g) Highlight the points the teacher stresses.
   (h) Keep your books, notes and tests well organised.

4.2.2 Providing a Better Understanding

Having provided the pupil with ideas on how to become more organised in his approach to mathematics it is important that teachers give attention to certain aspects of mathematics that help to provide a better understanding of the subject. Developing the pupil's cognitive skills requires special attention to the following.

1. Use of the curriculum.
2. Developing basic skills.
3. Language and notation.

By giving attention to these three areas of mathematics the teacher will be helping the pupil to develop an understanding of mathematics which will provide the basic ingredients for alleviating anxiety as the pupil progresses through school.

4.2.2.1 Use of the curriculum

It is essential that mathematics continuity is maintained as the pupil progresses through school. To provide this continuity it is necessary for teachers at all levels to liaise and be more co-operative. Even within a high school the mathematics taught at each level is often taught in isolation. Teachers qualified to teach Standard 6 to 8 are often not aware of the continuing needs of the pupil whilst teachers teaching Standard 9 to 10 concentrate fully on the final examination with little attention to any future requirements of their students. It is essential that "bridging the gap" meetings take place and the teachers at the various levels are all aware of the requirements and are all teaching with similar aims in mind.

The new syllabus for schools in Natal has the following aims for Standard 5 to 7 teachers; (N.E.D. Syllabus, 1984)

1. To develop a love for, an interest in and a positive attitude towards mathematics, by presenting the subject meaningfully.
2. To enable pupils to gain mathematical knowledge and proficiency.
3. To develop clarity of thought and the ability to make logical deductions.
4. To develop mathematical insight.
5. To develop accuracy in both calculation as well as mathematical expression.

6. To instill in pupils the habit of estimating answers where applicable and of verifying answers where possible.
7. To develop the ability of the pupils to use mathematical knowledge and methods in other subjects and in their daily life.
8. To provide basic training for future study and careers.

The Cockcroft Report (1982, p206) stresses the importance of not only regarding aims as a necessary formality but rather as a "statement of intent which has been discussed, developed and accepted by those who teach mathematics in a school". These aims need to be carefully considered before teachers can formulate a scheme of work for the year. The way in which a particular topic is to be taught and a particular objective achieved needs to be considered in relation to the aims of the course as a whole and especially of those aims to which it can make a direct contribution.

Teachers should note that by carefully considering the aims listed above they will be contributing greatly to reducing the chance of their pupils developing mathematics anxiety. For example;

1. Love, interest, positive attitude - are the aims of a long term treatment procedure for mathematics anxiety.
2. Gaining mathematical knowledge and proficiency - improving basic skills will improve confidence.
3. Developing mathematical insight - as opposed to learning how-to-do methods.
4. Using mathematics in other subjects and daily life - stresses the usefulness of mathematics and thus encourages interest.

Cockcroft (1982) suggests that an overriding aim to any syllabus should be "to maintain and increase confidence in mathematics". The following list of suggestions could be distributed to teachers to ensure that some attention is given to developing the necessary cognitive skills. These could become an integral part of the curriculum.

1. Mathematics is a heirarchical subject in that the ability to proceed to new work is most often dependent on sufficient understanding of work which has gone before. This is where mathematics differs greatly from other subjects and this is why teacher liaison is necessary. It is not enough that one merely follows the syllabus for each standard. The teachers should be teaching with the same aims in mind and with similar methods of developing understanding rather than rote-learning. Meetings between primary school teachers and high school teachers ,and high school teachers and university lecturers should be arranged regularly and discussions on important aspects of the syllabus should be discussed. Only in this way can a school teacher, of any level, be aware of the complete spectrum that the child must pass through.
2. The usefulness of mathematics can be a powerful ally. Researchers have shown that most pupils see mathematics as a useful subject. To build on this teachers need to continuously introduce everyday problems and cross curriculum problems that may arise in other subjects such as Science, Geography etc.
3. The widespread appeal of mathematics and enjoyment can be illustrated by the introduction of mathematics puzzles and problems. It is important to show that although mathematics is most useful it can also be enjoyed simply for its own sake.

4. The rote-learning habit has to be broken. Pupils who listen to an explanation and then ask, "Will it always be done like that?" are desperately trying to form rules by which to learn their mathematics. Teachers must recognise these tendencies and discourage such learning. In addition, teaching and testing should be such that rote-learning of topics becomes inappropriate. Problems should require the pupil to make more use of mathematical inferences.
5. "Abstraction and Generalization" can be introduced at primary school through the study of shape and space, graphs of data, and properties of numbers such as even, odd, prime, square etc.
6. Discussion in class should be encouraged and teachers should be trained to listen to what the pupil is saying. Group discussion can lead to pupils discovering various paths to solutions whilst the teacher can discover any misconceptions of their pupils.
7. Practical work should be an essential aspect of the primary teachers work. The child must learn to <u>use</u> the mathematics he has learned. Pupils must be given the opportunity to show that they are capable of using their knowledge in a practical application.
8. Problem solving techniques are an essential part of mathematics teaching. One of the most important aspects of this is the reading of a problem. It appears that many students learn the mechanical processes but are unable to apply them to "word problems". These problems should relate to every day examples that the student is likely to encounter and also to situations with which he is unlikely to be familiar. As soon as a wordy example is presented children tend to avoid answering it or

interpret the information completely incorrectly.

Fundamental mathematics skills are needed for all the above recommendations and it is still necessary for these skills to be emphasised. Straight forward mental calculations, estimation and measurement are essential ingredients in understanding mathematics and are crucial to the development of the child.

4.2.2.2 Developing basic skills.

A sound knowledge of basic mathematical skills will not only ensure that pupils receive a good foundation in mathematics but it will also provide for less anxiety provoking progress in this subject. The National Council of Supervisors of Mathematics in the United States of America have recommended that the following "Ten Basic Skills" form an essential part of the curriculum of all mathematics students (Chapline and Newman, 1984, p8).

1. Problem solving.
2. Applying mathematics to everyday situations.
3. Alertness to reasonableness of results.
4. Estimation and approximation.
5. Appropriate computational skills.
6. Geometry.
7. Measurement.
8. Reading, interpreting and constructing tables, charts and graphs.
9. Using mathematics to predict.
10. Computer literacy.

It is not appropriate to elaborate on these 10 basic skills in this study. However, it is not only the mathematical content involved in these topics that is essential to teaching but also the development of cognitive skills which will give the pupil a better grounding in mathematics and enable him or her to proceed to the more abstract elements of mathematics without fear or anxiety.

Dodson (1970) found that successful problem solvers are good mathematics students and displayed the following characteristics.

(1) Scored higher on test of verbal as general reasoning than less successful problem solvers.
(2) Were good at determining spatial relationships.
(3) Were able to resist distractions and disregard irrelevant elements.
(4) Were divergent thinkers.
(5) Were unconcerned about "messiness" or "neatness" in their work.
(6) Had teachers with academic work beyond the bachelor's degree.

Undoubtedly, problem solving success is important to the mathematically anxious student. The most common approach to improving problem solving skills is provided in a book by George Polya called "How to solve it" (1957). Most strategies have evolved from the four steps that Polya outlines:-

1. Understand the Problem
2. Devise a plan
3. Carry out the plan
4. Look back at the condition of the problem

The most important factor here is that problem-solving is often neglected in the schools. Teachers who found problem solving difficult themselves are reluctant to teach it thoroughly. Carpenter et al (1980, p72) says that "there is no magic formula for making students good problem solvers. It is clear, however, that they need ample opportunity to engage in problem solving activity". They go on to say that this must not be deferred until after computational skills or algebraic manipulation is mastered but rather during this period. They suggest the following approach;

1. Make problem solving an integral part of all instruction, i.e. introduce new work by referring to Polya's four-step model or probing with questions related to a problem solving approach.
2. Give as many examples as possible of problem solving strategies and heuristics, such as:
    (a) Analysing the problem
    (b) Determining the unknown
    (c) Drawing diagrams and charts
    (d) Estimating results
    (e) Guessing and testing methods
    (f) Take a rest and returning to the problem later

The Cockcroft Report (1982, p94) stresses the need for more study of "children's spontaneous problem-solving activities and of the extent to which strategies and processes for problem solving can be taught". Not a great deal is known about the ways in which these processes develop and it is often very difficult for teachers to find suitable material. However, it is important for teachers to collect the right material and to provide the pupils with the opportunity to develop his or her skills.

The most important factor to remember when teaching problem-solving at any level is that the problems must be at the right level for the pupils to achieve success from a concentrated effort. Without some sense of achievement and the experience of success from their strategies their problem-solving abilities will not develop satisfactorily. The pupils need to be provided with the skills and the confidence to believe that the task of problem solving is not as formidable as they may have thought.

Problem solving skills are an essential ingredient in developing the other nine skills listed earlier. However, one other essential aspect in the teaching of basic mathematical skills is allowing the pupils the opportunity to develop their skills of investigation.

The Cockcroft Report (1982) lists some ideas of how investigational skills can be developed.

(a) Making graphical or diagramatic representation of the problem (e.g. investigating probability by recording the scores obtained when throwing two dice).

(b) Interpreting a pattern of results from such a graphical representation.

(c) Making conjectures to forecast later results.

(d) Discover whether, and explain why, the conjecture is or is not correct.

(e) Looking at simpler related problems (e.g. replace x and y with known numbers).

(f) Develop persistence in exploring a problem.

(g) Develop an ability to work with others.

(h) Be able to communicate progress.

Investigational and exploratory techniques will help to develop the mathematical skills of the pupils and encourage them to make an attempt at a solution. The gaining of confidence and the ability to start a problem without panicking are essential ingredients in the alleviation of mathematics anxiety. Developing basic skills is an important aspect of a programme aimed at alleviating mathematics anxiety and providing long term improvement in mathematics and continued success and enjoyment in mathematics. There are several reasons why the ten basic skills mentioned earlier are important to the pupil.

1. They are regarded as important skills for the future.
2. They provide interesting opportunities to develop a greater enjoyment in the subject.
3. They include opportunities to develop essential skills for the future progression in mathematics, e.g. problem solving, divergent thinking and investigational work.
4. They stress aspects which need understanding and not rote-learned methods.
5. They include sections of the work which are often perceived as difficult because they are neglected or poorly taught.

In essence the teaching of basic skills will ease anxiety at the processing stage described by Tobias (In Sarason, 1980) by reducing perceived difficulty, reducing reliance on memory and providing a more organised approach to the task at hand.

4.2.2.3 Attention to language and notation

The correct use of the curriculum and the teaching of basic skills both depend to a considerable extent on an understanding of the language and notation used in mathematics. Research into the interplay between language and mathematics is in its infancy, although it is conceivable that future studies will uncover significant relationships between learning of language and the learning of mathematics.

Mathematics is a language in itself and this is an aspect which sets it apart from other subjects. Faulty cognitions in mathematical language and notation is a problem that can seriously impair mathematics ability and hence cause mathematics anxiety.
The following aspects pertaining to mathematical language and notation should be noted.

(a) Single letters such as x and y, words such as "infinite" or "greater" and phrases such as "if and only if" are used more frequently in mathematics than in ordinary English.

(b) Names of mathematical objects usually have a single denotation, unlike nouns in ordinary English, e.g. "point" denotes only one thing in mathematics but in everyday language it can have a variety of meanings.

(c) Many mathematical expressions are hypothetical, e.g. "let the unknown number be x". This type of hypothetical reasoning is difficult for a child or adolescent at least until he or she has reached the stage of formal operational thinking and abstract thinking.

(d) Words like "perimeter" and "area" are normally new concepts and school children do not use these concepts outside school. For this reason they may often be confused.

(e) Mathematical word problems are normally more compact than ordinary prose. Several important ideas are squeezed into a single sentence, thus requiring more specific reading skills.

(f) Word problems often appear in groups of similar problems and students develop a tendency to process each problem in the same way. This tendency is hard to break when other groups of problems are encountered.

(g) Language related misconceptions formed at an early age are often resistant to change, e.g. "multiply means to make bigger" is true when a child first encounters arithmetic but is not true once fractions or negative numbers are introduced.

Special attention can be given to vocabulary by classifying mathematical words and concentrating on helping students to understand this mathematical meaning. This can be done by:-

(i) Always providing the words in context to describe what they mean, i.e. "volume is a way of telling about the amount of space in something such as a box".

(ii) Drawing a diagram to illustrate the meaning of the word. This is most appropriate in word problems.

The important point here is that teachers do not take the language for granted. They must realise that mathematical terminology must be used frequently and explained frequently because much of what is used is not similar to everyday usage.

Notation used in mathematics is certainly not similar to anything encountered in everyday usage. The use of symbols to abbreviate sentences is often cause for confusion. Without a thorough understanding of these symbols the student could be totally unaware of the requirements or information of a question. Many faulty conceptions are developed early and are often not recognised. Talking to pupils about their mistakes can help identify misconceptions. For example, a division in an algebraic expression $\frac{2yh + h^2}{h}$ may produce the answer $2y + h^2$.The teacher may feel that this is simply a careless error by the pupil. However, what many pupils do is regard the + as just another symbol and thus the numerator is seen as a string of symbols of which only the h can be eliminated. Thus, a seemingly innocent but very common mistake revealed a gross misunderstanding of mathematical language.

There are two important factors to consider when ensuring that mathematical notation is well understood:

(1) Always repeat the meaning of the notation used. These notations are only used in mathematics and therefore they need maximum exposure when they are used.

(ii) Do not take seemingly "careless" or "stupid" mistakes at face value. Investigate by asking the pupils how he or she arrived at the answer.

Dunlap and McNight (1978, p183) believe that "teachers can help children work math problems if they first understand the reading/thinking process involved". The translation of words and symbols is seen as an essential part of problem solving. Dunlap and McNight (1978, p184) suggest the following approach to assist pupils with word problems.

1. Decode general vocabulary - pupils need to be taught to interpret the general and mathematical meanings of words.
2. Integrate general meanings - finding the main idea, making generalizations and grasping and assimilating relevant details.
3. Translate to technical vocabulary - the general meanings need to

be translated into mathematical messages.

4. Encode to symbolic vocabulary - the mathematical message must be converted to symbolic sentences.
5. Calculate answer.
6. Translate the answer to technical and general vocabulary.

It would not be appropriate in this study to labour on the point of vocabulary and notation. However, it is important that teachers of mathematics realise the importance of this aspect of mathematics which is often not given much attention. Faulty cognitions of mathematical language and notation need to receive attention and practicing translations between general, technical and symbolic meanings in mathematics need to become part of an overall strategy to provide better understanding in mathematics.

4.2.3 Alleviating Test-anxiety

As mentioned earlier, Tobias (In Sarason, 1980) views test-taking as an important cognitive skill. In mathematics the ability to solve a single problem is often regarded as a test. Test anxiety hinders the pupil at the post-processing stage and can negate any earlier efforts to provide a more organised approach and a better understanding of mathematics.

Testing and student evaluation is as important in mathematics as it is in any other subject. Evaluation is important because it provides the teacher with feedback on which areas of the subject content needs attention. However, testing is anxiety provoking especially in mathematics where one's ability is more measureable and faulty cognitions can be easily detected.

It is important that pupils become desensitized towards tests. The following factors will help towards easing anxiety.

1. Tests should not be a surprise but rather announced well in advance.
2. Test taking skills should be taught. These skills must include three important ingredients, viz. organising the information given, devising a plan of action, and using initiative to carry out the plan.
3. The teacher should discuss what aspects will be tested and prepare the pupils for the test.
4. Results of tests should be reviewed as soon after the test as possible or else students will tend to forget their thinking strategy for any particular problem.
5. It is important that the mathematics anxious student experiences some success in tests. To aid them, tests could be set without a time limit and tests could be repeated until the content is mastered.
6. Failure in tests should be carefully discussed and students should be encouraged to improve their performance and not think that failure in one test indicates a lack of ability to do any mathematics.
7. Success must be attributed to the pupils' hard work and not to external factors such as "an easy test" or "luck".
8. The teacher must ensure that the classroom atmosphere is such that pupils do not feel threatened. The self-concept and self-confidence should be enhanced or at least protected whenever possible.

4.3 SUMMARY

The ideas of Sigmund Tobias (Sarason, 1980, p293) provide a framework in which remediation may be structured. By attending to cognitive skills at three levels one can alleviate anxiety and ensure a more rational approach to mathematics. The three stages of cognitive processing will receive attention by considering the following factors.

1. Pre-processing stage - consideration of cognitive-attentional theory by concentrating on learning skills to develop attention to task-relevant cues.
2. Processing stage - consideration of three elements
    (a) difficulty - easing anxiety by attending to unreasonable perceptions of the difficulty of mathematics
    (b) reliance on memory - instruction techniques to consider long-term understanding of the material
    (c) organisation - providing a more structured approach to problem solving
3. Post-processing stage - providing less judgemental methods of assessment and some attention to test-taking skills.

PART 5: EDUCATIONAL FACTORS

The socio-cultural emotive and cognitive factors influencing mathematics anxiety are all linked to the school and the mathematics teacher. It is important, therefore, that the educational institution and the instructional methods used within that institution take cognisance of what has been discussed earlier in this chapter. In this section specific attention will be given to the school and the teacher of mathematics.

The Royal Society (1976, p42) says that "there is no area of knowledge where a teacher has more influence over the attitudes as well as the understanding of his pupils, than he does in mathematics. During his professional life, a teacher of mathematics may influence for good or ill the attitude to mathematics of several thousand young people, and decisively affect many of their career choices. It is therefore necessary that methamatics should not only be taught to all pupils, but well taught. All pupils should have the opportunity of studying mathematics in the company of enthusiastic and well qualified sensitive mathematics teachers".

5.1 Background

Certain aspects within education have a profound effect on the development of mathematics anxiety. Teachers and teaching strategies, classroom organisation and the education department influence are all factors which directly control the progress of mathematics at schools. The main instrument of remediation in schools must be the teacher and the quality of mathematics teaching is now receiving more attention than ever before. In England, the United States of America and Canada educators are concerned about the dropping in standards of mathematics and they emphasise that the quality of the mathematics teacher is more crucial than that of most other subjects. There is growing concern for the preparation of teachers at all levels and opinions and evidences proliferate on the shortage of specialist mathematics teachers in England, the United States of America and South Africa. There are also serious doubts being expressed about the quality of these teachers who are charged with teaching this vital subject at the earlier stages of a children's education.

The following important aspects pertaining to the teacher have been evident in the literature reveiwed for this dissertation.

1. Teachers present mathematics as "the manipulation of symbols having little or no meaning attached according to a number of rote-memorized rules" (Skemp, 1971, p36).
2. Teachers can start a "vicious circle effect" because children in primary school are vulnerable to the whims and fancies of their teachers. A teacher who has a dislike of mathematics could relegate it to a low and insignificant position in the hierarchy of events in the school day or project a negative attitude to the subject (Griffiths, 1974).
3. The teacher may present an unrealistic view of mathematics by preparing the work well and then boosting his or her ego by making pupils believe that answers to all mathematics come quickly (Ernest, 1976).
4. The teacher who is so unsure of his or her own ability to understand and explicate the material that the students themselves lose all self-confidence (Ernest, 1976).

5. The teacher who pounces on students with unexpected questions and is often sarcastic and humiliating when someone is brave enough to ask a "dumb" question (Ernest, 1976).

Clearly, teachers and teaching methods must necessarily form an important part in helping to eliminate mathematics anxiety in pupils. Teachers have to be aware of the problem of transmitting their personal fears to their pupils whilst also presenting mathematics in such a way that both understanding and self-confidence are encouraged.

5.1.1 The Cockcroft Report

Many of the aspects mentioned above are also discussed in the Cockcroft Report. This is a report by the committee of inquiry into the teaching of mathematics at schools in Britain, under the chairmanship of Dr W H Cockcroft. This document is entitled, "Mathematics Counts" and is a most comprehensive report on mathematics teaching in Britain. One of the underlying themes of this report is the need to develop confidence and positive attitudes towards mathematics (Cockcroft Report, 1982, p61).

The report shows a concern for the anxieties raised by mathematics and reveals evidence of these anxieties in parents, pupils, teachers and young employees. Parents often ascribed failure to a specific cause when young, and this cause was often traced to a teaching problem. In every mathematics lesson the teacher is conveying a message about mathematics which will influence the learners' attitude. "Once attitudes are formed, they can be very persistent and difficult to change. Positive attitudes assist the learning of mathematics, negative attitudes not only inhibit learning but ... very often persist into adult life". (Cockcroft Report, 1982, p61).

It is not surprising then that the Cockcroft Report tends to stress the importance of the primary school and the need for good primary school teachers. By the end of the primary years a child's attitude is often becoming fixed and will determine how he will approach mathematics at the secondary stage. The Report says that "the challenge for the teacher is to present mathematics in a way which continues to be interesting and enjoyable and so allowing understanding to develop" (Cockcroft Report, 1982, p68).

Although this particular study is not looking at attitudes in detail it is necessary to recognise the important role that they play and the fact that a positive attitude towards mathematics contributes to better performance and less anxiety. The Cockcroft Report proceeds to make recommendations as to what steps can be taken to improve the situation. Their recommendations cover four main areas; viz.

1. Facilities for teaching mathematics.
2. The supply of mathematics teachers.
3. Initial training courses.
4. In-service support for teachers of mathematics.

Cockcroft emphasises one of the main needs when he says: "the need therefore is to increase the mathematical expertise of primary teachers overall; and also to increase the number of teachers who take mathematics as a main subject during initial training or who at a later stage undertake a substantial course of in-service training in mathematics, so that there will be sufficient supply of teachers who are able to provide leadership and help for their colleagues" (Cockcroft Report, 1982, p243).

Although there is no specific mention of mathematics anxiety the teaching arena and the mathematics teacher are two essential ingredients in this concern and any study on mathematics anxiety must include a study of teaching and teachers whilst any study of teaching and teachers must include a study of the Cockcroft Report. Pre-service and in-service courses must not only strive to increase the mathematical expertise of teachers but also strive to equip them with the confidence to overcome their own anxieties and hence help their students to combat mathematics anxiety.

5.1.2 Teacher Education and Mathematics (TEAM)

There is an abundance of work being done on mathematics anxiety in the United States of America. However, the bulk of the theoretical work has concentrated mainly on psychological approaches whilst much of the practical work has been to upgrade students registered for tertiary education. In a reference compiled by Sheila Tobias (1980) approximately 150 institutions in the United Sates of America offer some remedial help. Of these 150 institutions only 3 are concerned with schools and/or teachers. The course for prospective teachers at Queens College, New York is probably indicative of what may be the direction of future concern. The complete findings and a progress report is soon to be published by the Directors of this course; Claire Newman and Elaine Chapline.

Their main concern has been the role of the elementary school teacher and the large part she plays in developing childrens' attitudes towards mathematics and the relation between sex role and achievement in mathematics. Ernest (1976) reported finding 40% of a mathematics class for future teachers had expressed either negative or indifferent attitudes towards mathematics. He emphasised the need for teachers who are competent in mathematics, who love the subject, who enjoy teaching it and who will not project sexist expectations on the students. Donady and Tobias (1977) point out the need for teachers to become free of mathematics anxiety so that they can help their students avoid or overcome discomfort with mathematics.

TEAM is a response to the important need for programmatic approaches in teacher preparation which:

(a) foster positive attitudes towards mathematics;
(b) create awareness of sex-stereotyping in mathematics curriculum materials and classroom practice;
(c) develop a perception of mathematics as an appropriate domain for females.

The course is female orientated because the majority of students, all training as primary school teachers, are female.

The TEAM course consists of a set of modules designed for use in a variety of ways. It is best used in small classes which allow for discussion and it is designed to increase mathematical skills and improve attitudes within an elementary programme prior to the mathematics methods course. The modules which provide a course to increase mathematics understanding, skills and confidence for prospective elementary school teachers consist of:-

1. Patterns)
2. Approximation and estimation) improvement of mathematical
3. Choice and chance) skills
4. Metric Measurement)

5. Demystifying mathemtics)
6. Sex-role stereotyping in mathematics education) improvement of
7. Women, mathematics and careers) mathematics
8. Women in mathematics) attitude

The course is comprehensive and the strategies that have been designed and selected deal with a range of students' needs for mathematics knowledge and skills while concurrently dealing with students' attitudes. The most significant aspect of the TEAM approach is their attempt to integrate cognitive and affective learning opportunities. Although adhering to the theory that an increase in mathematics skills is usually accompanied by an increase in confidence in dealing with situations or problems calling for mathematics, attention is not only given to mathematics content but also to attitudinal commentary provided in the mathematics modules.

Problem solving techniques are taught and problems which are interesting and relevant to life experiences are predominant. Individual differences in difficulties with mathematical vocabulary are diagnosed and given attention. The inductive learning process of guiding the learner through a series of experiences or observations to a generalization, is the preferred method of tuition. The idea is for the students to experience the benefit of this method of tuition so that they might appreciate the value of this process's contribution to a learner's understanding of mathematics.

As many of the students are women, the materials have been designed to include information on the contributions of women to mathematics. Opportunities to learn what sex-bias entails and to examine mathematics curriculum materials for evidence of bias is provided.

Besides the excellent material choice offered in this course, the organisers have been careful to ensure that they create the correct learning environment. A non-threatening learning environment is essential for using the instructional materials. Both support and challenge are needed to create a climate in which learning is sustained. Instructors emphasise the processes with which the students are working, rather than focussing only on obtaining a right answer. Alternative routes in problem solving are sought after as the instructor recognises that students differ in learning styles, approach to the subject and background experience.

The important role of the instructor is to maintain an openness while ideas are being considered but this needs to be balanced with the concern for students' having clear knowledge of the correctness, efficiency and merit of the various ideas which may be considered. The strategy needed here is one of empathy. A psychologist or a counsellor may have no problem here but the mathematics instructor needs to be well versed with the strategies that convey empathy. The empathy must "exemplify an attitude towards students that facilitates supportive, non-threatening, yet task-oriented instructor behaviour" (TEAM Instructor's Manual, 1984, p11). Students are encouraged to work in groups and to co-operate on tasks rather than be in competition with one another. This mutual support system can encourage curiosity, experimentation and inductive thinking. Since teaching is the career goal of the students, they will find it especially meaningful to assist each other. However, it is important to recognise that there are specific times when modes of tuition may differ. Large groups, small groups and individual activities are all valid class organisation schemes and all three may be used.

For evaluation purposes the word "quiz" is used instead of test. The feeling is that "quiz" sounds less formal and although it will produce some tension this is necessary to keep the student interested and active. Students were allowed to retake quizzes until they mastered them. This policy has proved useful in increasing achievement, developing positive attitudes and providing psychological security. The instructor is encouraged to review the results with their students so that any negative feelings about self-worth and ability can be discussed openly and rationally. Self-evaluation is important because anxious students often attribute their successes to external variables such as "luck" rather than recognise that they worked hard and did well. Attitudinal interventions recognise the fact that a certain amount of tension can be facilitating and the goal is to provide and maintain such levels. The instructor learns to recognise anxiety when it appears, to permit students to express their feeling, to listen carefully and to monitor tension levels during class activities. Instead of talking about mathematics anxiety it is more useful to talk about mathematics confidence and confidence-building in general.

The module "Demystifying Math" provides the student with an insight into himself/herself as a mathematics learner. Students are made aware of what has caused some of their negative feelings and how they have maintained behaviour that is self-defeating. Once students can see that their behaviour is no longer useful, they can begin to replace it with more appropriate, self-serving learning strategies. Students are encouraged to keep a "weekly log" or "diary" which serves to clarify their feelings, ideas and reactions. In this way they are able to reflect on their behaviour and in so doing gain substantial self-knowledge. The log entries can also serve as a basis for classroom discussion and/or group discussion.

The instructor is the key to attitudinal change and it is important that he or she provides the structures and encouragement that enables students to shed tensions and replace them with growing confidence. In addition to cultivating sensitivity to students' feelings, the instructor must be able to provide help with the technical problems students encounter. Terms, symbols and problems should be more acceptable to these prospective teachers because they are now adults and have a greater verbal facility than when they were children. What is often needed though is encouragement to start a problem when the solution is not apparent. Students must be taught not to focus on their inability to cope but rather on some productive problem-solving activity related to the problem.

The TEAM approach is a most comprehensive programme which is sure to gain much acclaim in the United States of America and internationally when the instructional material is published. The programme is based on information in the research literature on mathematics attitudes, mathematics anxiety, sex-role socialization, sex-role stereotyping, mathematics instruction and educational psychology.

Many of the strategies suggested by the TEAM project have already been discussed in this study. Both emotive and cognitive factors form an essential part of this remediation programme whilst the ultimate aim is to prepare future teachers for the classroom. The prospective teachers are made familiar with the literature and are then encouraged to develop skills that will enable them to identify and counteract mathematics-anxious elements. This knowledge plus the whole construction of this course is aimed partly at preventing the prospective teacher from perpetuating the problems associated with mathematics anxiety by repeating stereotypic teacher behaviours and providing biased learning experiences for children.

5.1.3 Factors Influencing the Mathematics Learner

Several researchers have emphasised elements of the teachers situation that can have a debilitating effect on mathematics anxiety. The following is a summary of some of the most relevant aspects influencing the mathematics learner.

1. Buxton (1981, p7) emphasises the effects of three seemingly unavoidable factors in the school situation.

(a) The mere presence of an "authoritative figure" in the classroom is anxiety provoking because "that figure will make judgements about right or wrong". The effect on the pupil is one of pressure, confusion and panic. From the surveys done at a Durban primary school and Edgewood College of Education it would appear that the effect of the authoritative figure is less threatening at an early age. The threat is not felt only in the presence of the teacher but also in the knowing that the teacher marks the tests and will find out if anyone has not understood the work.

(b) Speed is the second factor that Buxton lists as adding to classroom anxiety. The need to complete a curriculum in a given time often leads to mathematics' teachers emphasising the need to work fast. Examinations and tests are set under pressure with a restrictive time limit and class work is often under pressure because if work is not completed it has to be finished at home. Although these problems do exist for other subjects the emphasis on method and accuracy makes mathematics a particularly difficult test to complete if one is a slow thinker. The speed factor works in conjunction with the "authoritative figure" factor because the teacher or examiner will be judging the work that the pupil has had to do so quickly.

(c) The classroom is a public place and this fact can have a profound effect on a child. The child is surrounded by his peers and a question asked in front of them can be totally exposing. For this reason many pupils prefer to remain ignorant rather than expose this ignorance in a public place. Although this applies to all subjects, questions in mathematics are often more frequent and revealing. In addition mathematics ability can be more easily measured by teachers and gauged by pupils than subjects such as English, Afrikaans and History etc. Too many experiences of incorrect answers and perceived ridicule in the classroom can cause the child to "give up" and not make any effort to participate in lessons.

2. Tobias (1980b, p34) has worked mainly with mathematics anxious adults and she has been able to gauge where the bad memories come

from. Needless to say, most bad memories of mathematics are school related and she places them in four categories which are classroom concerns. In some cases these concerns are very similar to those listed by Buxton.

(a) "Time Pressure" is again emphasised and here Tobias makes the point that "persistence and not speed is what teachers should be fostering". All too often a child will give up doing a problem because he cannot forsee completing it in a given time span.

(b) "Humiliation" in the classroom is the second cause of bad mathematics experience listed by Tobias. Here she makes the point that the child will not benefit from a public viewing of his or her mathematical weaknesses. The teacher should be aware of the fact that what they say can have a lasting effect on their pupils. Statements such as "You will never be able to do mathematics" can be most harmful and have obvious consequences. Even more subtle statements such as, "this section of the work is easy" can have a detrimental effect and be anxiety provoking. The implications to the child is that he had better be able to grasp this section of the work pretty quickly or else he is stupid.

(c) "The emphasis on one right answer" is often given too much attention. Tobias says that "over-emphasising accuracy makes students fearful of making mistakes. More credit and time should be given to method and the discovery of different ways to do a problem. It should be emphasised that mathematics is often a matter of trial and error that one is often working in the dark and may try several methods before hitting on the correct approach.

(d) "Working in isolation" is seen as undesirable by Sheila Tobias. She says the traditional mathematics class is never encouraged to work in groups. Emphasis is always on individual work and not discussing the answer or method with others. Tobias (1981) suggests that this is not in the best interests of the pupils. Pupils should be encouraged to work in groups so that they can learn from each other by discussing problem-solving strategies. In this way they will be more inclined to talk about their methods, learn to experiment with new methods and to take more risks in their problem solving techniques.

Hence, according to Sheila Tobias (1981) persistence not speed, praise not humiliation, method not answers and group discussion not isolation are theoretically the answers to reducing stressful situations in the classroom and perhaps achieving a better understanding and liking of mathematics.

3. Thompson (1982) carried out a study on three junior high school teachers' conceptions of mathematics and mathematics teaching. This is a rather small sample but the interesting aspect which was revealed in this study was the fact that what the teachers practiced was not what they preached. All three teachers did not discuss the practical uses of topics taught when they had all said that they believe in the relevance of mathematics. In addition, the teachers concerned used mainly prescriptive teaching when they had verbally expressed preference for activities requiring logical reasoning. It is often true that teachers may express a preference for methods which are more desirable and educationally preferred but when they work under the

pressure of having to complete a curriculum for an examination they often revert to more less favourable methods which are quicker and easier to administer but simply fill the head with know-how-to-do methods rather than develop a liking and understanding of the subject.

It is likely that many teachers are guilty of similar practices to those found by Thompson. It is easier to ignore those pupils in class who are considered incapable of coping with mathematics whilst curriculum and examination pressure tends to have a negative influence on the teaching of the subject. No matter what the philosophical aims of the curriculum may be it is only the teacher who can portray these aims and ensure they are effective.

4. Bulmahn and Young (1982, p56) hypothesised that, "in general, the kind of person who is drawn to elementary school teaching is not necessarily the kind who enjoys mathematics in the broad sense - from its logical beauty to its real-world applications".
Bulmahn and Young investigated their hypothesis by administering a 40 item questionnaire on attitude from 200 students at Indiana University. The students were also asked to write an essay based on their feelings towards mathematics. About half of these students were prospective elementary school teachers whilst the others were in mathematics and psychology classes and had majors of many different types. The authors point out that although essays are not considered "respectable statistical instruments" they are nevertheless valuable methods of investigation and did provide most informative reading. The findings included the following:-

(a) The prospective elementary school teachers have a much greater interest in language arts and social studies than in mathematics and science.

(b) Many students expressed the fact that,"math had always been my worst subject".

(c) Even students who had done relatively well at mathematics admitted to a real fear of word problems.

(d) Many students expressed the feeling that teachers do not really have to be very good at mathematics beyond the basic computations.

It is obvious from these findings that many elementary school teachers do not have the feelings for mathematics that could contribute to fostering a better attitude towards the subject amongst their pupils. In addition, the expressed view of little need for mathematics competence is an attitude which should be a cause for concern amongst educationalists. This attitude was also revealed earlier in this thesis when the survey results from Edgewood College of Education were discussed (see p 51).

5. Widmer and Charez (1982) conducted a survey of elementary school mathematics teachers in five northern Kentucky cities. They investigated the relationships between mathematics anxiety and four other characteristics of the teacher, viz. sex, career inhibition, type of training and recency of training. They found no significant relationships between:-

(a) mathematics anxiety and sex

(b) mathematics anxiety and recency of training.

However, the study did indicate that:-

(a) subjects classified as mathematics-anxious showed more evidence of inhibited career goals than those classified non-anxious

(b) their perception of their mathematics training had a significant effect on mathematics anxiety. Those teachers who perceived their training as more understanding orientated were found to exhibit less mathematics anxiety than those who perceived their training to be more computationally orientated.

This study seems to indicate that teachers should be made aware of the fact that the way pupils perceive their teaching will have a profound effect on the anxiety they exhibit. Teaching with empathy and understanding are essential ingredients for successfully combating mathematics anxiety which, in turn, prevents inhibition of career goals.

The background provided in this section is perhaps as important as the treatment ideas which will follow. The reason for this is that the success of the treatment is dependent to a large extent on the attitude and the personality of the mathematics teacher. Hence, an understanding of certain aspects of the classroom which can cause anxiety will enable the teacher to approach the task of remediation well equipped to rectify the problems that may arise.

5.2 Treatment

Clearly treatment in this area has to take the form of educating teachers and prospective teachers on how to teach mathematics to avoid anxiety developing in their students. Such a programme requires the support of the Education Department and the school. Attention needs to be focussed on the following three areas.

1. Departmental influence
2. Headmaster/school implementations
3. Classroom strategies to avoid mathematics anxiety.

It is essential that all three issues provide the necessary input to encourage remediation. The Education Department can lay the foundations for the headmaster and school to provide the facilities for a remediation programme which will give the teacher ample scope to implement teaching strategies necessary to combat mathematics anxiety.

Aspects discussed here can be implemented at teacher training institutions and at all schools but the consensus of opinion amongst researchers indicates that the primary school and the primary school teacher should be the main concern.

5.2.1 Departmental Influence

The Education Department has a responsibility to all schools to provide certain requirements that facilitate better teaching methods and classroom techniques. The Department should:-

(1) Advise on schemes of work for the schools and provide guidance at Primary and Secondary School seminars.

(2) Be responsible for obtaining up-to-date teaching aids and inventories and ensure that teachers are aware of the resources available.

(3) Encourage less formal testing at school level and more practical application.

(4) Arrange in-service training for small groups (area based or school based).

(5) Provide literature (brochures) for parents informing them of the methods used in the teaching of mathematics, the aims behind these methods, and how the parent can be of assistance by being supportive.

(6) Provide opportunities for children with difficulties in mathematics to be diagnosed and remediated.

(7) Arrange seminars for "bridging the gap" between high school and primary school teachers as well as high school and university.

(8) Provide training for prospective teachers which includes an awareness of the problem of mathematics anxiety and how the problem may be perpetuated. Methods to combat the problem should also be expounded during pre-service training.

5.2.2 Headmaster/School Implementations

As head of the school the headmaster needs to be sympathetic to the requirements of preventing and treating mathematics anxiety. He needs to involve his school in a strategy which will facilitate better learning of mathematics. It is the headmaster's responsibility to ensure that the staff and the parents are encouraged to work together towards alleviating mathematics anxiety. At the same time provision should be made to facilitate a programme which is designed to combat mathematics anxiety.

5.2.2.1 The staff

The entire staff of any school should be aware of the problems that mathematics anxiety can cause and the detrimental affect they may have on a child's progress. It is not enough that the mathematics teacher alone cultivates confidence in the subject. Other teachers must not consciously or subconsciously disturb the progress. Teachers of other subjects may proudly announce that they were never any good at mathematics or teachers of many subjects (as in primary school) may present mathematics unfavourably when compared to the other subjects. Often mathematics is the work period and English or History is the reward or relaxation period. For example, children may be asked to complete a mathematics exercise before being allowed to read. The implication being that mathematics is hard work and reading fun.

The headmaster should utilise the literature and brochures suggested earlier in this chapter, to make all staff aware of the problem and the pitfalls. The timetable should be arranged so that mathematics is not disadvantaged. Mathematics need not always be early in the day but rather at various times to compliment the varying aspects of the teaching of mathematics, i.e. mental, mechanical, practical. In addition, the mathematics should be utilised in as many other subjects as possible. The difficulty that pupils display with word problems on everyday experiences seems to indicate that there is very little cross-curriculum work done at school.

5.2.2.2 The parents

The school should also accept the responsibility of involving parents in the programme. Again the brochures that are suggested should perhaps be given to parents during a parent evening or open day address. Once parents are aware of the problem and the considerable influence that they have on their children's attitude then they may be recruited to help, They could be made aware of the following ways in which they can help:

(1) Encourage their children to make use of mathematics during normal family activities. They could be involved in weighing and measuring at home, whilst during shopping they could be

encouraged to use money.

(2) Parents need to be careful not to reveal any fear or dislike they may have for mathematics. Parents should also have realistic expectations. Exerting too much pressure on a child can lead to failure and dislike of mathematics.

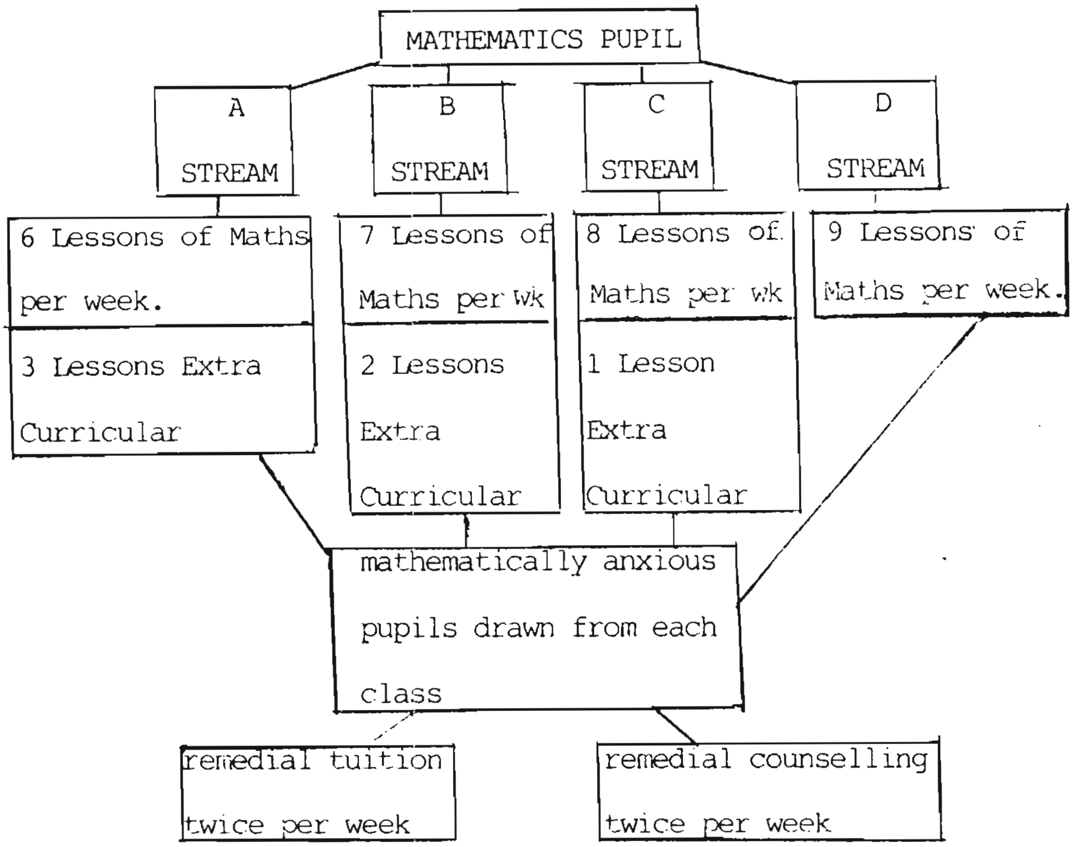
(3) Parents should be made aware of the negative effects of remarks which they may make which may add to the poor attitudes the pupils may develop.

(4) Parents can be made aware of the methods being used in mathematics teaching and the requirements of the mathematics syllabus.

Much of what is required here by the headmaster/school has already been mentioned in the section on socio-cultural factors influencing mathematic anxiety. However, it is important that the headmaster takes cognisance of the above points and provides for parent evenings and encourages parental support in a campaign against mathematics anxiety.

5.2.2.3 School organisation

The headmaster can ensure that pupils are receiving remedial attention by organising the school time-table to accommodate the mathematics anxious pupils. As needs change from school to school and from standard to standard it is difficult to be too prescriptive here. However, an idea of what each school may be offering is given in the following diagram.



This model shows how the mathematically anxious pupils may receive attention in both the classroom context, together with other pupils, and as a selected group. Mathematics performance receives attention whilst at the same time anxieties are being calmed. Extra-curricular activities for the brighter pupils need not necessarily be in mathematics but should serve to extend these pupils. The periods indicated are not prescribed but would vary according to need.

In implementing the above structure into the school programme it is important to note that remedial work will only be successful if teaching methods during normal lessons do not create mathematics anxiety.

5.2.3 Teaching To Avoid Mathematics Anxiety

It has been mentioned throughout this study that alleviating mathematics anxiety requires attention to both cognitive and emotive issues. It is important that teaching methods take account of these issues and that teaching strategies include attention to:-

1. Improving content knowledge, and
2. Providing a suitable classroom atmosphere.

The manifestation of mathematics anxiety is often the result of a combination of reactions to a lack of understanding the material and bad experiences in the classroom situation. By attending to both the cognitive and emotive requirements in the classroom the teacher can provide a situation which is less likely to provoke anxiety.

5.2.3.1 Improving content knowledge

Certain topics in mathematics are generally more anxiety-provoking than others. These topics may have been "badly" taught or may simply cause more difficulty than others. Topics such as spatial skills, problem solving, fractions and percentages are often quoted as topics which are difficult to teach and are not fully understood by the pupils. Although teaching mathematics should involve a thorough understanding of all topics it is of particular importance in those topics which create difficulties and thus lead to anxiety.

The Cockcroft Committee thoroughly investigated the teaching of mathematics in schools in the United Kingdom and their recommendations on teaching mathematics content provide excellent ideas for the teacher. Their review of research reveals that in the teaching of mathematics content it is possible to distinguish between three elements.

1. Facts and skills.
2. Conceptual structure.
3. General strategies and appreciation

(Cockcroft, 1982, p70).

These ideas can provide a working structure for the mathematics teacher which would ensure that the mathematics anxious child receives mathematics tuition which not only provides basic facts and skills but also develops his interest in mathematics and provides him with the necessary thinking ability which would benefit him as he progresses through school.

Whichever topic is being taught considerable thought and preparation should preceed any action. The three elements listed above could firstly be expanded as follows.

1. Facts (Knowing) 2. Skills (Developing Routines)	Element 1
3. Conceptual Structures (Understanding)	Element 2
4. General Stragegies 5. Appreciation	Element 3

If the topic "Percentages" proved to be one that was causing difficulty the mathematics teacher should first consider the following:

1. Facts	Per cent means 1 in 100 Symbol % 1 cent in the Rand. G.S.T. Interest, Cost Price, Selling Price Profit and Loss etc.
2. Skills	The following routines should be developed

	Finding a % of a quantity % increase or decrease Expressing 1 quantity as a % of another Changing a fraction to a %
3. Conceptual Structures	To ensure understanding of percentages some attention needs to be given to fractions, ratio and proportion, decimals, statistics etc.
4. General Strategies	The pupils should be taught when percentages are used and how they often automatically use them, e.g. What percentage of the "possession of ball" has their rugby team had from the scrum? or what percentage is the flour ingredient to the whole cake recipe?
5. Appreciation	This can be easily linked with the general strategies by emphasising common everyday usage of percentages in many examples.

Whilst emphasising that it is not desirable that all teachers use the same teaching style, The Cockcroft Report (1982, p71) does express a need for mathematics teaching to include certain ingredients at all levels. The following teaching methods will ensure that the five important elements listed earlier will receive attention in the classroom situation.

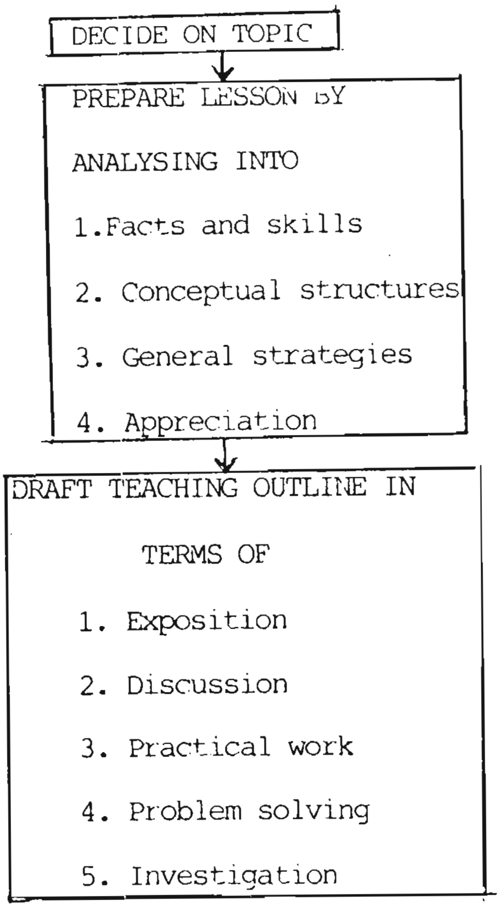
1. Exposition by the teacher.
2. Discussion between teacher and pupils and between pupils themselves.
3. Appropriate practical work.

4. Consolidation and practice of fundamental skills and routines.
5. Problem solving including the application of mathematics to everyday situations.
6. Investigational work.

Using the example of teaching percentages, these teaching guidelines suggest an approach which would follow the procedure outlined below.

1. Exposition	Introduce the facts about % and explain words such as G.S.T., Interest, Profit and Loss etc.
2. Discussion	Allow the group to discuss reasons for %, uses of % - comparisons with decimals and fractions etc. and when to use %.
3. Practical	Calculating G.S.T. on items they see in the newspaper. Calculating interest on money they might save. Percentage increase in shares. Play games e.g. %, fractions, decimals matched on dominoes.
4. Problem solving	Problems involving money, credit cards, compound interest, investment, inflation rate etc.
5. Investigations	e.g. Newspaper adverts with WAS and NOW prices. Discover if the discount % is the same for each item, or, how would you decide how much acid to add to the water in a swimming pool to make it a 1% acid solution?

The following diagram summarises the approach suggested by the Cockcroft Committee.



By careful preparation and a well-structured lesson the teacher can assist those pupils that have difficulty in certain topics of mathematics and who may have developed an anxiety which although connected to these topics has led to a more generalised anxiety when dealing with any mathematics.

5.2.3.2 Providing a suitable classroom atmosphere

Whilst efforts to improve understanding of the content material in mathematics will give the pupil added confidence it is essential that teachers develop strategies which will help alleviate emotive reactions to mathematics. For this reason it is important that teachers are equipped to break the cycle of poor attitudes and anxieties and are eager and able to provide their pupils with positive experiences in the learning of mathematics. The following points could form a summary of ideas for the teacher to increase interest in the subject and to reduce the possibility of developing anxiety-provoking situations in the classroom. Some of these points may have been mentioned earlier in connection with other anxiety-provoking factors. However, it has been explained that there will necessarily be some overlap and it is important that all the factors influencing teaching strategies are mentioned at this stage. Teaching to avoid mathematics anxiety could be regarded as the consolidation of much of what has been discussed in this study.

1. Create a positive supportive classroom atmosphere

(a) Empathy is a necessry ingredient for all mathematics teachers to develop. Comments such as, "I just explained that", or "you should have learnt that years ago", or "this should be an easy section", should be avoided. Mathematics anxious pupils are especially sensitive to this type of criticism and often their history will reveal that they have encountered such lack of empathy somewhere in the past.

(b) The rigidity of right and wrongness of mathematics causes much tension. Mathematics teachers should consider the origin of various answers without immediately claiming they are wrong. This will ease the anxiety of the pupils and encourage them to answer more questions.

(c) It is better to acknowledge that some mathematics may be difficult rather than claim it is easy and cause pupils to become anxious because they cannot understand a section of the work. When difficulty is acknowledged it should be communicated with a faith in the learner's ability to master the material.

(d) The mathematics teacher should avoid insensitive behaviour which can create a dislike for mathematics. This insensitivity could take the form of:-

(i) making condescending remarks

(ii) using mathematics as a punishment

(iii) refusing to answer legitimate questions or giving help where needed

(iv) creating humiliating experiences for pupils

(v) making tests and assignments unreasonably long or difficult

(e) It is essential that pupils are provided with the supportive climate in which taking risks is perceived as acceptable. It should be emphasised that although some mathematics can be purely mechanical and computational, it is more important to develop inventive approaches. Educated guessing, estimation, creative and unique methods and perseverance should all be supported and regular positive reinforcement should be used to encourage pupils to investigate an inventive idea.

2. Encourage student-to-student communication

(a) Co-operation not competition is what should be encouraged. Positive student attitudes can be developed from a student's sense of being part of a mutual support system which can encourage curiosity, experimentation and intuitive thinking.

(b) Pairing and group work can serve to enrich a student's experience. Whilst a low level of competition may be constructive, the teacher needs to be aware of any tensions that may arise as a result of competition.

(c) Students should be encouraged to discuss their difficulties in class. In this way common problems will be recognised and students will feel less individual tension.

(d) Class discussion will also provide greater opportunity to correct faulty cognitions.

3. <u>Vary classroom organisation and learning activities</u>

To facilitate a supportive classroom environment and student-to-student communication as well as helping to maintain interest, the mathematics teacher should vary classroom organisation. Large groups to present specific content, small groups working on problems and individual activities to evaluate their own skills. The teacher should make use of these methods in accord with the nature of specific objectives and activities he or she has in mind. Instruction to a large group makes best use of the instructor's time. Working in small groups can serve to strengthen and expand students' mastery of specific concepts by applying what has been learned, whilst also providing opportunities to clarify their understanding of concepts. They may also discuss feelings, reactions, responses and questions.

Peer tutoring should be encouraged when groups are working together. Pupils feel less threatened when revealing their problems to their peers rather than to the teacher. Pupils may also be given a chance to select from various learning activities and audio tapes, video tapes, games, charts etc. can be used whenever possible. These activities will help to stimulate interest and increase motivation.

4. <u>Be sensitive to timing and pacing</u>

(a) The teacher needs to develop a sensitivity to each class as a group. This enables him or her to select the appropriate alternative learning activities and to judge the need for repitition.

(b) Grouping in classes may be used to facilitate the different ability levels in the classroom and the various groups can be encouraged to work to their specific learning rate and style.

(c) Pupils may be encouraged to take a break in the middle of solving a problem. This allows for a less rigid approach to problem solving and more time to assess new ideas and discuss methods.

(d) Allowing more time for pupils to respond to questions will allow for more answers. Receiving more questions and answers from pupils is an indication of their interest and enthusiasm.

5. Stress understanding

As mentioned throughout this study, memorization and rote-learning often replaces understanding. The problem that the teacher faces is the fact that almost certainly at primary school and lower high school level, the rote-learning method will produce good examination results. The teacher is often judged on the evidence provided by examinations and therefore it is clearly more advantageous to resort to a method of teaching that promotes rote-learning. This may be avoided by eliminating formal examinations but it is also essential that the teacher is motivated to prepare pupils for the more abstract type of mathematics which they will encounter in later years.

Rote-learning habits should be discouraged at an early age by giving less emphasis to formulas and rigid methods. Whilst purely mechanical and computational skills are important a greater emphasis should be given to processes and applications which develop mathematics understanding.

6. Avoid inflexible or excessively authoritarian teaching

An aspect of teaching which often leads to the promotion of rote-learning is the rigid, authoritarian approach that some teachers adopt. Teachers should avoid describing methods to pupils and claiming that understanding will be evident at a later stage. This type of teaching often leads to a dislike for the subject and an anxiety that perhaps the topic will never be fully explained. A more investigative approach will ensure greater participation and less dependence on teacher instruction. The recently introduced new syllabus for mathematics provides opportunities for teachers to adopt a less authoritarian approach and to give more emphasis to topics which foster individual thought. The following factors should be considered.

(a) Encourage creativity in problem solving.

(b) Give more emphasis to method and less emphasis to the final answer.

(c) Encourage good, intelligent guessing and intuition by teaching estimation and approximation.

(d) Do not dismiss wrong answers without investigation. Often pupils misinterpret the question and then give the right answer to the wrong question.

(e) Allow more discussion in class and only assume the role of the teacher as the final source of authority.

(f) Provide as many positive maths experiences as possible in order to develop in the pupils a willingness to try a problem. Too often pupils avoid starting a problem as a defensive mechanism to protect themselves from what they are sure will be defeat or humiliation.

7. Avoid sex-role stereotyping of mathematics as a male domain

Evidence has been found to point to the fact that mathematics anxiety can be nurtured by the perception of mathematics as an activity which is more appropriate for males. Studies discussed previously have revealed that sex-role stereotyping can lead to girls being encouraged, directly or indirectly, to avoid high school mathematics. Teachers tend to treat male and female pupils differently and they reinforce in both males and females behaviours which one deems appropriate for their sex. Differential expectations can lead to differences in performance. It is important therefore that teachers note the following:-

(a) Do not have different expectations for success and achievement in mathematics for male and female students.

(b) Do not differ in interactions with male and female students in the classroom.

(c) Be aware of sex-biased questions in text books and be careful not to include them in tests.

(d) Provide positive, appropriate role models for students of both sexes. Female students need to see other females succeeding in mathematics.

8. Be aware of the possible negative effects of testing

Betz (1978, p85) says that "most tests are administered under conditions which violate almost every principle for effectively doing mathematics, thus they themselves generate anxiety and establish a stable association between education and anxiety". Betz is obviously referring to the emphasis on correct answers and the speed factor as well as the anxiety provoking evaluative situation. Teachers need to develop a new attitude towards testing by considering the following:

(a) Do not overemphasise testing as a means of evaluating mathematics. Use other methods such as assignments and projects.

(b) Provide ample time for working a test. Avoid always giving timed tests which create excessive pressure on pupils. Obviously this would be more difficult to implement as the pupil progresses but the fact that an external examination is set in Standard 10 does not necessitate excessive testing from an early age.

(c) Do not always set excessively difficult tests or mark tests over strictly. The non-anxious pupils may respond to the need to improve but the anxious pupils need positive reinforcement which will enhance their self-confidence and their belief that they can do mathematics.

(d) Give written comments on tests. Answers should not simply be marked right or wrong. Encouraging comments should be included where correct procedures are noted and errors should be analysed and constructive advice given which will assist the pupil in rectifying mistakes.

(e) By allowing pupils to rewrite a test the teacher will be providing an opportunity for the contents to be mastered. Mastery of the material is as important as the evaluative aspects of testing.

5.3 SUMMARY

The educational factors influencing mathematics anxiety which have been discussed in this section are essentially school related and more specifically teacher related. Factors discussed as socio-cultural, cognitive and emotive variables influencing mathematics anxiety are all evident in the school situation and therefore a certain amount of overlap is to be expected. Within the school itself, strategies for remediation can only be implemented by enlisting the support of all parties concerned.

1. The Education Department must provide guidelines on how best to implement the new curriculum to provide for anxious-free continuity of mathematics.
2. The headmaster and staff need to work together to provide the best structure of classroom organisation and the teaching environment.
3. Mathematics teachers must present the subject in a non-anxiety provoking manner and in a way that stresses understanding and a development of the subject matter.
4. Teachers at all levels should liaise on the continuing nature of mathematics and ensure that teaching strategies provide for anxiety-free continuation in the subject.
5. Teaching to avoid mathematics anxiety should involve providing remedial tuition to improve mathematics content knowledge as well as creating an anxiety-free classroom atmosphere.

CONCLUSION

CONCLUSION

The intention of this study is to provide ideas on the treatment of mathematics anxiety. Like most developmental problems, mathematics anxiety is influenced by many factors and it is difficult to restrict the number of related aspects which should receive attention. However, certain factors recur frequently in the literature and it is these crucial concerns which have been included in this study.

There are two main criticisms of the overseas studies which have been described in this thesis.

1. Many studies have been short-term orientated in that attempts have been made to measure mathematics anxiety levels in small groups at a particular institution. These levels of anxiety are then lowered by some means of remediation. No follow up information is provided to assess the long-term success of these interventions.
2. The more comprehensive surveys such as those implemented by the NFER and Brunel University have merely identified problems and no attempt has been made towards any remediation.

Whilst these methods do have some benefit it should be realised that mathematics anxiety is widespread and that any attempt at remediation should be an ongoing process and involve as many people in the population as possible. The approach in this thesis is more one of prevention by providing insight into the problem and educating a broad spectrum of society about mathematics anxiety and its consequences.

For this reason the background information provided should be seen as a treatment factor in itself. The background information and research also provides one with a basis for treatment strategies and it is with these in mind that the following premises may be listed as the foundation to one's approach.

1. The problem of mathematics anxiety does exist.
2. There is a need for something to be done about this problem.
3. Mathematics anxiety manifests itself at an early age.
4. There are several factors that influence this manifestation.
5. Remedial strategies need to be developed which deal with aspects pertaining to the sources of mathematics anxiety.
6. There are two main aims to remediation, viz. mathematics performance must be improved and mathematics anxiety must be alleviated.
7. The approach to treatment must include both prevention and cure strategies.
8. Remediation must lead to long-term improvement in performance, reduced anxiety levels and a more positive attitude; and, aim at a life-long improvement and appreciation of mathematics.

Before attempting to describe remediation processes it is necessary to define mathematics anxiety, identify the sources of this anxiety and investigate ways of assessing a person's level of anxiety and how it will affect his performance. Mathematics anxiety is complex in nature and the sources are multifaceted. To provide some clarity the sources were categorised and discussed under the four headings:-

1. Socio-cultural factors.
2. Emotive factors.

3. Cognitive factors.
4. Educational factors.

The idea of dividing this study into four categories is intended to merely provide a clearer picture of the diverse aspects influencing the manifestation of mathematics anxiety. It must once again be stressed that these four areas are not clearly defined but rather interrelated and overlapping in parts.

Socio-cultural factors influencing mathematics anxiety are those conditions which are developed by society through certain culturally acceptable beliefs. The emotive factors are seen mainly as the individual's reaction to certain culturally held beliefs and are influenced particularly by emotive attitudes which arise from the connotations and myths connected with mathematics. Hence, the socio-cultural and emotive issues influencing mathematics anxiety are seen as more closely related although not entirely divorced from other factors.

The cognitive and educational factors influencing mathematics anxiety are also closely related. Cognitive factors are recognised as certain elements pertaining to the contents of mathematics which can cause anxiety. As with emotive factors, cognitive factors are of an individualistic nature as each individual is affected differently by the various problems caused by the unique nature of the subject. Educational factors are categorised as those aspects of the school which have the most influence on mathematics anxiety. The school as the educational institution and the teacher as the main instrument of instruction are seen as the central aspects which influence mathematics anxiety and where treatment can begin.

Assessing levels of mathematics anxiety is an important prerequisite for treatment methods. Whilst a brief mention of the historical development of mathematics anxiety scales gives some insight into the methods of measurement it was necessary to select and recommend a scale suitable for the South African situation. The Mathematics Anxiety Rating Scale (MARS) described in Chapter 2 was recommended for use in large surveys. However, it was suggested that this scale should be modified and adapted to suit the composition of the sample population being tested so that measurement of levels of mathematics anxiety may be carried out at different levels and at various institutions. Two exploratory investigations were carried out at Edgewood College of Education and at a Durban primary school. This type of survey will help to identify the mathematics anxious pupil and the areas of mathematics that may need attention.

To measure mathematics ability, attitudes and personality traits other tests will need to be developed according to the requirements of the research. The ultimate success of a mathematics anxiety remedial programme can only be assessed when mathematics ability is measured before and after treatment. An important aspect of measuring mathematics ability was identified as an "inference factor" and is described as the ability of the student to make the correct mathematical inferences from the basic knowledge which has been accumulated. Tests constructed to measure mathematics ability must take cognisance of this aspect and questions which probe the student's understanding of the basics of mathematics must be included.

Knowledge gained from assessing anxiety and other related aspects will provide a basis for arranging remedial class groups and organising a remedial programme. However, it was emphasised that individual anxieties are uniquely manifested and that attention to individual assessment is crucial to the success of remediation.

Individual remediation is, however, rather time consuming and not entirely practical in large institutions. In smaller groups or when a small number of pupils have been identified as particularly mathematics anxious a more individualistic approach may be used. Mathematics anxious pupils may be identified by interviewing pupils individually and faulty methods can be discovered by listening to pupils describe their approach to a mathematics problem. In this way remediation can be more specific in dealing with alleviating the individual's bad experiences and rectifying the topics of mathematics which cause his anxiety.

In most instances treatment procedures will need to be devised for large institutions and it is for this reason that the ideas suggested in this study are of a more general nature. It is recommended that treatment starts at an early age and therefore remedial programmes are described which would be suitable in the primary school. However, it is envisaged that these ideas can be easily adapted to suit high schools and tertiary insitutions. In particular, teacher training institutions should include a programme which creates an awareness of mathematics anxiety whilst also providing recommended teaching strategies which will help to alleviate the problem of mathematics anxiety.

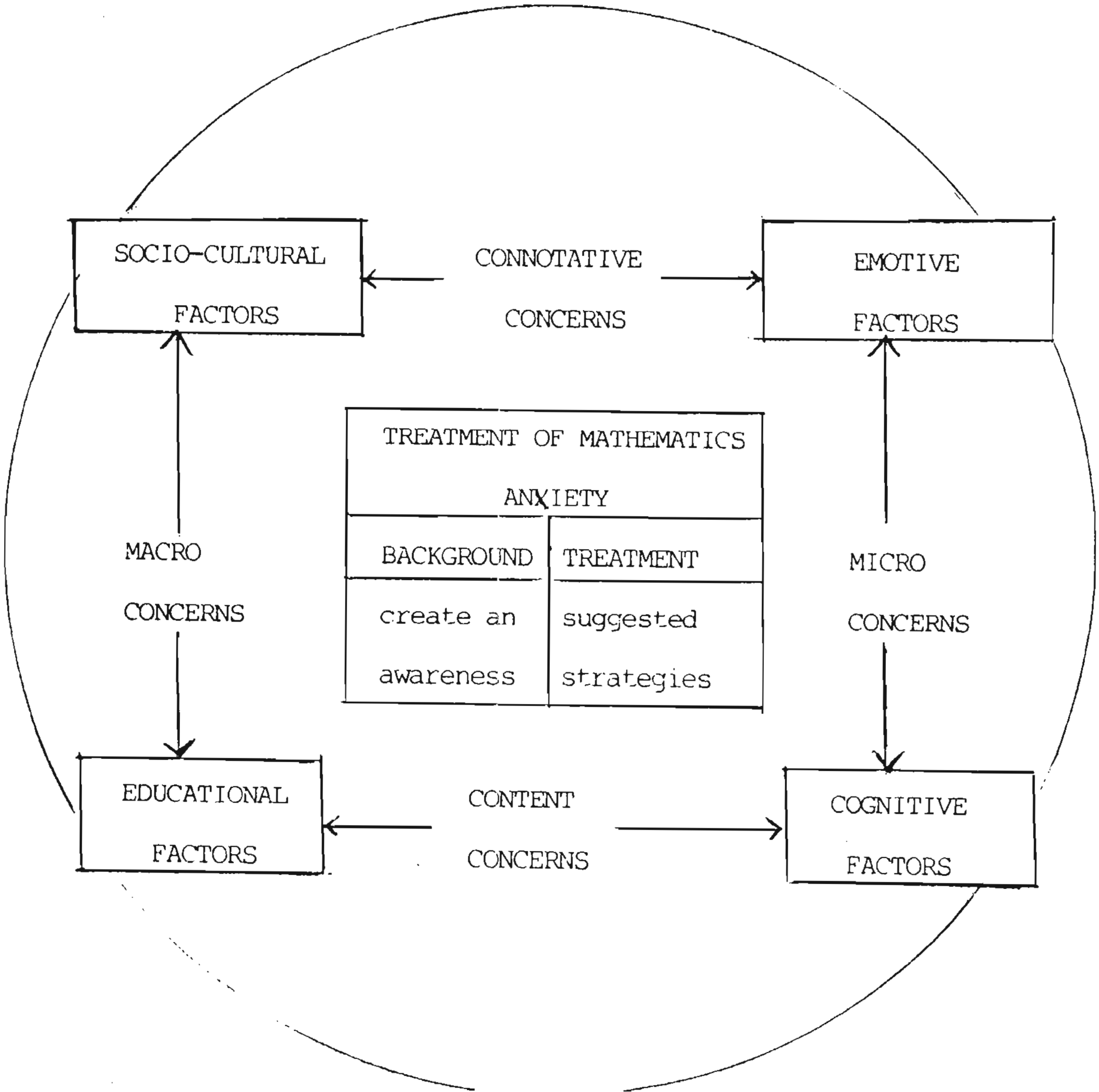
Treatment methods are divided into the categories which identified the main sources of mathematics anxiety. Once again the problem of interrelated issues and some overlap was unavoidable and the fact that many aspects are closely related must be recognised. The approach to remediation could be described in the sociological terms of macro and micro concerns. The macro issues involve the socio-cultural and educational structures whilst the micro issues are more individually orientated and deal with the emotive and cognitive factors which impede the mathematics progress of the individual.

In addition to the categorisation of macro and micro concerns, the four categories of remediation could also be classified according to their mathematical approach. Socio-cultural and emotive treatment procedures are orientated more towards the connotative elements of mathematics whilst educational and cognitive treatment is concerned more with mathematical content. These are not clearly defined divisions but they do help to describe the intricate link between the four areas involved in treatment.

The overall strategy towards treatment in the four areas is firstly to create an awareness of the problems influencing mathematics anxiety and secondly to suggest certain remediation methods. For this reason the four categories in Chapter 4 were discussed under the headings "Background" and "Treatment". The background should not be regarded as simply a prologue to treatment strategies but rather as an important aspect of treatment in that the information provided is intended to stimulate interest and create an acute awareness of the problem of mathematics anxiety.

The treatment factors also provide some ideas on how best to use the background knowledge in the formulation of a plan of remediation. The essential aspects of micro concerns is to improve the self confidence of the individual and develop a better understanding of mathematics. The macro concerns require a structured approach towards informing and educating the public as well as providing opportunities in the school for classroom organisation and teaching methods which will be beneficial to the remediation of mathematics anxiety.

The diagram below provides a simplified yet clear picture of the overall strategy towards remediation of mathematics anxiety.



In the diagram the circle depicts the interrelation of all four treatment concerns whilst the macro and micro approaches and the connotative and content links are also indicated. Whilst this diagram tends to simplify a complicated situation it does illustrate how the treatment of mathemtics anxiety should include attention to all four related areas.

There is inevitably some overlap when considering micro and macro concerns but the difference is in the approach. Development should take place within the individual whilst this development is facilitated by societal conditions favourable to alleviating mathematics anxiety. The final result should provide for three basic requirements.

1. Ensuring that the problem of mathematics is not perpetuated through pupils, parents and teachers.
2. Ensuring that mathemtics anxiety is alleviated in students and that they are given the opportunities to progress free of the emotive issues which may hinder them.
3. Ensuring that mathematics performance is improved by providing understanding, concentrating on weaknesses and improving basic mathematical skills.

By using a combination of prevention and cure methods it is envisaged that the complex problem of mathematics anxiety can be alleviated and that this will lead to a better understanding of mathematics, a long-lasting improvement in mathematics ability and a greater enjoyment and appreciation of the subject.

APPENDIX

COLLEGE OF EDUCATION SURVEY

The items in the questionnaire refer to things and experiences that may cause fear or apprehension. For each item place a tick (✓) in the box under the column that describes how anxious you feel about the situation described.

	NOT AT ALL	A LITTLE	A FAIR AMOUNT	MUCH	VERY MUCH
1. Watching a lecturer do maths on the board.					
2. Having someone watch you when you do maths.					
3. Opening a maths book and seeing a page full of problems.					
4. Studying for a maths test.					
5. Thinking about an up-coming maths test one day before.					
6. Entering a maths class					
7. Studying for a maths examination.					
8. Working with a calculator.					
9. Having your lecturer watch you as you work through a problem.					
10. Writing a maths test					
11. Waiting to get the results of a maths test in which you expected to do well					
12. Waiting to get the results of a maths test in which you expected to do badly					
13. Being asked how you arrived at a particular answer to a problem.					
14. Being given a sudden quiz in a maths class.					

	NOT AT ALL	A LITTLE	A FAIR AMOUNT	MUCH	VERY MUCH
15. Asking your maths lecturer to help you with a problem you do not understand.					
16. Listening to a lecture in a maths class.					
17. Not having the formula needed to solve a particular problem.					
18. Listening to someone explain how a computer works					
19. Reading a formula in chemistry.					
20. Having a friend try to teach you a maths problem and finding you do not understand.					
21. Discussing a maths problem with someone in your class who does well at maths.					
22. Receiving your final maths results in the post.					
23. Reading and interpreting graphs or charts.					
24. Trying to estimate the answer to a square root problem before looking for it in your tables book.					
25. Being called upon unexpectedly to recite in a maths class.					
26. Doing a word problem in Algebra.					
27. Watching a lecturer work an Algebraic equation on the blackboard.					

	NOT AT ALL	A LITTLE	A FAIR AMOUNT	MUCH	VERY MUCH
28. Having to use a 3 figure table book.					
29. Being given a homework assignment of many difficult maths problems which is due in the next class meeting.					
30. Calculating the sales tax on a purchase.					

QUESTIONNAIRE

Please answer the following questions on this page.
There is no need to write your name on this questionnaire.
All answers will be treated confidentially.

1. Are you Male or Female? ____________________
2. Are you taking the general maths course or the specialised maths course? ____________________
3. What was the highest level of mathematics you achieved at school? (e.g. Std. 8, Std. 10 (Standard Grade) Std. 10 (Higher Grade) ____________________
4. If you wrote mathematics for matric, what symbol did you get? ____________________
5. Up to what level of mathematics will you feel confident teaching? ____________________

The remaining questionnaire consists of several things or experiences that may cause fear or apprehension.

This is not a test. Please answer the questions truthfully and try to assess your feelings as accurately as possible by imagining the situations described. Work quickly but be sure to consider each item individually.

COLLEGE OF EDUCATION SURVEY

ANALYSIS OF ANXIETY SCORES

PERSONAL ATTAINMENT LEVEL	STD. 7	STD. 10 STD. GRADE D OR BELOW	STD. 10 STD. GRADE C OR ABOVE	STD. 10 HIGH GRADE D OR BELOW	STD. 10 HIGH GRADE C OR ABOVE	TOTAL
No. of Students	16	44	46	30	12	148
Mean	91,75	73,25	69,06	65,53	49,25	70,6
Std. Deviation	17,88	14,54	15,31	13,9	10,05	17,64

COLLEGE OF EDUCATION SURVEY

TOTAL ANXIETY RATINGS FOR EACH ITEM ON THE MATHEMATICS ANXIETY RATING SCALE

NO. OF ITEM	TOTAL ANXIETY RATING	POSITION	NO. OF ITEM	TOTAL ANXIETY RATING	POSITION
1	678	27	16	684	29
2	511	13	17	431	4
3	530	15	18	540	17
4	484	11	19	557	19
5	448	6	20	482	10
6	692	30	21	669	26
7	427	3	22	385	2
8	681	28	23	547	18
9	492	12	24	559	20
10	448	6	25	440	5
11	465	9	26	534	16
12	323	1	27	648	25
13	579	21	28	638	24
14	527	14	29	452	8
15	623	23	30	620	22

SCORING: NOT AT ALL TO VERY MUCH 1 to 5

NO. OF STUDENTS: 148

POSSIBLE LOWEST SCORE: 148
(Reflecting Highest Anxiety Provoking Item)

POSSIBLE HIGHEST SCORE: 740
(Reflecting Least Anxiety Provoking Item)

COLLEGE OF EDUCATION SURVEY

TABLE SHOWING ANXIETY LEVELS OF FIRST YEAR STUDENTS AND LEVEL THAT STUDENT IS CONFIDENT TO TEACH

(Anxiety Scores Range 150 High to 30 Low Anxiety)

Personal Attainment Level	Std. 7		Std. 10 - Std. Grade D or Below		Std. 10 - Std. Grade C or Above		Std. 10 - High Grade D or Below		Std. 10 - High Grade C or Above	
	Anxiety Rating	Level Confident to Teach	Anxiety Rating	Level Confident to Teach	Anxiety Rating	Level Confident to Teach	Anxiety Rating	Level Confident to Teach	Anxiety Rating	Level Confident to Teach
	129	3	101	7	106	5	96	7	67	5
	118	1	100	5	96	5	93	1	60	7
	113	4	100	3	95	5	88	9	58	1
	110	3	100	5	92	7	84	6	56	5
	100	0	98	3	92	8	82	1	55	10
	95	7	90	2	90	8	81	10	48	9
	93	5	89	8	88	2	79	3	46	7
	89	1	87	4	85	8	76	5	45	10
	83	3	86	3	84	7	68	4	44	10
	83	5	85	1	81	8	68	7	40	7
	81	2	84	4	81	6	67	7	40	6
	80	7	84	4	78	10	67	5	32	8
	80	6	81	5	78	8	65	5		
	77	5	79	7	77	8	65	5		
	70	5	79	7	77	0	64	7		
	67	0	79	5	75	1	63	5		
			78	4	75	7	62	8		
			78	1	72	7	61	4		
			77	3	71	8	60	7		
			76	5	71	7	59	4		
			72	5	69	1	58	8		
			72	5	68	8	58	7		
			71	6	68	8	56	7		
			70	7	65	8	54	6		
			69	4	65	5	52	7		
			69	5	65	10	52	5		
			68	7	64	8	52	9		
			67	7	64	5	50	8		
			66	8	63	5	43	10		
			64	5	62	5	43	10		
			64	8	62	0				
			62	4	61	5				
			62	7	61	7				
			62	7	60	8				
			60	5	59	7				
			59	7	59	7				
			59	5	58	5				
			58	7	56	1				
			57	5	56	8				
			56	5	56	4				
			55	8	54	5				
			53	6	44	8				
			51	5	44	5				
			46	5	44	8				
					43	8				
					42	5				

STANDARD FIVE SURVEY

PRIMARY MATHEMATICS TEST

NAME: ____________ BOY GIRL

DO THE FOLLOWING PROBLEMS:

ANSWER

1. Write $\frac{37}{100}$ as a decimal

1. ____________

2. What number must be placed in the box to make the following true?

$$\frac{\square}{8} = \frac{3}{12}$$

2. ____________

3. 41 x 40

3. ____________

4. How many squares of length 3 cm could I fit into a square with sides of length 6 cm.

4. ____________

5. 0,7 ÷ 0,7

5. ____________

6. The ratio of boys to girls in a class is 2:5. If there are 15 girls, how many boys are there?

6. ____________

7. Change $\frac{3}{8}$ to a decimal

7. ____________

8. 0,4 x 0,4

8. ____________

9. 513 ÷ 27

9. ____________

0. What number must go in the box to make the following true:

$12 + 6 - \square = 15$

10. ____________

1. 0,3 x 0,3

11. ____________

2. What number must x be to make the following true?

$x + 8 + x = 12$

12. ____________

3. What number must go in the box to make the following true:

$$\frac{2}{\square} = \frac{1}{3}$$

13. ____________

. In John's class there are 30 children. 5 of them wear glasses. What fraction of the class wear glasses?

14. ____________

. $2\frac{1}{16} - \frac{3}{8} =$

15. ____________

. If a girl can cycle at a speed of 8 km per hour, what time will she take to travel 2 km

16. ____________

17. Add the following numbers
16,36 1,9 243,075

17. ____________

18. Which of the following fractions is the smallest:

$\frac{7}{16}$ $\frac{5}{32}$ $\frac{63}{64}$ $\frac{3}{8}$

18. ____________

19. If the area of a square is $25m^2$, what is the length of each side?

19. ____________

'0. In a Supermarket I bought a tin of paint costing R3,69 and a brush costing R1,15. The Cashier rang up an incorrect price, making a total bill of R5,21. How much was I overcharged.?

20. ____________

1. Add the following numbers:

298,78 72,36 13,89

21. ____________

2. You are going to the U.S.A. on holiday and take R100,00 to spend. If the exchange rate is 0,52 dollars to the Rand, what number of dollars will you receive for your R100,00?

22. ____________

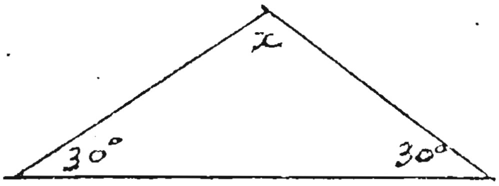
3. 816 $\div$ 8

23. ____________

l. $\frac{1}{6} + \frac{2}{3}$

24. ____________

.



How many degrees is x

25. ____________

3./ ....

Now that you have answered the 25 questions above, read the questions again carefully and rate each question on the scale below.

Place a tick (✓) in the block below the heading that best describes your opinion of each question.

	VERY EASY	EASY	NOT SURE	DIFFICULT	VERY DIFFICULT
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					
11.					
12.					
13.					
14.					
15.					
16.					
17.					
18.					
19.					
20.					
21.					
22.					
23.					
24.					
25.					

BOY GIRL

NAME: ______________ TOTAL SCORE: __________

The items in the questionnaire refer to things and experiences that may cause fear or apprenhension. For each item place a tick (✓) in the box under the column that described how much you are frightened by the situation described.

	NOT AT ALL	A LITTLE	A FAIR AMOUNT	MUCH	VERY MUCH
1. Checking your change after buying several items at a shop					
2. Having someone watch you when you do mathematics					
3. Calculating the sales tax on a purchase					
4. Watching a teacher doing mathematics on the board					
5. Sitting in your mathematics class.					
6. Watching someone work with a calculator					
7. Listening to someone explain how a computer works.					
8. Studying for a maths test					
9. Writing a maths test					
10. Reading a maths book					
11. Raising your hand in a maths class to ask a question					
12. Playing cards where numbers are involved					
13. Thinking about a maths test one week before					
14. Thinking about a maths test one day before					
15. Thinking about a maths test one hour before					

Page Two

	NOT AT ALL	A LITTLE	A FAIR AMOUNT	MUCH	VERY MUCH
16. Waiting to get a maths test returned in which you expected to do well					
17. Waiting to get a maths test returned in which you expected to do badly.					
18. Opening a math book and seeing a page full of problems					
19. Being given a sudden quiz in a maths class					
20. Asking your maths teacher to help you with a problem you do not understand.					
21. Being asked how you arrived at a particular answer to a problem					
22. Having your teacher watch you as you work through a problem.					

PRIMARY MATHEMATICS TEST

ANALYSIS OF RESULTS AND DEGREE OF DIFFICULTY RATINGS

NUMBER OF PUPILS (109)

Question No.	% Correct Answers	% Considered Question very easy or easy but gave the wrong answer	4 Teachers Rating	
			Very Easy	Easy
1	69	13	2	2
2	45	14	0	4
3	81	15	2	2
4	23	42	0	2
5	59	29	0	2
6	41	12	0	1
7	19	21	0	2
8	41	40	1	2
9	69	15	1	3
10	92	5	2	2
11	3	77	1	2
12	81	9	1	2
13	79	4	1	2
14	72	8	1	2
15	23	17	0	1
16	45	15	0	1
17	59	33	1	3
18	38	33	0	1
19	14	27	0	2
20	70	20	0	4
21	77	14	2	2
22	14	21	0	1
23	66	25	2	2
24	35	41	1	2

STANDARD FIVE SURVEY

ANALYSIS OF MATHEMATICS ANXIETY RATING

Item No.	Total Anxiety Rating	Position
1	161	19
2	249	10
3	230	12
4	140	22
5	151	20
6	165	18
7	175	17
8	300	5
9	341	3,
10	179	16
11	197	15
12	146	21
13	225	13
14	320	4
15	383	2
16	296	7
17	410	1
18	297	6
19	266	9
20	219	14
21	244	11
22	271	8

No. of Pupils:	109	
Possible High Anxiety Score (Reflecting High Anxiety)	545	(5 x 109)
Possible Low Anxiety Score (Reflecting Low Anxiety)	109	(1 x 109)

STANDARD FIVE SURVEY

RESULTS OF 1ST TERM EXAMINATIONS/ PRIMARY TEST/MATHEMATICS ANXIETY RATING/ DEGREE OF DIFFICULTY RATING

A CLASS

GIRLS				BOYS			
1st Term Exam	Primary Test %	Anxiety Rating	Easy Rating	1st Term Exam	Primary Test %	Anxiety Rating	Easy Rating
70	63	63	99	80	71	43	118
80	75	38	83	84	83	52	90
71	54	61	80	78	67	39	112
67	38	49	103	88	79	57	93
76	46	42	93	82	88	36	118
88	58	49	100	86	88	33	106
73	71	53	91	72	63	50	84
76	71	36	104	70	71	42	98
82	54	24	106	87	67	31	99
78	50	57	103	69	67	31	101
73	71	45	101	72	75	54	88
86	63	76	73				
86	75	54	105				
79	75	40	102				
86	67	42	97				
78	54	52	86				
92	50	57	88				
81	54	55	111				
80	79	53	102				
70	42	48	98				
95	54	57	102				
83	54	50	115				
73	54	59	93				
70	50	37	92				

B CLASS

GIRLS				BOYS			
1st Term Exam	Primary Test %	Anxiety Rating	Easy Rating	1st Term Exam	Primary Test %	Anxiety Rating	Easy Rating
72	54	44	84	75	42	57	105
84	46	48	89	68	50	38	101
61	46	46	86	73	54	48	103
58	46	46	79	62	54	38	94
73	54	53	96	73	46	36	94
76	42	43	83	57	54	41	95
79	58	52	96	71	38	63	90
62	46	44	90	77	79	43	106
76	42	61	90	68	54	31	109
65	54	51	96	73	46	38	105
67	83	30	109	64	38	37	89
				55	54	57	84
				53	50	42	93
				82	67	33	112
				68	54	28	107
				56	54	36	109
				56	46	44	94
				69	67	43	93
				73	63	62	99

C CLASS

GIRLS				BOYS			
1st Term Exam	Primary Test %	Anxiety Rating	Easy Rating	1st Term Exam	Primary Test %	Anxiety Rating	Easy Rating
44	29	60	91	43	54	67	79
69	46	60	79	62	54	53	76
66	29	47	83	34	13	78	101
47	42	72	95	48	50	42	105
54	42	62	70	74	33	57	100
56	29	78	99	54	54	40	92
51	29	70	88	64	46	46	90
51	29	62	61	77	46	57	87
53	13	56	89	64	38	55	96
52	29	64	93	56	58	58	96

D CLASS

GIRLS				BOYS			
1st Term Exam	Primary Test %	Anxiety Rating	Easy Rating	1st Term Exam	Primary Test %	Anxiety Rating	Easy Rating
37	38	63	71	44	33	56	99
50	17	46	84	64	38	53	99
44	38	41	104	35	25	71	64
45	46	53	85	30	50	45	90
42	42	42	99	26	21	56	87
63	50	42	95	44	54	52	96
38	46	46	89	63	50	76	97
				51	46	56	88

Total Number of Pupils:	100	(9 Spoilt Papers)
Possible High Anxiety Scope	110	
Possible Low Anxiety Scope	22	
Possible High Degree of Easy Rating	120	
Possible Low Degree of Easy Rating	24	

STANDARD FIVE SURVEY

PEARSON PRODUCT MOMENT CORRELATIONS BETWEEN MATHEMATICS PERFORMANCE (AS MEASURED ON THE PRIMARY TEST) AND MATHEMATICS ANXIETY (AS MEASURED ON THE RATING SCALE)

X = Score on Primary Test

Y = Score on Mathematics Anxiety Rating Scale

	GIRLS	BOYS	TOTAL
Mean X	49	54	51
Mean Y	50	48	49
Standard Deviation X	15,3	16,3	15,9
Standard Deviation Y	11,1	12,1	11,6
Pearson Product Moment Correlations	-0,32	-0,49	-0,39

Significant at the 0,05% Level.

BRUNEL UNIVERSITY

EXAMPLES OF TESTS USED IN SURVEY
CONDUCTED BY THE DEPARTMENT OF EDUCATION

BRUNEL UNIVERSITY DEPARTMENT OF EDUCATION

PRIMARY MATHEMATICS TEST II

SCHOOL: ....
CLASS: ....
NAME: Last...................First.....................
AGE: ....Date of Birth...............

Please tick BOY ☐

GIRL ☐

When you are told to start turn over to the following page and read the first problem. Then, before answering the problem, answer the two short questions below it in the way in which you have been instructed. Then answer the question.

Please show any working: to do so use the back of the previous page, or any blank space.

Write your final answer clearly on the line marked 'Answer'.

Do the same thing for each of the following questions.

Attempt all questions and work carefully. Do not worry about time but do not spend too long on any one question, if you can't do it go on to the next one.

Now do the following two practice problems.

Example 1

75 x 5

I think this problem is............

easy ________________________________ difficult

I think that my answer to this problem will be ....

correct ________________________________ wrong

Answer: ____________

Example 2

How many pencils costing 5p each can I buy for £1?

I think this problem is...................

easy ________________________________ difficult

I think that my answer to this problem will be ....

correct ________________________________ wrong

Answer: ____________

1) Write $\frac{37}{100}$ as a decimal

I think that this problem is..........

easy ____ difficult

I think that my answer to this problem will be........

correct ____ wrong

Answer: ____________

---

2) What number must be placed in the box to make the following true?

$$\frac{\square}{8} = \frac{3}{12}$$

I think that this problem is..........

easy ____ difficult

I think that my answer to this problem will be........

correct ____ wrong

Answer: ____________

---

3) 41 x 40 =

I think that this problem is...........

easy ____ difficult

I think that my answer to this problem will be.........

correct ____ wrong

Answer: ____________

---

4) How many squares with sides of length 3cm could I fit into a square with sides of length 6cm?

I think that this problem is..........

easy ____ difficult

I think that my answer to this problem will be.........

correct ____ wrong

Answer: ____________

5) 0.7 ÷ 0.7 =

I think that this problem is.............

easy ________________________________ difficult

I think that my answer to this problem will be........

correct ________________________________ wrong

Answer: __________

---

6) The ratio of boys to girls in a class is 2:5. If there are 15 girls, how many boys are there?

I think that this problem is............

easy ________________________________ difficult

I think that my answer to this problem will be.........

correct ________________________________ wrong

Answer: __________

---

7) Change $\frac{3}{8}$ to a decimal.

I think that this problem is...........

easy ________________________________ difficult

I think that my answer to this problem will be.........

correct ________________________________ wrong

Answer: __________

---

8) 0.4 x 0.4 =

I think that this problem is...........

easy ________________________________ difficult

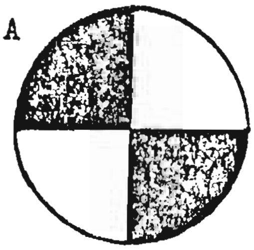
I think that my answer to this problem will be.........

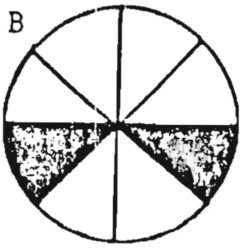
correct ________________________________ wrong

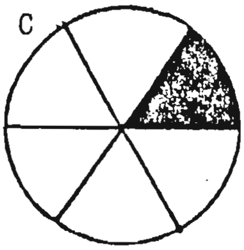
Answer: __________

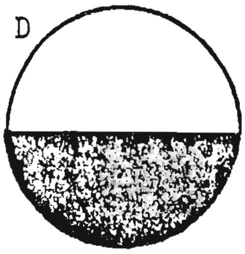
---

9) In which one of the following circles is $\frac{1}{4}$ of the area shaded?

A


B


C


D


I think that this problem is.......

easy ________________________________ difficult

I think that my answer to this problem will be.........

correct ________________________________ wrong

10) In 1cm there are 10mm. How many mm^2 are there in $1cm^2$?

I think that this problem is..............

easy ____ difficult

I think that my answer to this problem will be..........

correct ____ wrong

Answer: ____________

---

11) What number must go in the box to make the following true?

$$12 + 6 - \boxed{} = 15$$

I think that this problem is..............

easy ____ difficult

I think that my answer to this problem will be.........

correct ____ wrong

Answer: ____________

---

12) $513 \div 27 =$

I think that this problem is..............

easy ____ difficult

I think that my answer to this problem will be.........

correct ____ wrong

Answer: ____________

---

13) $0.3 \times 0.3 =$

I think that this problem is..............

easy ____ difficult

I think that my answer to this problem will be..........

correct ____ wrong

Answer: ____________

---

14) $187 \div 11 =$

I think that this problem is..............

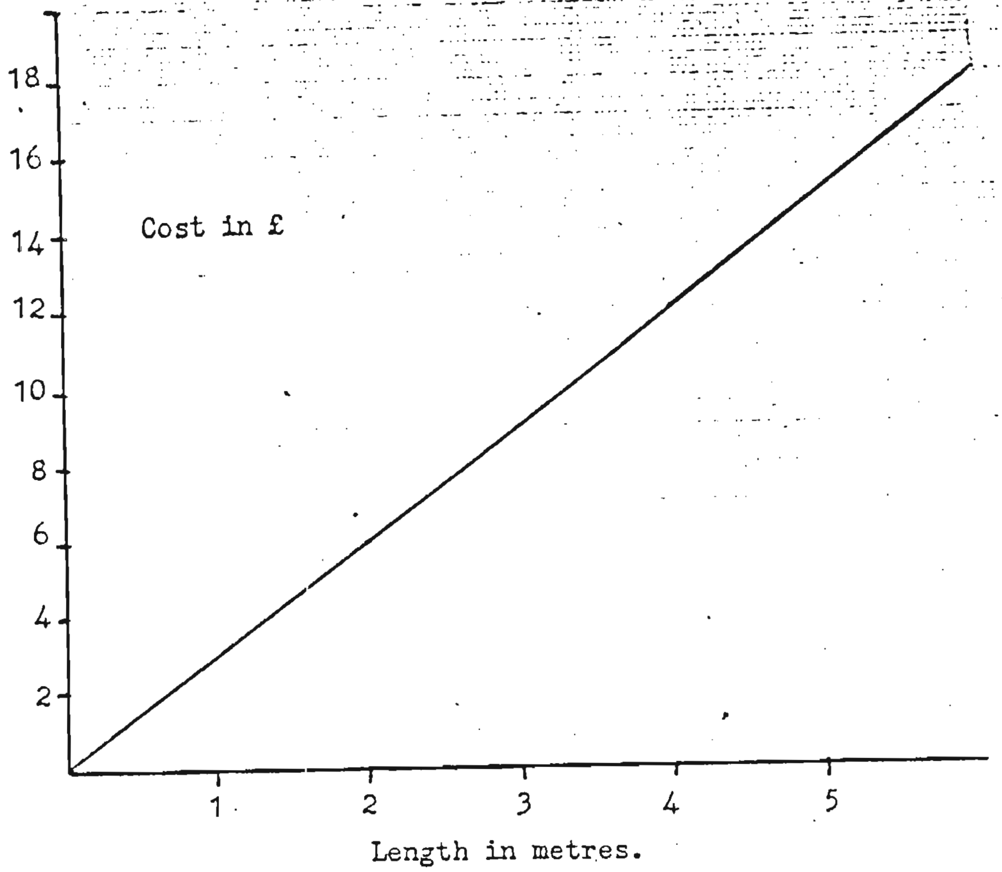
easy ____ difficult

I think that my answer to this problem will be..........

correct ____ wrong

Answer: ____________

15) The graph below shows the cost of curtain material. What is the cost of 4 metres of the material?



I think that this problem is..............

easy ______________________________ difficult

I think that my answer to this problem will be.......

correct ______________________________ wrong

Answer: ____________

---

16) In the triangle below; what is the number of degrees in the angle marked x?

I think that this problem is...........

easy ______________________________ difficult

I think that my answer to this problem will be........

correct ______________________________ wrong

Answer: ____________

17) What number must x be to make the following true?

$$x + 4 + x = 12$$

I think that this problem is..............

easy ____ difficult

I think that my answer to this problem will be......

correct ____ wrong

Answer: __________

---

18) What number must go in the box to make the following true?

$$\frac{2}{\square} = \frac{1}{3}$$

I think that this problem is...........

easy ____ difficult

I think that my answer to this problem will be.......

correct ____ wrong

Answer: __________

---

19) What number must go in the box to make the following true?

$$\square + 3 = 9 - 2$$

I think that this problem is..........

easy ____ difficult

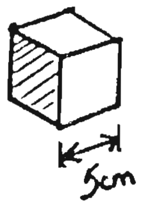
I think that my answer to this problem will be.......

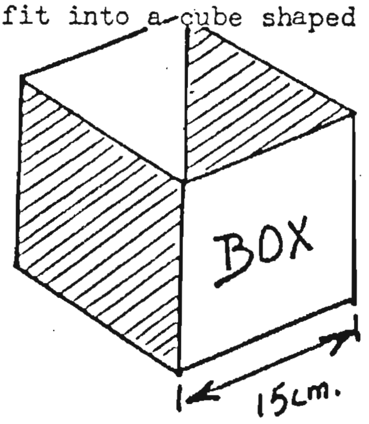
correct ____ wrong

Answer: __________

---

20) I have a collection of cubes like the one below. Each cube has sides of length 5cm. How many of these cubes could I fit into a cube shaped box whose sides are 15 cm long?





I think that this problem is.........

easy ____ difficult

I think that my answer to this problem will be.......

correct ____ wrong

Answer: __________

21) $2\frac{1}{16} - \frac{3}{8} =$

I think that this problem is.........

easy ____ difficult

I think that my answer to this problem will be........

correct ____ wrong

Answer: __________

---

22) If a girl can cycle at a speed of 8 miles per hour, what time will she take to travel 2 miles?

I think that this problem is..........

easy ____ difficult

I think that my answer to this problem will be.........

correct ____ wrong

Answer: __________

---

23) If π = 3.14, what is the circumference of a circle with a diameter of 5cm?

I think that this problem is...........

easy ____ difficult

I think that my answer to this problem will be.........

correct ____ wrong

Answer: __________

---

24) Add the following numbers: 16.36, 1.9, 243.075

I think that this problem is............

easy ____ difficult

I think that my answer to this problem will be..........

correct ____ wrong

Answer: __________

---

25) Which of the following fractions is the smallest? $\frac{7}{16}$, $\frac{5}{32}$, $\frac{63}{64}$, $\frac{3}{8}$.

I think that this problem is............

easy ____ difficult

I think that my answer to this problem will be.........

correct ____ wrong

Answer: __________

26) Can you think of one number to put in the box and another to put in the circle so that it makes the following sum true?

$$9 + \square = 5 + \bigcirc$$

I think that this problem is..........

easy ____ difficult

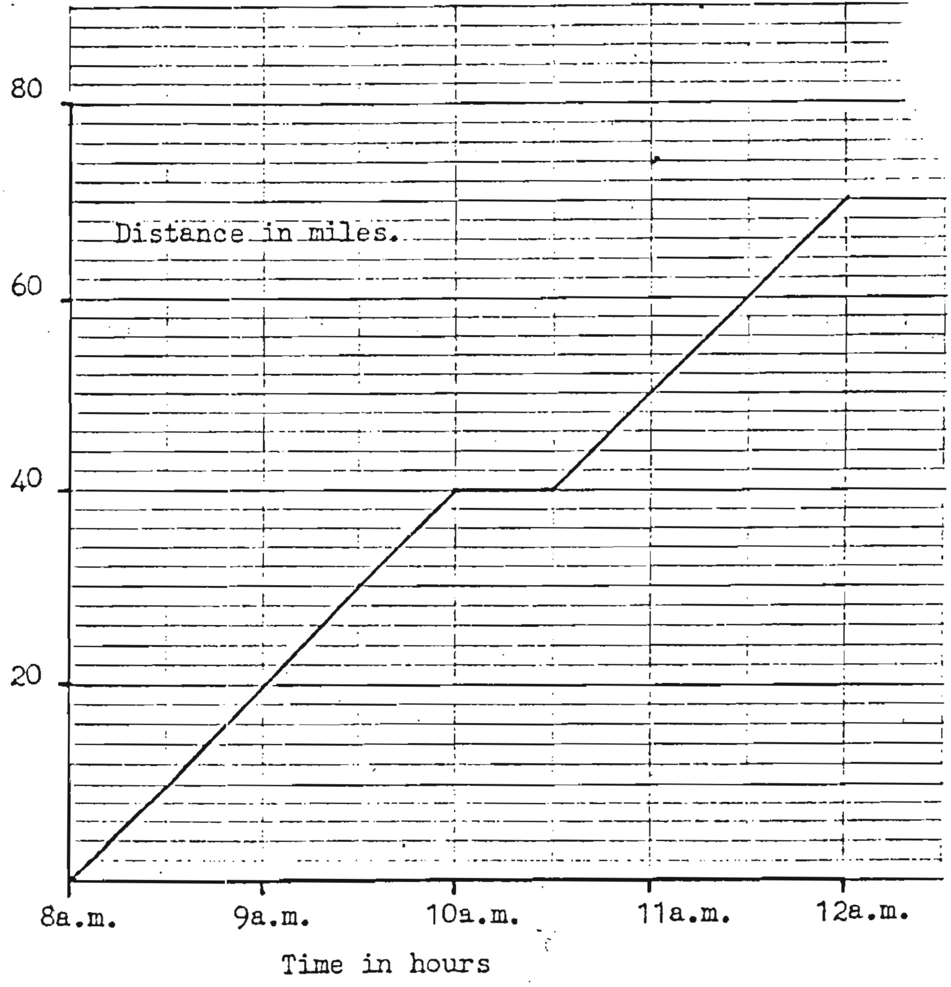
I think that my answer to this problem will be.......

correct ____ wrong

Answer: __________

---

27) The graph below shows the distance travelled by a van-driver at different times on a journey. At 10 a.m. the driver stopped at a cafe. Use the graph to calculate how long he stopped at the cafe.



I think that this problem is...........

easy ____ difficult

I think that my answer to this problem will be

correct ____ wrong

Answer: __________

28) If the area of a square is $25m^2$, what is the length of each side?

I think that this problem is............

easy ______________________________ difficult

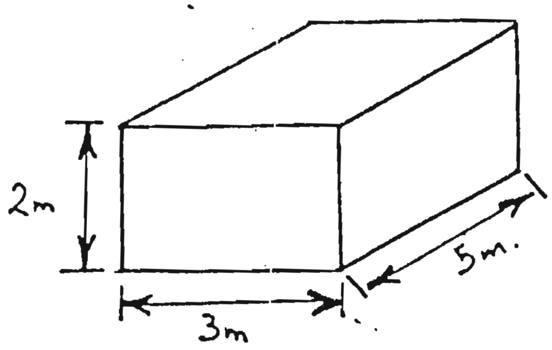
I think that my answer to this problem will be.........

correct ______________________________ wrong

Answer: __________

---

29) What is the volume of the solid shape shown in the figure below?



I think that this problem is.............

easy ______________________________ difficult

I think that my answer to this problem will be.........

correct ______________________________ wrong

Answer: __________

---

30) In a supermarket I bought a gallon of paint costing £ 3.69 and brush costing £1.15. The cashier rang up an incorrect price, making the total bill £5.21. How much was I overcharged?

I think that this problem is............

easy ______________________________ difficult

I think that my answer to this problem will be.........

correct ______________________________ wrong

Answer: __________

---

31) Add the following numbers: 298.78, 72.36, 13.89

I think that this problem is..............

easy ______________________________ difficult

I think that my answer to this problem will be......

correct ______________________________ wrong

Answer: __________

NAME:.................................... CLASS:....................

SCHOOL:..

MATHEMATICS

good ___:___:___:___:___:___:___: bad

friendly ___:___:___:___:___:___:___: unfriendly

strong ___:___:___:___:___:___:___: weak

beautiful ___:___:___:___:___:___:___: ugly

heavy ___:___:___:___:___:___:___: light

large ___:___:___:___:___:___:___: small

useful ___:___:___:___:___:___:___: useless

masculine ___:___:___:___:___:___:___: feminine

NAME:.................................... CLASS:....................

SCHOOL:..

SCHOOL

good ___:___:___:___:___:___:___: bad

friendly ___:___:___:___:___:___:___: unfriendly

strong ___:___:___:___:___:___:___: weak

beautiful ___:___:___:___:___:___:___: ugly

heavy ___:___:___:___:___:___:___: light

large ___:___:___:___:___:___:___: small

useful ___:___:___:___:___:___:___: useless

masculine ___:___:___:___:___:___:___: feminine

.... CLASS.......... ....

C.M.A.S. (short form).

Read each question carefully. Put a circle round the word YES if you think it is true about you. Put a circle round the word NO if you think it is not true about you.

1. It is hard for me to keep my mind on anything......... YES NO
2. I get nervous when someone watches me work............ YES NO
3. I blush easily.. YES NO
4. I notice my heart beats very fast sometimes........... YES NO
5. Others seem to do things easier than I can............ YES NO
6. I feel that others do not like the way I do things.... YES NO
7. I have trouble making up my mind...................... YES NO
8. I worry most of the time.............................. YES NO
9. I get angry easily.................................... YES NO
10. I worry about what other people think about me........ YES NO
11. My feelings get hurt easily........................... YES NO
12. It is hard for me to go to sleep at night............. YES NO
13. I worry about how well I am doing in school........... YES NO
14. My feelings get hurt easily when I am scolded......... YES NO
15. I often feel lonely when I am with people............. YES NO
16. I am afraid of the dark............................... YES NO
17. It is hard for me to keep my mind on my school work... YES NO
18. I worry when I go to bed at night..................... YES NO
19. I often do things I wish I had never done............. YES NO
20. I often worry about what could happen to my parents... YES NO
21. I have bad dreams..................................... YES NO

T.A. QUESTIONNAIRES

PLEASE PRINT:

NAME......................

SCHOOL....................

CLASS.....................

AGE (YRS)...... DATE OF BIRTH........

PLEASE TICK BOY ☐
GIRL ☐

TA score ☐☐ MTA score ☐☐

1. Do you worry when one of your teachers says he is going to ask you questions to find how much you know?........................... YES NO

2. When your maths teacher says that he is going to ask some pupils to do mathematics problems, do you hope that he will ask someone else and not you?.............................. YES NO

3. If one of your teachers asks you to get up in front of the class and read aloud, are you afraid that you are going to make some bad mistakes?.................................. YES NO

4. When your maths teacher is teaching you about mathematics, do you feel that other pupils in the class understand him better than you?...................................... YES NO

5. Do you sometimes dream at night that you are in school and cannot answer some of the teacher's questions?................................. YES NO

6. When you are at home and you are thinking about your mathematics lesson for the next day, do you become afraid that you will get the answers wrong when your teacher asks you?..................... YES NO

7. When your maths teacher asks you to do a mathematics problem on the blackboard in front of the class, does the hand you write with sometimes shake a little?............................. YES NO

8. When one of your teachers says that he is going to find out how much you have learned, does your heart begin to beat faster?................... YES NO

9. Do you worry more about mathematics than other subjects?................................ YES NO

10. When you are in bed at night do you sometimes worry about how you are going to do in class the next day?.................................... YES NO

11. When your French teacher is teaching you do you feel that other pupils in the class understand him better than you?........... YES NO

12. When your maths teacher says he is going to find out how much mathematics you have learned do you get a funny feeling in your stomach?... YES NO

13. Do you think you worry more about school than other pupils?............................. YES NO

14. Do you sometimes dream at night that your maths teacher is angry because you do not know your mathematics?................................. YES NO

15. If you are sick and miss school, do you worry that you will do worse in your schoolwork than other pupils when you return to school?....... YES NO

16. When your maths teacher says that he is going to find out how much mathematics you know does your heart begin to beat faster? YES NO

17. Are you afraid of mathematics tests?........... YES NO

18. Do you sometimes dream at night that other pupils in your class can do things you cannot do?.. YES NO

19. Do you worry a lot before you take a mathematics test?.. YES NO

20. Are you afraid of school tests?................ YES NO

21. Do you worry a lot while you are taking a test?.... YES NO

22. When your maths teacher says that he is going to give the class a mathematics test, do you become afraid that you will do badly?........ YES NO

23. While you are taking a mathematics test do you usually think you are doing badly?........... YES NO

24. Do you sometimes dream at night that you did badly on a test you had in school that day?............................. YES NO

25. While you are on your way to school do you sometimes worry that your maths teacher may give the class a mathematics test?......... YES NO

26. When you are taking a test, does the hand you write with shake a little?.......... YES NO

27. Do you wish a lot of times that you didn't worry so much about tests?............... YES NO

28. When you are taking a hard mathematics test, do you forget some things you knew very well before you started taking the test?......... YES NO

29. When one of your teachers says that he is going to give the class a test, do you get a nervous or funny feeling?................... YES NO

30. After you have taken a mathematics test, do you worry how well you did on the test?.... YES NO

EXAMINATION ATTITUDE SCALE
AND
WORK/EMOTIONALITY QUESTIONNAIRE

DEVELOPED BY SIGMUND TOBIAS

F 16. During a course examination I frequently get so nervous that I forget facts I really know.

F 17. I seem to defeat myself while working on important tests.

F 18. The harder I work at taking a test or studying for one, the more confused I get.

F 19. As soon as an exam is over I try to stop worrying about it, but I just can't.

F 20. During exams I sometimes wonder if I'll ever get through school.

F 21. I would rather write a paper than take an examination for my grade in a course.

F 22. I wish examinations did not bother me so much.

F 23. I think I could do much better on tests if I could take them alone and not feel pressured by a time limit.

F 24. Thinking about the grade I may get in a course interferes with my studying and my performance on tests.

F 25. If examinations could be done away with I think I would actually learn more.

F 26. On exams, I take the attitude, "If I don't know it now there's no point worrying about it."

F 27. I really don't see why some people get so upset about tests.

F 28. Thoughts of doing poorly interfere with my performance on tests.

F 29. I don't study any harder for final exams than for the rest of my course work.

F 30. Even when I'm well prepared for a test, I feel very anxious about it.

F 31. I don't enjoy eating before an important test.

F 32. Before an important examination I find my hands or arms trembling.

F 33. I seldom feel the need for "cramming" before an exam.

F 34. The high school ought to recognize that some students are more nervous than others about tests and that this affects their performance.

F 35. It seems to me that examination periods ought not to be made the tense situations which they are.

F 36. I start feeling very uneasy just before getting a test paper back.

F 37. I dread courses where the teacher has the habit of giving "pop" quizzes.

Examination Attitude Scale

c ______________________________

e ______________________________

ections: This questionnaire is designed to give you an opportunity to indi-
e how and what you feel about examinations. Read each statement carefully
decide whether it is generally true as applied to your reactions to examina-
ns. If it is generally true circle T to the left of the statement; if false,
le F. Answer every item.

le one

F 1. While taking an important exam I find myself thinking of how much brighter the other students are than I am.

F 2. If I were to take an intelligence test, I would worry a great deal before taking it.

F 3. If I knew I was going to take an intelligence test, I would feel confident and relaxed, beforehand.

F 4. While taking an important examination I perspire a great deal.

F 5. During course examinations I find myself thinking of things unrelated to the actual course material.

F 6. I get to feel very panicky when I have to take a surprise exam.

F 7. During tests I find myself thinking of the consequences of failing.

F 8. After important tests I am frequently so tense that my stomach gets upset.

F 9. I freeze up on things like intelligence tests and final exams.

F 10. Getting a good grade on one test doesn't seem to increase my confidence on the second.

F 11. I sometimes feel my heart beating very fast during important tests.

F 12. After taking a test I always feel I could have done better than I actually did.

F 13. I usually get depressed after taking a test.

F 14. I have an uneasy, upset feeling before taking a final examination.

F 15. When taking a test my emotional feelings do not interfere with my performance.

ID #----------------

W/E QUESTIONNAIRE

Directions: To the left of each of the following statements, indicate your feelings, attitudes, or thoughts as they were while you were working on the final test for this study. Use the following numerical scale:

1. The statement does not describe my condition.
2. The condition was barely noticeable.
3. The condition was moderate.
4. The condition was strong.
5. The condition was very strong; the statement described my condition very well.

-----I felt my heart beating fast.

-----I felt regretful.

-----I was tense and my stomach was upset.

-----I am afraid that I should have studied more for that test.

-----I had an uneasy, upset feeling.

-----I felt that others would be disappointed in me.

-----I was nervous.

-----I felt I may not have done as well on that test as I could have.

-----I felt panicky.

-----I did not feel very confident about my performance on that test.

MATHEMATICS : THE INVISIBLE FILTER

(EXAMPLES OF PAMPHLETS PROVIDED IN THIS PROJECT)

FUTURE FORECAST: HIGHLY SKILLED AND HIGHLY QUALIFIED WORKERS NEEDED...

PROJECTED CAREER OPPORTUNITIES IN THE 1980'S REQUIRING MATHEMATICS

- Engineering and Engineering Technology: *almost every field.*
- Microelectronics and Emerging Biotechnology Industry: *systems analysts, programmers, repairers of robots and electronic systems.*
- Telephone and Telecommunications: *skilled workers for cable systems and satellite services.*
- Geology and Earth Sciences: *workers knowledgeable in prospecting and developing oil and natural gas.*
- Metal Machinery: *tool and die makers, mold makers, industrial machinery mechanics.*
- Business: *management personnel, advanced office positions.*
- Medical, Nursing and Health Services: *post secondary and graduate workers in geriatrics, psychological and chronic care.*

Most students do not know where the jobs are likely to be!

MANY STUDENTS DO NOT HAVE THE HIGH SCHOOL MATH COURSES REQUIRED TO ENTER THE JOBS OF THE 80'S!

Toronto Board – 1980-81

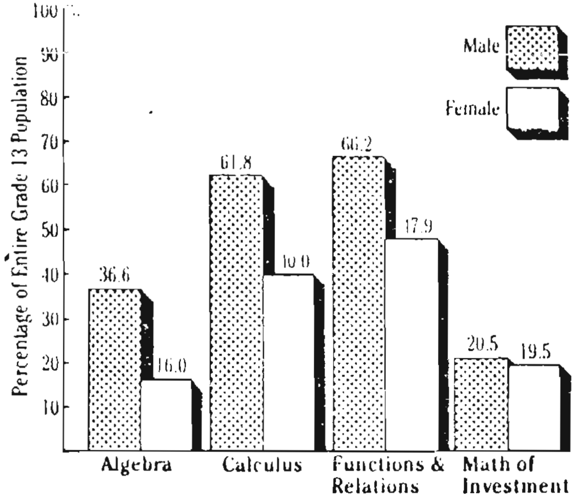
In grades 11 and 12:

- Twice as many males as females took computer science courses.

In grade 12:

- 21% of both males and females did not take math
- 12% fewer females were enrolled in math courses
- Grade 12 mathematics is required for entry to many highly skilled careers such as X-ray technician, pilot, and engineering technologist.

Percentages of entire population by sex enrolled in the different mathematics courses in grade 13



In grade 13:

- 18-22% fewer females took mathematics.
- One or more grade 13 mathematics courses are required for entry to such fields as statistics, computer science, engineering and other sciences.

THUS, FOR MANY STUDENTS AND ESPECIALLY FEMALES, MATH IS THE "INVISIBLE FILTER" LIMITING THEIR FUTURE CAREER POSSIBILITIES.

WHY ARE STUDENTS AVOIDING MATH?

- Students frequently do not see math as useful in their future careers.
- Some students experience math anxiety or lack confidence in their ability to do math.
- Many students do not enjoy math and they do not experience it as a creative subject.
- Parents, teachers, and others who influence students' lives are sometimes unaware of the consequences of dropping math.
- Often girls see math as a 'male domain' and consider it 'unfeminine' to study math.
- Girls often do not plan to have careers. They think they will marry, have children and spend only a few years in the work force.

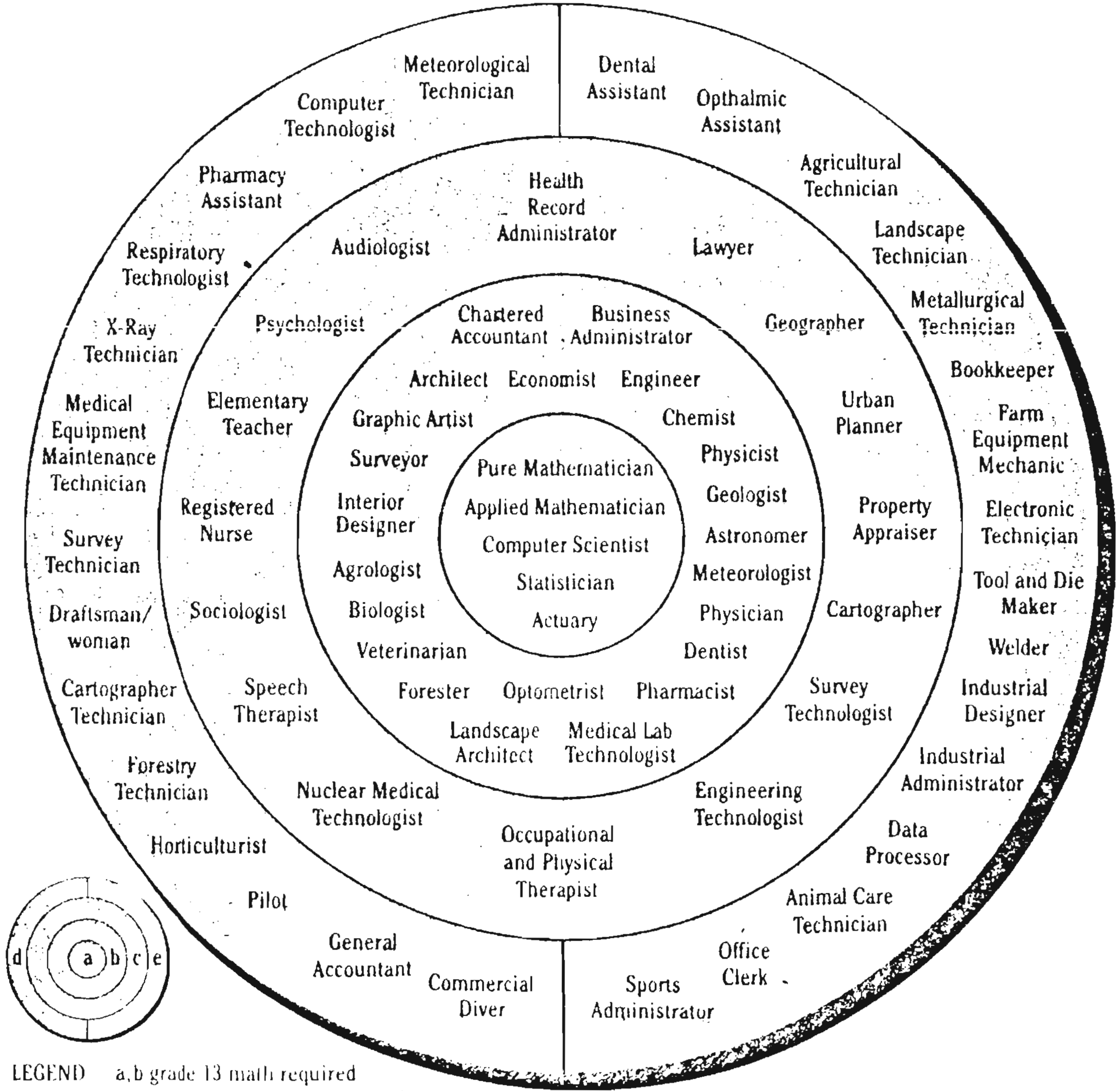
  The reality is: Many women who marry and have children spend approximately 25 years in the labour force. Single women may spend as many as 45 years.

IN 1982 IN ONTARIO:

- 55% of women with children under the age of six were in the labour force.
- Many women worked because their husbands were not paid enough to support another adult and two or three children.
- 40% of all working women were single, widowed or divorced. They worked to support themselves, and in many cases, dependents as well.
- 61% of women in the labour force were clustered in clerical, sales and service occupations, jobs which are generally low paying.

MATHEMATICS: A KEY TO THE FUTURE

CAREERS INVOLVING MATH



LEGEND a, b grade 13 math required
c grade 13 math recommended
d grade 12 math required
e grade 12 math recommended

MATHEMATICS ANXIETY RATING SCALE (MARS)

DEVELOPED BY RICHARD M. SUINN (1972)

NAME ____________________ Total Score ____________

MATHEMATICS ANXIETY RATING SCALE (MARS)

The items in the questionnaire refer to things and experiences that may cause fear or apprehension. For each item, place a check (✓) in the box under the column that describes how much you are frightened by it nowadays. Work quickly but be sure to consider each item individually.

	Not at all	A little	A fair amount	Much	Very much
1. Determining the amount of change you should get back from a purchase involving several items.	☐	☐	☐	☐	☐
2. Having someone watch you as you total up a column of figures.	☐	☐	☐	☐	☐
3. Having someone watch you as you divide a five digit number by a two digit number.	☐	☐	☐	☐	☐
4. Being asked to add up 976 + 777 in your head.	☐	☐	☐	☐	☐
5. Dividing a five digit number by a two digit number in private with pencil and paper.	☐	☐	☐	☐	☐
6. Calculating a simple percentage, e. g., the sales tax on a purchase.	☐	☐	☐	☐	☐
7. Listening to a salesman show you how you would save money by buying his higher priced product because it reduces long term expenses.	☐	☐	☐	☐	☐
8. Listening to a person explain how he figured out your share of expenses on a trip, including meals, transportation, housing, etc.	☐	☐	☐	☐	☐
9. Having to figure out how much it will cost to buy a product on credit (figuring in the interest rates).	☐	☐	☐	☐	☐
10. Totaling up a dinner bill that you think overcharged you.	☐	☐	☐	☐	☐
11. Telling the cashier that you think the dinner bill was incorrect and watching the cashier total up the bill.	☐	☐	☐	☐	☐
TOTAL	____	____	____	____	____

	Not at all	A little	A fair amount	Much	Very much
12. Being treasurer for a club.	☐	☐	☐	☐	☐
13. Totaling up the dues received and the expenses of a club you belong to.	☐	☐	☐	☐	☐
14. Adding up 976 + 777 on paper.	☐	☐	☐	☐	☐
15. Doing a word problem in algebra.	☐	☐	☐	☐	☐
16. Solving a problem such as: If $x = 11$, and $y = 3$, then the results of x/y is equal to ________?	☐	☐	☐	☐	☐
17. Solving the problem such as: If $x = 12$, and $y = 4$, then the ratio of x to y is equal to_______?	☐	☐	☐	☐	☐
18. Determining the grade point average for your last term.	☐	☐	☐	☐	☐
19. Reading an article on the basketball team, showing what percentage of free throws each player made, the percentage of field goals made, the total number attempted, etc.	☐	☐	☐	☐	☐
20. Reading an historical novel with many dates in it.	☐	☐	☐	☐	☐
21. Counting the number of pages left in a novel you are engrossed in.	☐	☐	☐	☐	☐
22. Guessing at the number of people attending a dance you're at.	☐	☐	☐	☐	☐
23. Buying a math textbook.	☐	☐	☐	☐	☐
24. Watching someone work with a slide rule.	☐	☐	☐	☐	☐
25. Watching a teacher work an algebraic equation on the blackboard.	☐	☐	☐	☐	☐
26. Signing up for a math course.	☐	☐	☐	☐	☐
27. Listening to another student explain a math formula.	☐	☐	☐	☐	☐
28. Walking into a math class.	☐	☐	☐	☐	☐
TOTAL	_____	_____	_____	_____	_____

	Not at all	A little	A fair amount	Much	Very much
29. Having to compute the miles/gallon on your car.	☐	☐	☐	☐	☐
30. Watching someone work with a calculator.	☐	☐	☐	☐	☐
31. Looking through the pages of a math text.	☐	☐	☐	☐	☐
32. Working on an income tax form.	☐	☐	☐	☐	☐
33. Reading your W-2 form (or other statement showing your annual earning and taxes).	☐	☐	☐	☐	☐
34. Studying for a math test.	☐	☐	☐	☐	☐
35. Starting a new chapter in a math book.	☐	☐	☐	☐	☐
36. Walking on campus and thinking about a math course.	☐	☐	☐	☐	☐
37. Meeting your math teacher while walking on campus.	☐	☐	☐	☐	☐
38. Reading the word "Statistics."	☐	☐	☐	☐	☐
39. Sitting in a math class and waiting for the instructor to arrive.	☐	☐	☐	☐	☐
40. Solving a square root problem.	☐	☐	☐	☐	☐
41. Signing up for a course in Statistics.	☐	☐	☐	☐	☐
42. Checking over your monthly bank statement.	☐	☐	☐	☐	☐
43. Taking the math section of a college entrance exam.	☐	☐	☐	☐	☐
44. Having someone explain bank interest rates as you decide on a savings account.	☐	☐	☐	☐	☐
45. Raising your hand in a math class to ask a question.	☐	☐	☐	☐	☐
46. Reading and interpreting graphs or charts.	☐	☐	☐	☐	☐
TOTAL	____	____	____	____	____

	Not at all	A little	A fair amount	Much	Very much
47. Reading a cash register receipt after your purchase.	☐	☐	☐	☐	☐
48. Figuring the sales tax on a purchase that costs more than $1.00.	☐	☐	☐	☐	☐
49. Having a person illustrate to you the best way to divide your money into a savings and a checking account.	☐	☐	☐	☐	☐
50. Figuring out which of two summer job offers is the most lucrative: where one involves a lower salary, room and board, and travel, while the other one involves a higher salary but no other benefits.	☐	☐	☐	☐	☐
51. Reading a formula in chemistry.	☐	☐	☐	☐	☐
52. Hearing a lecture in a social science class where the instructor is commenting on some figures, e. g., the percentage of each socio-economic group who voted Republican.	☐	☐	☐	☐	☐
53. Taking an examination (quiz) in a math course.	☐	☐	☐	☐	☐
54. Taking an examination (final) in a math course.	☐	☐	☐	☐	☐
55. Hearing two of your friends exchanging opinions on the best way to calculate the cost of a product.	☐	☐	☐	☐	☐
56. Having someone ask you to recheck his figures in a simple calculation, such as division, or addition.	☐	☐	☐	☐	☐
57. Being asked by a friend to answer the question: how long will it take to get to Denver if I drive at 30 miles per hour?	☐	☐	☐	☐	☐
58. Studying for a driver's license test and memorizing the figures involved, such as the distances it takes to stop a car going at differing speeds.	☐	☐	☐	☐	☐
59. Hearing friends make bets on a game as they quote the odds.	☐	☐	☐	☐	☐
60. Playing cards where numbers are involved, e. g., bridge or poker.	☐	☐	☐	☐	☐
TOTAL	____	____	____	____	____

	Not at all	A little	A fair amount	Much	Very much
61. Hearing a friend try to teach you a math procedure and finding that you cannot understand what he is telling you.	☐	☐	☐	☐	☐
62. Scheduling my daily routine to allocate set times for classes, for study time, for meals, for recreation, etc.	☐	☐	☐	☐	☐
63. Juggling class times around at registration to determine the best schedule.	☐	☐	☐	☐	☐
64. Deciding which courses to take in order to come out with the proper number of credit hours for full time enrollment.	☐	☐	☐	☐	☐
65. Working a concrete, everyday application of mathematics that has meaning to me, e. g., figuring out how much I can spend on recreational purposes after paying other bills.	☐	☐	☐	☐	☐
66. Working on an abstract mathematical problem, such as: "If x = outstanding bills, and y = total income, calculate how much you have left for recreational expenditures."	☐	☐	☐	☐	☐
67. Being given a set of numerical problems involving addition to solve on paper.	☐	☐	☐	☐	☐
68. Being given a set of subtraction problems to solve.	☐	☐	☐	☐	☐
69. Being given a set of multiplication problems to solve.	☐	☐	☐	☐	☐
70. Being given a set of division problems to solve.	☐	☐	☐	☐	☐
71. Picking up the math text book to begin working on a homework assignment.	☐	☐	☐	☐	☐
72. Being given a homework assignment of many difficult problems which is due the next class meeting.	☐	☐	☐	☐	☐
73. Thinking about an upcoming math test one week before.	☐	☐	☐	☐	☐
74. Thinking about an upcoming math test one day before.	☐	☐	☐	☐	☐
TOTAL	___	___	___	___	___

	Not at all	A little	A fair amount	Much	Very much
75. Thinking about an upcoming math test one hour before.	☐	☐	☐	☐	☐
76. Thinking about an upcoming math test five minutes before.	☐	☐	☐	☐	☐
77. Talking to someone in your class who does well about a problem and not being able to understand what he is explaining.	☐	☐	☐	☐	☐
78. Waiting to get a math test returned in which you expected to do well.	☐	☐	☐	☐	☐
79. Waiting to get a math test returned in which you expected to do poorly.	☐	☐	☐	☐	☐
80. Walking to math class.	☐	☐	☐	☐	☐
81. Realizing that you have to take a certain number of math classes to fulfill the requirements in your major.	☐	☐	☐	☐	☐
82. Picking up a math textbook to begin a difficult reading assignment.	☐	☐	☐	☐	☐
83. Being called upon to recite in a math class when you are prepared.	☐	☐	☐	☐	☐
84. Not knowing the formula needed to solve a particular problem.	☐	☐	☐	☐	☐
85. Receiving your final math grade in the mail.	☐	☐	☐	☐	☐
86. Opening a math or stat book and seeing a page full of problems.	☐	☐	☐	☐	☐
87. Being responsible for collecting dues for an organization and keeping track of the amount.	☐	☐	☐	☐	☐
88. Getting ready to study for a math test.	☐	☐	☐	☐	☐
89. Listening to a lecture in a math class.	☐	☐	☐	☐	☐
90. Figuring out your monthly budget.	☐	☐	☐	☐	☐
TOTAL	____	____	____	____	____

	Not at all	A little	A fair amount	Much	Very much
91. Being given a "pop" quiz in a math class.	☐	☐	☐	☐	☐
92. Seeing a computer printout.	☐	☐	☐	☐	☐
93. Having to use the tables in the back of a math book.	☐	☐	☐	☐	☐
94. Being told how to interpret probability statements.	☐	☐	☐	☐	☐
95. Asking your math instructor to help you with a problem that you don't understand.	☐	☐	☐	☐	☐
96. Being asked to explain how you arrived at a particular solution for a problem.	☐	☐	☐	☐	☐
97. Tallying up the results of a survey or poll.	☐	☐	☐	☐	☐
98. Acting as secretary, keeping track of the number of people signing up for an event.	☐	☐	☐	☐	☐
TOTAL	___	___	___	___	___

Total Score ______________________________

ASSESSMENT OF PERFORMANCE UNIT

ATTITUDE QUESTIONNAIRES FOR 11 AND 15 YEAR OLDS
DEVELOPED BY THE NATIONAL FOUNDATION FOR EDUCATIONAL RESEARCH

Pupil Number

ASSESSMENT OF PERFORMANCE UNIT

Department of Education and Science
Welsh Education Office
Department of Education for Northern Ireland

MATHEMATICS ATTITUDE QUESTIONNAIRE

BOY / GIRL

DATE OF BIRTH

Day	Month	Year

TODAY'S DATE

Day	Month	Year

0120

P1982

This is a questionnaire asking
how you feel about mathematics.

It is NOT a test.

There are no right or wrong answers

PART A

Pages 3 and 4 contain a list of statements that pupils of your age have made about maths.

We want to know how much you agree or disagree with these statements.

FIRST, read each statement carefully.

NEXT, decide whether you agree or disagree with the statement or whether you are unsure about how you feel towards it.

THEN, tick the column that is most true for you.

Look at this example :

STATEMENT	Strongly Agree	Agree	Disagree	Strongly Disagree	Unsure
I would like to do well in maths.					
If you strongly agree, place a tick like this :	✓				
If you agree, but not strongly, place your tick like this :		✓			
If you disagree, but not strongly, place your tick like this :			✓		
If you strongly disagree, place your tick like this :				✓	
If you are unsure about your feelings, then place your tick in the last column.					✓

There is only one tick in each row.

Please put one tick in each row and don't miss any rows.

IF YOU DON'T UNDERSTAND, put up your hand and tell your teacher.

STATEMENT	Strongly Agree	Agree	Disagree	Strongly Disagree	Unsure	
I enjoy most things I do in maths.						10
I often get into difficulties with my maths.						11
Maths is a very useful subject.						12
I'm always glad of a break from maths.						13
I'm surprised if I get a lot of maths right.						14
I never feel like doing maths.						15
Maths is only important in a few jobs.						16
Maths never gets boring.						17
I think that girls and boys are equally good at maths.						18
Maths is not one of my favourite subjects.						19
I use maths to help me in lots of ways in school.						20
I usually understand a new idea in maths quickly.						21
Maths books are interesting.						22
I think it's difficult to get on in life if you haven't done much maths.						23
Maths is one of my better subjects.						24
At the end of a maths lesson I feel more clever.						25
I can usually understand my maths textbook.						26
I wish I didn't have to do maths.						27

STATEMENT	Strongly Agree	Agree	Disagree	Strongly Disagree	Unsure	
I can use maths to solve some everyday problems.						28
Even when I can do maths I don't like it.						29
I get lost if I miss any work in maths.						30
I like it when there is something new to learn in maths.						31
I enjoy everything I do in maths.						32
I think that without maths our lives would be much harder.						33
I don't like maths lessons.						34
Maths often gets too complicated for me.						35
Maths will help me to get a job one day.						36
I'm disappointed when I miss a maths lesson.						37
There are far too many things to remember in maths.						38
I sigh with relief when maths is over for the day.						39
I don't need maths much out of school.						40
I'd rather do other subjects than maths.						41
A lot of the maths we do is a waste of time.						42
Maths books are hard to follow.						43
I think that girls are normally better than boys at maths.						44
I'm always keen to start my maths lessons.						45

PART B

On pages 7 and 8 is a list of maths topics and activities.

We would like to know how easy or how hard you find these topics and activities in school.

Tick the column that is most true for you.

This example shows you what to do.

If you don't think you have done any work in school on a topic in the list, or you don't know a name in the list then tick the last column called Not Done.

TOPIC	Very Easy	Easy	Hard	Very Hard	Unsure	Not Done
If you think the topic is <u>very easy</u>, place your tick like this :	✓					
If you think the topic is <u>fairly easy</u>, place your tick like this :		✓				
If you think the topic is <u>fairly hard</u>, place your tick like this :			✓			
If you think the topic is <u>very hard</u>, place your tick like this :				✓		
If you are <u>unsure</u> how easy or hard the topic is, place your tick like this :					✓	
If you don't think you have done any work on the topic in school, place your tick like this :						✓

There is only <u>one</u> tick in each row.

Please put one tick in each row and don't miss any rows.

IF YOU DON'T UNDERSTAND, put up your hand and tell your teacher.

TOPIC	Very Easy	Easy	Hard	Very Hard	Unsure	Not Done	
graphs							55
adding							56
weighing							57
angles							58
time							59
volume							60
factors							61
number bases							62
algebra (using letters & symbols for numbers)							63
money							64
equations (questions like $51 + \square = 90$ and $2x + 1 = 15$)							65
fractions							66
practical maths							67
multiplying (times)							68
sets							69
tessellations (fitting shapes together, tiling walls or floors).							70
length							71
subtracting (taking away)							72

TOPIC	Very Easy	Easy	Hard	Very Hard	Unsure	Not Done	
geometry							73
arithmetic							74
triangles							75
decimals							76
area							77
multiplication tables							78
sorting							10
dividing							11
problems							12
symmetry							13
number patterns							14
measuring							15
percentages							16
shapes							17
prime numbers							18
averages							19
mirror reflections							20

If you have done some maths topics which are not in the list on pages 7 and 8, then write them in the extra spaces below.

TOPIC	Very Easy	Easy	Hard	Very Hard	Unsure	Not Done

Check that you have only one tick, for each topic, in the list on this page and those on pages 7 and 8.

Now answer these questions :-

What sort of maths do you like doing most? Write, on the dotted line, the two maths topics you like most.

- . . . 21

Write, on the dotted line below, the two maths topics you dislike most.

- . . . 22

What are the subjects or activities you like doing at school? Write, on the dotted line below, the two subjects or activities you like most.

- . . . 23

Write, on the dotted line below, the two subjects or activities you dislike most.

- . . . 24

PART C

In this part, there is a maths question for you to work out at the top of each page. Look at the one opposite on page 11 that Sharon has worked out.

Sharon has done this type of question before, so she does not tick the small box at the bottom of the question space.

After doing the question, Sharon shows what she thinks about this type of question.

Sharon shows that she likes the question and that it is hard but very useful.

She does this by putting a ring round the words like it , on the first line, hard , on the second line and very useful , on the third line.

IF YOU DON'T UNDERSTAND, put up your hand and tell your teacher.

IF YOU DO, turn to page 12.

his question is about multiplying

23 x 12 = 276

23
x 1,2
46
230
276

f you have not done this type of question
efore, tick this box. ☐

his is what I think of it :

I LIKE IT A LOT — [✓ LIKE IT] — DISLIKE IT — DISLIKE IT A LOT

IT'S VERY EASY — EASY — [✓ HARD] — VERY HARD

IT'S [✓ VERY USEFUL] — USEFUL — NOT USEFUL — NOT USEFUL AT ALL

OMMENTS? I think I get most questions like this right.

Here is an addition question

139 + 4282 + 11 = __________

If you have not done this type of question before, tick this box. ☐

This is what I think of it :

I	LIKE IT A LOT	LIKE IT	DISLIKE IT	DISLIKE IT A LOT
IT'S	VERY EASY	EASY	HARD	VERY HARD
IT'S	VERY USEFUL	USEFUL	NOT USEFUL	NOT USEFUL AT ALL

COMMENTS? ____________________

____

____

is question is about tables

This table has the dates of birth of five boys. . . 29

Derek	3rd June 1961
John	7th July 1962
Simon	23rd June 1962
Andrew	11th July 1961
Robert	2nd August 1961

Which boy is the youngest? _____________

f you have not done this type of question
efore, tick this box. ☐

is is what I think of it :

I LIKE IT A LOT ——— LIKE IT ——— DISLIKE IT ——— DISLIKE IT A LOT 30

IT'S VERY EASY ——— EASY ——— HARD ——— VERY HARD 31

IT'S VERY USEFUL ——— USEFUL ——— NOT USEFUL ——— NOT USEFUL AT ALL 32

OMMENTS? ____________________

This question is about money

Jane buys 4 books.
2 cost 60p each
1 costs 50p
and the other costs 75p.

How much does she pay altogether for the books?

____

If you have not done this type of question before, tick this box. ☐

This is what I think of it :

I	LIKE IT A LOT	LIKE IT	DISLIKE IT	DISLIKE IT A LOT	34
IT'S	VERY EASY	EASY	HARD	VERY HARD	35
IT'S	VERY USEFUL	USEFUL	NOT USEFUL	NOT USEFUL AT ALL	36

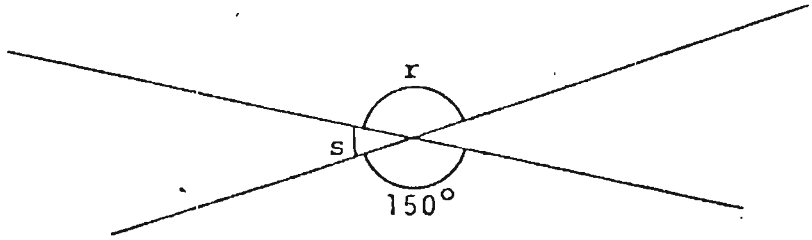
COMMENTS? ______________________________

____

____

This question is about angles

. . 37



What is the size of:

angle r ________________

If you have not done this type of question before, tick this box. ☐

This is what I think of it :

I LIKE IT A LOT —— LIKE IT —— DISLIKE IT —— DISLIKE IT A LOT 38

IT'S VERY EASY —— EASY —— HARD —— VERY HARD 39

IT'S VERY USEFUL —— USEFUL —— NOT USEFUL —— NOT USEFUL AT ALL 40

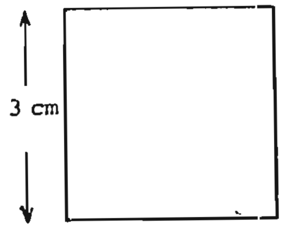
COMMENTS? ________________

____

____

This question is about area

41



What is the area of the square? _____________ cm^2

If you have not done this type of question before, tick this box. ☐

This is what I think of it :

I LIKE IT A LOT ——— LIKE IT ——— DISLIKE IT ——— DISLIKE IT A LOT 42

IT'S VERY EASY ——— EASY ——— HARD ——— VERY HARD 43

IT'S VERY USEFUL——— USEFUL ——— NOT USEFUL ——— NOT USEFUL AT ALL 44

COMMENTS? ____________________________________

____

____

Here is a multiplication question

381 x 11 = ___________ . . 45

If you have not done this type of question before, tick this box. ☐

This is what I think of it :

I	LIKE IT A LOT ———	LIKE IT ———	DISLIKE IT ———	DISLIKE IT A LOT	46
IT'S	VERY EASY ———	EASY ———	HARD ———	VERY HARD	47
IT'S	VERY USEFUL ———	USEFUL ———	NOT USEFUL ———	NOT USEFUL AT ALL	48

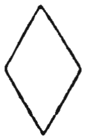
COMMENTS? ____________________

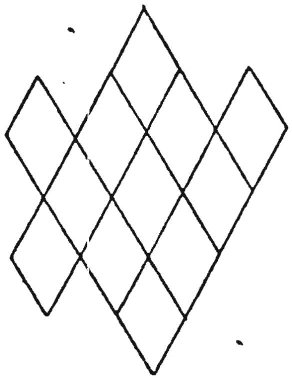
____

____

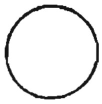
This question is about tessellations

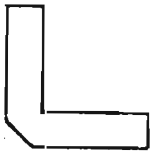
You can fit a lot of these shapes together without leaving any gaps: . . 49

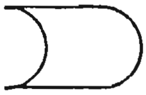


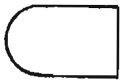


You can do the same with one of the shapes below. Put a ring round it.









If you have not done this type of question before, tick this box. ☐

This is what I think of it :

I LIKE IT A LOT ——— LIKE IT ——— DISLIKE IT ——— DISLIKE IT A LOT 50

IT'S VERY EASY ——— EASY ——— HARD ——— VERY HARD 51

IT'S VERY USEFUL ——— USEFUL ——— NOT USEFUL ——— NOT USEFUL AT ALL 52

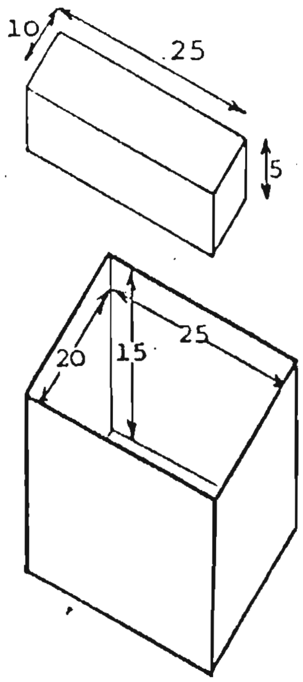
COMMENTS? ______________________________

This question is about volume

How many boxes like this

would fit exactly into this carton?

--------------- 53



If you have not done this type of question before, tick this box. ☐

This is what I think of it :

I LIKE IT A LOT ——— LIKE IT ——— DISLIKE IT ——— DISLIKE IT A LOT 54

IT'S VERY EASY ——— EASY ——— HARD ——— VERY HARD 55

IT'S VERY USEFUL ——— USEFUL ——— NOT USEFUL ——— NOT USEFUL AT ALL 56

COMMENTS? ______________________________

Here is a subtraction question

246 ÷ 184 = __________ 57

If you have not done this type of question before, tick this box. ☐

This is what I think of it :

I LIKE IT A LOT ——— LIKE IT ——— DISLIKE IT ——— DISLIKE IT A LOT 58

IT'S VERY EASY ——— EASY ——— HARD ——— VERY HARD 59

IT'S VERY USEFUL ——— USEFUL ——— NOT USEFUL ——— NOT USEFUL AT ALL 60

COMMENTS? ______________________________

This question is about fractions

$\frac{1}{6} + \frac{2}{3} =$ ----------

. . 61

If you have not done this type of question before, tick this box. ☐

This is what I think of it :

I LIKE IT A LOT ——— LIKE IT ——— DISLIKE IT ——— DISLIKE IT A LOT 62

IT'S VERY EASY ——— EASY ——— HARD ——— VERY HARD 63

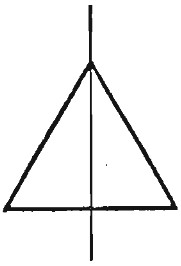
IT'S VERY USEFUL ——— USEFUL ——— NOT USEFUL ——— NOT USEFUL AT ALL 64

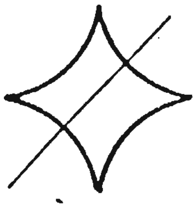
COMMENTS? ____________________

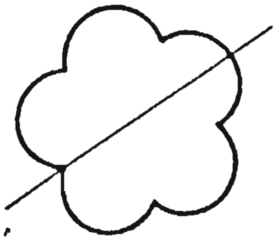
This question is about symmetry

John has drawn one line of symmetry on each of these shapes, but there are others. . . 65

Draw in all the missing ones for him







If you have not done this type of question before, tick this box. ☐

This is what I think of it :

I LIKE IT A LOT ——— LIKE IT ——— DISLIKE IT ——— DISLIKE IT A LOT 66

IT'S VERY EASY ——— EASY ——— HARD ——— VERY HARD 67

IT'S VERY USEFUL ——— USEFUL ——— NOT USEFUL ——— NOT USEFUL AT ALL 68

COMMENTS? ____________________

____

Here is a problem

. . 69

In Anne's class there are 30 children.
5 of them wear glasses.

What fraction of the class wears glasses?

____

If you have not done this type of question before, tick this box. ☐

This is what I think of it :

I LIKE IT A LOT	LIKE IT	DISLIKE IT	DISLIKE IT A LOT	70
IT'S VERY EASY	EASY	HARD	VERY HARD	71
IT'S VERY USEFUL	USEFUL	NOT USEFUL	NOT USEFUL AT ALL	72

COMMENTS? ______________________________

Here is a division question

816 ÷ 8 = ___________ . . 73

If you have not done this type of question before, tick this box. ☐

This is what I think of it :

I LIKE IT A LOT ——— LIKE IT ——— DISLIKE IT ——— DISLIKE IT A LOT 74

IT'S VERY EASY ——— EASY ——— HARD ——— VERY HARD 75

IT'S VERY USEFUL——— USEFUL ——— NOT USEFUL ——— NOT USEFUL AT ALL 76

COMMENTS? ______________________________

FAMOUS WOMEN MATHEMATICIANS

by Elenor Rubin Denker

Do you know about these famous women mathematicians? Read these brief introductions and decide which two you'd like to know more about.

HYPATIA (375-415)

Although everyone who has studied the history of mathematics has heard of Hypatia, no one knows very much about her. Apparently Hypatia was involved in a political-love triangle that resulted in her death in 415. Historically, she is best known for her philosophical works. In the mathematical arena, we do know that she was well respected by mathematicians of her day. Much of her training she received from her father, Theon of Alexandria.

EMILIE, MARQUISE DUE CHATELET (1706-1749)

The Marquise du Chatelet is a somewhat controversial figure in the history of mathematics. While her personal life was rather notorious, that seemed not to enter into the controversy. There is a question as to the value of her contributions and her understanding of higher mathematics. Although she wrote a large volume on the mathematical principles of natural philosophy, it is unclear whether these were her own ideas or those of her teacher, Clairaut. In any event, it was uncommon for a woman of her day to be involved in any way with these concepts.

MARIA GAETANA AGNESI (1718-1799)

Agnesi's principal contribution to mathematics was a book that systematically outlined all that was known about mathematics at that time. She felt that mathematical knowledge was progressing quickly and a newcomer needed a reference source in order to absorb all the latest 18th century discoveries. Calculus, for example, was in a very rudimentary state at the time.

SOPHIE GERMAIN (1776-1831)

Mlle. Germain used a man's name on the papers she submitted to her mathematics professors. When a prize was offered for the best essay on the mathematical theory of elastic membranes (which vibrate according to mathematical laws), Sophie submitted a solution, although most of the mathematicians at the time felt it was too difficult. In fact, she entered the same competition three times and did receive an award for the third entry, which was the only one submitted in her own name.

MARY SOMERVILLE (1780-1872)

At the age of 92, just before she died, Mrs. Somerville was studying "Higher Algebra and the Calculus of Quaternions." Much of her writings were translations of French mathematicians, specifically Laplace, who said that Mary Somerville was the only woman who understood his work. She wrote numerous books of her own as well, such as a book on physical geography and another on molecular and microscopic science.

SONYA KOVALEVSKY (1850-1891)

Professor Kovalevsky has been called the most glamorous woman mathematician who ever lived. She was born in Russia in 1850 and later wanted to study at a foreign university. She did what many other women did at the time--married a young man who was going to study abroad and could take her with him. Since she was a woman, she couldn't attend lectures so she had private lessons. Even when she received her doctorate, it was in absentia, because women could not attend the ceremonies. One of Sonya's greatest recognitions came when she was awarded the Prix Bordin, the most prestigious award of the French Academy, for her work "On the Rotation of a Spatial Body about a Fixed Point."

EMMY NOETHER (1882-1935)

According to Albert Einstein, Emmy Noether was the most "significant creative mathematical genius thus far produced since the higher education of women began." Dr. Noether was born in Germany and lived there most of her life. Her family was mathematically inclined--her father a well-known mathematician and her brother a math professor. She developed slowly and only began publishing major creative ideas when she was almost 40. Up to that point, her papers, mostly on algebra, were more formal and less abstract.

MARIA CIBRARIO (1905-)

Maria Cibrario was born in Turin, Italy at the beginning of this century. She studied math at the University of Turin and spent most of her life as a professor of mathematics. Some of her works were done in collaboration with her husband, Silvio Cinquini, also a mathematician.

SOPHIE PICCARD (1904-)

The Piccard family left Russia in the 1920's and moved to Switzerland. Sophie found it difficult to find a teaching job there, although she had numerous advanced degrees. However, while she worked in other areas, she continued her research, which has been prolific, particularly on set theory and group theory. Since 1943, she has been a full professor of higher geometry and probability theory.

JACQUELINE LELONG-FERRAND (1918-   )

As a child, Jacqueline received the first prize in a national mathematics competition. She then entered one of the best high schools in France at a time when women were just beginning to attend these schools. She has had a remarkable career, mostly in France, although she also spent some time with her husband and children at Princeton.

MARIA PASTORI

Maria and her sister Giuseppina showed a great determination in obtaining their education. As children in a large family of modest means, they were expected to go to work as soon as they finished elementary school. With some help from one of her teachers, and hours of study with her sister, Maria managed to become one of only three women who presently have full professorships in mathamtics at leading Italian universities. Dr. Pastori is known for her work on tensor calculus, which is'important for the understanding of dynamics, hydrodynamics, and elasticity.

PAULETTE LIBERMANN

Dr. Libermann is a contemporary scholar in France, working in the realm of pure mathematics. Algebraic topology is her main area of interest, and a development of her undergraduate work at Sevres. Much of her work is related to Einstein's discoveries.

CATHLEEN MORAWETZ (1923-   )

In 1946 Cathleen moved to New York and tried to find a job. She already had a Masters Degree in mathematics from MIT but jobs were difficult to find. Through her father, who was a well-known mathematican, she finally got a job editing a book on shock waves. Eventually, this was the subject of her Ph.D.thesis. Her research had direct relevance to the design of airplane wings.

BIBLIOGRAPHY

Aiken, L.

Nonintellective variables and mathematics achievement: directions for research. Journal of School Psychology, 1970, 8 (1), 28-36

Aiken, L.

Update on attitudes and other affective variables in learning mathematics. Review of Educational Research, 1976, 46, 293-311

Aiken, L.R.

Intellective Variables and Mathematics Achievement. Directions for Research. Journal of School Psychology, 9, 201-212 (1971)

Albrecht, Stan L.; Bahr, Howard M.; Chadwick, Bruce A.

"Public Stereotyping of Sex Roles, Personality Characteristics and Occupations". Sociology and Social Research, 1977, 61, 231-240

Alpert, R. & Haber, R.

Anxiety in academic achievement situations. Journal of Abnormal and Social Psychology, 1960, 61, 207-215

Auslander, Susan B.

Minimizing Math Anxiety. Journal of College Science Teaching 1979, Vol. 9, No. 1

Bander, Ricki S.; Russell, Richard K.; Zamostny, Kathy P.

A comparison of Cue - Controlled Relaxation and Study Skills Counselling in the Treatment of Mathematics Anxiety. Journal of Educational Psychology 1982 Vol. 74, No. 1 96-103

Bandura, A.; Blanchard, E.B.; Ribber, B.

Relative efficacy of desensitization and modelling approaches for inducing behaviioural, affective and attitudinal changes. Journal of Personality and Social Psychology, 1969, 13, 173-199

Barnes, Elizabeth

"Demystifying Math." American Education 16, 7 (August - September 1980): 6-8

Bell, A.W.; Castello, D.; Küchermann, D.

A Review of Research in Mathematics Education - Part A. N.F.E.R. (1984)

Betz, N.

Prevalence, distribution and correlates of math anxiety in college students. Journal of Counselling Psychology, 1978, 25, 441-448

Blackburn, Katherine Taggart

A Correlational and Multiple Regression Analysis of Seventh Grade Mathematics Students' Attitudes and their Teachers' Characteristics. Ph.D. Thesis, University of Tennessee, 1983

Blum, L.

Educating College Women in Mathematics : A report of an action program in progress. Paper presented at the Conference, Educating Women for Science : A continuous spectrum, Oakland, California, April, 1976

Boodt, Mary Ione

The Nature of the Relationship between anxiety toward Mathematics and Achievement in Mathematics.
Ph.D. Thesis, Indiana University, U.S.A. 1979

Bregman, Susan

Math Anxiety
Independent School (1978) Vol. 37, No. 4

Brooks, K.H.; Faderman, L.; Gregory, J.; Rice, N.J.

Basic Mathematical Skills and reducing "math anxiety" in women students. Future Talk, 1976, 15, 6-7, 10

Bruch, M.A.

Relationship of test-taking strategies to test anxiety and performance : Toward a task analysis of examination behaviour. Cognitive Therapy and Research, 5, 41-56, 1981

Bruch, M.A.; Juster, H.R.; Kaflowitz, N.G.

Relationships of Cognitive Components of test anxiety to test performance : Implications for assessment and treatment. Journal of Counselling Psychology, 30, 527-536, 1983

Brush, Lorelei

Attitudes and Achievement in Mathematics Learning.
Wellesley College Mathematics Anxiety Project,
Wellesley, MA November 1976

Brush, L.K.

A validation study of the Mathematics Anxiety Rating Scale (MARS). Educational and Psychological Measurement, 1978, 38, 485-489

Brush, Lorelei K.

Some thoughts for teachers on maths anxiety.
Arithmetic Teacher, 1981, Vol. 29, No. 4

Buckley, P.A. and Ribordy, S.C.

Mathematics Anxiety and the Effects of Evaluative Instructions on Mathematics Performance.
Paper presented in mid-western Psychological Association (1982)

Bulmahn, Barbara J. and Young, David M.

On the transmission of Mathematics Anxiety.
Arithmetic Teacher Vol. 30, No. 3, 1982

Burkhardt, Hugh

The Real World and Mathematics
Blackie; Glasgow 1981

Buxton, Laurie

Do you Panic about Mathematics?
Coping with Anxiety.
Heineman Educational Books, London 1981

Buxton, Laurie

(Author of "Do You Panic about Mathematics")
Personal Interview - Tape Recorded 1984

Byrd, Pamela Gulley

A Descriptive Study of Mathematics Anxiety :
It's Nature and Antecedents.
Ph.D. Thesis Indiana University CISM 1982

Carpenter, T.P.; Moser, J.M.; Romberg, T.A.

Addition and Subtraction : A Cognitive Perspective.
Lawrence Erlbaums, New Jersey (1982)

Chapline, Elaine B. and Newman, Claire M.

Teacher Education and Mathematics Project : Final Report.
Queens College, City University of New York, 1980

Chapline, Elaine B. and Newman, Claire M.

Personal Interview : Tape Recorded (1984)

Chapline, Elaine B. and Newman, Claire M.

Teacher Education and Mathematics : A Project to Reduce
Mathematics Anxiety and Sex-Role Stereotyping in the
Classroom : U.S. Department of Education.
Queen's College, New York, 1984

Cockcroft, W.H. (Chairman)

Mathematics Counts : Report of the Committee of Inquiry
into the teaching of Mathematics in Schools.
H.M.S.O. England (1982)

Crumpton, S.D.

A Mathematics Anxiety Reduction Project.
Ph.D. Thesis, University of Tennessee, U.S.A. 1977

Culler, R.E. and Hulahan, C.

Test Taking and Academic Performance : The effects of
Study-related behaviours.
Journal of Educational Psychology, 72, 16-20, 1980

Curnyn, James

An Experimental and case-study approach to the study of some difficulties experienced in learning mathematics.
A Research Report on a study funded by the Leverhulme Trust, Brunel University, England. 1978

Curnyn, James

A study of the Nature and Development of Mathematical Ability from late Primary to early Secondary.
Unpublished report. Brunel University, England. 1980

Curran, J.P.

Social Skills training and systematic desensitization in reducing dating anxiety. Behaviour Research and Therapy, 1975, 13, 65-68

Davis, Robert B.

Learning Mathematics : The Cognitive Science Approach to Mathematics Education.
Billing and Sons, Worcester, 1984

De Lange, J.M.

Relative effectiveness of assertive skill training and desensitization for high and low anxiety women.
Doctoral dissertation, University of Wisconsin, 1976

Desiderato, O. and Koskinen, P.

Anxiety, study habits, and academic achievement.
Journal of Counselling Psychology, 1969, 16, 162-165

Dessart, Donald K. and Suydan, Marilyn N.

Classroom Ideas from Research on Secondary School Mathematics.
N.C.T.M. (United States of America) 1983

Dolan, Daniel T. and Williamson, James

Teaching Problem - Solving Strategies.
Addison - Wesley, United States of America (1983)

Donady, B. and Tobias, S.

Mathematics Anxiety.
Teacher, 1977, 95, 71-74

Dougherty, Knowles

Math Anxiety : Causes and Cures
Unpublished Report on Math Anxiety Programme at Wesleyan University (1981)

Dreger, R.M. and Aiken, L., Jr.

The identification of number anxiety in a college population.
Journal of Educational Psychology, 1957, 48, 344-351

Driscoll, Mark

Research within Reach : Secondary School Mathematics.
A Research Guided Response to the Concerns of Educators.
N.C.T.M. (United States of America) 1983

Duchesneau, Joyce

Mathematics Anxiety : Helping the mathematics anxious student. The Oregon Mathematics Teacher.(January, 1980)

Dunlop, William P. and McNight, Martha Brown

Vocabulary Translations for conceptualizing math word problems. The Reading Teacher, Nov. 1978, 183-189

Dusek, J.B.; Kermis, M.D.; Mergler, N.L.

Information Processing in Low and High test anxious children as a function of grade level and verbal labelling. Developmental Psychology, 11, 651-652, 1975

Dusek, J.B.; Mergler, N.L.; Kermis, M.D.

Attention encoding, and information processing in Low and High-test anxious children. Child Development, 4, 201-207, 1976

Dutton, W.H.

Attitudes of Senior High School Pupils towards Arithmetic The School Review, 18-22, January 1956

Edmonds, B. and Knights, G. (Ed)

Teaching Styles : A Response to Cockcroft 243 Association of Teachers of Mathematics, England (1983)

Eisler, R.M.; Hersen, M.; Miller, P.M.

Effects of modelling on components of assertive behaviour. Journal of Behaviour Therapy and Experimental Psychiatry, 1973, 4, 1-6

Ernest, John

Mathematics and Sex. American Mathematical Monthly, 83(8), October, 1976

Fennema, Elizabeth

Influences of Selected Cognitive, Affective, and Educational Variables on Sex-related Differences in Mathematics Learning and Studying. National Institute of Education, Washington, D.C. November 1977

Fennema, Elizabeth and Carpenter, Thomas P.

Sex-related differences in Mathematics. Results from National Assessment. The Mathematics Teacher, 74 (October 1981), 554-559

Fennema, Elizabeth and Sherman, Julia A.

Fennema, Sherman Mathematics Attitude Scales; Instruments Designed to Measure Attitudes Towards the Learning of Mathematics by Females and Males. Journal for Research in Mathematics Education. (November 1976), 324-326

Fennema, Elizabeth and Sherman, Julia A.

Sex-Related Differences in Mathematics Achievement and Related Factors: A further study.
Journal for Research in Mathematics Education 9 (May 1978): 189-203

Fennema, Elizabeth and Sherman, J.

Sex-Related Differences in Mathematics Achievement, Spatial Visualization and Affective Factors.
American Educational Research Journal Vol. 14, No. 1 (Winter 1977), 51-71

Foxman, Derek and Mitchell, Peter

Assessing Mathematics: A.P.U. Framework and Modes of Assessment.
Mathematics in School. November 1983

Foxman, D.D.; Martini R.M.; Mitchell, P.

Mathematical Development. Secondary Survey Report No. 3
H.M.S.O. London 1982

Foxman, D.D.; Ruddock, G.J.; Badger, M.E.; Martini, R.M.

Mathematical Development. Primary Survey Report No. 3
H.M.S.O. London 1982

Frary, Robert B. and Ling, Jeanne L.

A Factor Analytic Study of Mathematics Anxiety
Educational and Psychological Measurement 1983
Vol. 43, No. 4

Freeman, Carol Lipps

The Effect of a Mathematics Anxiety Reduction Model on the Students in a College Level,
Basic Mathematics Skills Course
Ph.D. Thesis St Louis University, United States of America, 1982

Frye, Elizabeth Weimer

The Effect of Knowledge of level of Mathematics Basic Skills on Mathematics Anxiety.
Ed.D. Thesis, West Virginia University, United States of America, 1983

Furneaux, W.D. and Curnyn, J.C.

A summary of an experiment and statistical study of the structure and development of Mathematical ability during the late primary and early secondary stages of education, together with an investigation of some of its cognitive and affective concomitants.
Brunel University, England, 1982

Furneaux, W.D. and Rees, R.

The structure of mathematical ability.
British Journal of Psychology, 1978

Gaudry, E. and Spielberger, C.D.

Anxiety and Educational Achievement.
Sydney: John Wiley and Sons Australasia Ltd., 1971

Goodall, Charles Gayle

The Reduction of Mathematics Anxiety Utilizing Relaxation and Desensitization and the Presentation of Practical Examples.
Ph.D. Thesis, University of South Florida, United States of America, 1980

Griffiths, J.L.

An Exploratory analysis of attitudes towards Mathematics held by Student Teachers and Children in Primary Schools.
M.Litt. Thesis, Bristol, 1974

Handler, Barbara Hershey

Reduction of Mathematics Anxiety in College, Remedial Algebra Students. Ed.D. Thesis, University of Tennessee, United States of America, 1982

Hannafin, Michael J.

Effect of Teacher and Student Goal Setting and Evaluation on Mathematics Achievement and Student Attitudes.
Journal of Educational Research, 1981 (May/June P.74/75)

Hendel, Darwin D. and Davis, Sandra O.

Effectiveness of an Intervention Strategy for Reducing Mathematics Anxiety. Journal of Counselling Psychology, 25 September 1978, 429-434

Hill, Shirley (Ed)

Education in the 80's : Mathematics.
National Education Association, United States of America, 1982

Hilton, Peter

Some Thoughts on Math Anxiety. Ontario Mathematics Gazette, 1978

Hunkler, R. and Quast, W.G.

Improving the Mathematics Attitudes of Prospective Elementary School Teachers.
School Science and Math, 1972, 72, 709-714

Hyman, June R.

Systematic Desensitization of Math Anxiety in High School Students : The role of Mediating responses, imagery, emotionality and expectancy.
Ph.D. Thesis, Wayne State University, Detroit, 1973

Jacobs, Judith E. (Ed)

Perspectives on Women and Mathematics
ERIC, Ohio State University, 1978

Joffe, Lynn

(Senior Research Officer, "National Foundation for Educational Research.)
Personal Interview - Tape Recorded, 1984

Johnson, Gayle Ann S

An Investigation of Selected Variables and their Effect upon the Attitude toward the Teaching of Elementary School Mathematics by Preservice Elementary School Teachers.
Ed.D. Dissertation, University of Houston, 1981

Keely, M.

(Acting Head of Department, Edgewood College of Education.)
Personal Interview, 1985

Kepner, Henry Jr. and Koehn, Litane R.

Sex Roles in Mathematics: A study of the status of sex stereotypes in elementary mathematics text.
Arithmetic Teacher, 24(5), 379-85, May, 1977

Kirkland, K. and Hollandsworth, J.

Effective test taking: Skills-acquisition versus anxiety-reduction techniques.
Journal of Counselling and Clinical Psychology, 1980, 48, 431-439

Kirkland, K. and Hollandsworth, J.

Test Anxiety, study skills and academic performance.
Journal of College Personnel, 1979, 431-435

Kogelman, Stanley and Warren, Joseph

Mind over Math. Dial Press, New York, 1978

Kogelman, Stanley; Nigro, Elizabeth; Warren, Joseph

Mind over Math : Overcoming Math Anxiety at the Dalton School.
Independent School - Vol. 37, No. 4, (1978)

Kogelman, Stanley

Director of "Mind over Math".
Personal Interview - Tape Recorded, 1984

Kreinburg, N.

Furthering the Mathematical Competence of Women
Public Affairs Report 17, 1-7, 1976

Krutetskii, V.A.

The Psychology of Mathematical Abilities in School children.
The University of Chicago Press, Chicago, 1976

Lazarus, Mitchell

S.R. Education : Rx for Mathphobia
Saturday Review, United States of America, 28.6.1975

Lazarus, Mitchell

Mathophobia: Some Personal Speculations.
National Elementary Principal, 53 (January-February, 1974), 16-22

Lazarus, Mitchell

Rx for Mathophobia. Education Digest 41: November 1975, 7-10

Lazarus, M.

Mathophobia: Some Personal Speculations.
National Elementary Principle, 1974, 53, 16-22

Mathematical Development Secondary Survey Report No. 4

Unpublished Draft 1984

Mathematical Development Primary Survey Report No. 4

Unpublished Draft 1984

Mathematics Practical Assessment (Age 11)

Video Tape produced by C.S.M.E.
Assessment of Performance Unit, England, 1980

Mathematics Practical Assessment (Age 15)

Video Tape produced by C.S.M.E.
Assessment of Performance Unit, England, 1980

Mathematics : The Invisible Filter

A Report on Mathematics Avoidance, Mathematics Anxiety and Career choice by the Mathematics Department, Toronto Board of Education, 1983

Morris, Janet

Math Anxiety : Teaching to avoid it.
The Mathematics Teacher 1981, Vol. 75, No. 6

Nash, Philip C.

Treatment of math anxiety through Systematic Desensitization and insight-oriented therapy groups.
Ph.D. Thesis, Arizona State University, 1970

National Advisory Committee on Mathematical Education

Overview and Analysis of School Mathematics, Grades 7-12
Washington, D.C. : Conference Board of the Mathematical Sciences, 1975

National Council of Supervisors of Mathematics

Task Force on Basic Mathematical Skills. Position Paper on Basic Mathematical Skills.
Washington, D.C., 1977

Naylor, F.D. and Gandry, E.

The Relationship of Adjustment, Anxiety and Intelligence to Mathematics Performance.
Journal of Educational Research, 66, 9, 413-417 (1973)

Payne, Joseph N. (Ed.)

Maths Learning in Early Childhood
NCTM 37th Year Book (1975)

Peterson, P.L.

Interactive effects of student anxiety, achievement orientation, and teacher behaviour on student achievement and attitude. Journal of Educational Psychology, 1977, 69, 779-792

Phillips, B.N.; Martin, R.P.; Meyers, J.

School-related interventions with anxious children In C.D. Spielberger (Ed), Anxiety Current Trends in Theory and Research (Vol. 2) New York : Academic Press 1972

Polya, George

How to Solve it - A New Aspect of Mathematical Method. Doubleday Anchor, Garden City, New York, 1957

Rae, G. and McPhillimy, W.N.

Learning in the Primary School : A systematic approach (2nd Edition) Hodder and Stoughton, London, (1985)

Rees, R.

Maths with Meaning
Tape Recording of programme presented on BBC radio:
BBC Continuing Education. 8 March to 12 April, 1981

Rees, Ruth and Barr, George

Diagnosis and Prescription : Some Common Maths Problems
Harper and Row, London, 1984

Rees, R. (1978)

Learning Difficulties in Mathematics. A further investigation of the Nature of the Determinants of Mathematical Performance. Unpublished Report prepared for B.P. Conference, Brunel University, England.

Richardson, F. and Suinn, R.

A comparison of traditional systematic desensitization, accelerated massed desensitization, and anxiety management training in the treatment of mathematics anxiety. Behaviour Therapy, 1973, 4, 212-218

Richardson, F. and Suinn, R.

The Mathematics anxiety rating scale: psychometric data. Journal of Counselling Psychology, 1972, 19, 551-554

Richardson, S.A.

Effectiveness of Rational-Emotive Therapy or Problem solving/ Relaxation in reducing math anxiety and/or improving attitudes toward math in potential elementary school teachers. Ph.D. Thesis, University of Wyoming, 1980

Royal Society

The training and Professional life of teachers of mathematics. November 1976

Sandman, Richard S.

Factors related to Mathematics Anxiety in the Secondary School. Paper presented at a meeting of the American Educational Research Association. San Francisco (April 1979): 1-15

Sarason, I.G. (Ed)

Test Anxiety: Theory, research, applications.
Hillslade, N.J.; Erlbaum Association, 1980

Sarason, I.G.

Experimental approaches to test anxiety : Attention and the uses of information. In C.D. Spielberger (Ed) Anxiety : Current trends in Theory and Research (Vol. 2)
New York : Academic Press, 1972

Schafer, A.T.

Wellesley College - Wesleyan University Mathematics Project, Interim Report.
Wellesley, Mass. Wellesley College, Department of Education 1977

Schminke, C.W.; Maertens, N.; Arnold, W.

Teaching the Child Mathematics, Dryden Press, Illinois (1973)

Schofield, Hilary L.

Teacher effects on cognitive and affective pupil outcomes in elementary school mathematics.
Journal of Educational Psychology, 1981. Vol. 73, No. 4

Schonberger, Ann K.

Are Mathematics Problems a problem for Women and Girls? Paper presented at the Annual General Meeting of the N.C.T.M. San Diego, April, 1978

Schonell, F.J. and Schonell, F.E.

Diagnosis and Remedial Teaching in Arithmetic
London : Oliver and Boys 1957

Sells, Lucy

Mathematics - A Critical Filter - The Science Teacher 45(2); 1978

Sells, Lucy W.

High School Math as the Critical Filter in the Job Market
Research Report, 1973

Shaughnessy, J,; Haladyna, T.; Shaughnessy, J.M.

Relations of Student, Teacher and learning environment. Variables to attitude towards mathematics
School Science and Mathematics, 1983, Vol. 83, No. 1

Shaughnessy, J.; Haladyna, T.; Shaughnessy, J.M.

A Causal Analysis of attitude towards mathematics.
Journal for research in mathematics education 1983. Vol. 14, No. 1

Sherard, Wade

Math Anxiety in the Classroom.
The Clearing House (55). November 1981, 106-110

Sherman, Julia

Effects of Biological Factors on Sex-Related Differences in Mathematics Achievement. Women and Mathematics: Research Perspectives for Change, 137-206. NIE Papers in Education, and Work: No.8. National Institute of Education, Washington, D.C. November, 1977

Shumway, Richard K. (Ed)

Research in Mathematics Education
N.T.C.M. Professional Reference Series 1980

Sirber, J.E.; O'Neil, H.F.; Tobias, S.

Anxiety, learning and instruction. Hillsdale, N.J.; Erlbaum Associates, 1977

Skemp, Richard R.

The Psychology of Learning Mathematics. Penguin Books, Baltimore, MD 1971

Smith, William Herman

Treatments of Mathematics anxiety : Anxiety Management Training : Systematic Desensitization and self-help Bibliotherapy
Ph.D. Thesis. The University of Texas at Austin, United States of America, 1979

Sovchick, R.; Meconi, L.J.; Steiner, E.

Mathematics Anxiety of Preservice, Elementary Mathematics Methods Students.
School Science and Mathematics (1981), Vol. 81, No. 8

Stallings, Jane A.

Comparison of Men's and Women's Behaviours in High School Math Classes.
SRI International, Menlo Park, California, 1978

Streim, Leonard

A comparison of the relative Efficacies of Negative Practice and Anxiety Management Training in the Treatment of Math Anxiety.
Ph.D. Thesis, Hofstra University, United States of America, 1979

Suinn, R.

The STABS, a measure of test anxiety for behaviour therapy normative data.
Behavioural Research and Therapy, 1969, Vol. 7

Suinn, R.; Edie, C.; Nicoletti, J.; Spinelli, R.

The MARS, a measure of mathematics anxiety: psychometric data.
Journal of Clinical Psychology, 1972, 28, 373-375

Suinn, R.; Edie, C.; Spinelli, P.

Accelerated massed desensitization; innovation in short-term treatment. Behaviour Therapy, 1970, 1, 303-311

Suinn, R. and Richardson, T.

Anxiety management training: a nonspecific behaviour therapy programme for anxiety control.
Behaviour Therapy, 1971, 2, 498-510

Themes, Ellen Patricia

Three Methods of Reducing Math Anxiety in Women.
Ph.D. Thesis, Kent State University, United States of America, 1982

Thompson, Alba Gronzalez

Teachers' Conceptions of Mathematics and Mathematics Teaching : Three Case Studies.
Ed.D. Thesis, University of Georgia, United States of America, 1982

Tobias, Sheila

Overcoming Math Anxiety. W.W. Norton & Co.
New York, 1978

Tobias, Sheila

Paths to Programs for Intervention : Math Anxiety, Math Avoidance; Re-entry Mathematics.
The Institute for the Study of Anxiety in Learning.
Washington, 1980

Tobias, Sheila

Managing Math Anxiety; A New Look at an Old Problem.
Children Today. 7 September/October 1978, 7-9

Tobias, Sheila

Math Anxiety: What You Can Do About It.
Today's Education: Journal of the National Education Association, Vol. 69, No. 3, September/October, 1980b

Tobias, Sheila

Math Anxiety, Ms., September 1976, 56-59

Tobias, Sheila and Donady, B.

Report on the second year of the Wesleyan University
Math Anxiety Project
Manuscript submitted for publication, 1976

Tobias, S. and Donady, B.

Counselling the Math Anxious
Journal of the NAWDAC 41, 13-16, 1977

Tobias, Sheila

Anxiety research in educational psychology
Journal of Educational Psychology, 1979, 71, 573-582

Tobias, Sigmund

Test Anxiety and Cognitive Interference or Inadequate Preparation?
Paper presented at the Annual Convention of the American Educational Research Association.
New Orleans, April, 1984

Tobias, Sigmund

Anxiety Research in Educational Psychology.
Journal of Educational Psychology, 1979, 71, 573-582

Tobias, Sigmund and Ingber, I.

Achievement - Treatment - interactions in programmed instruction.
Journal of Educational Psychology, 1976, 68, 43-47

Toliver, Peggy Jean

Effects of an anxiety Management Treatment on Mathematics Anxiety.
Ph.D. Thesis, University of Texas at Austin, United States of America, 1982.

Troutman, James G.

The Effects of a Mathematics Clinic on Reducing Anxiety in Female Students: Social Factors. Nova University, March, 1978

Visser, Delene

Mathematics and the Sexes
Compass H.S.R.C. Magazine No. 3, April, 1983

Visser, Delene

Attitudes to Mathematics.
Report from the Psychology Department, No. 9
University of South Africa, November 1983

Wachs, Brian Jay

The Mathematics Anxieties and Attitudes of Urban Public School Teachers.
Ed.D. Thesis, Yeshiva University, United States of America, 1983

Walden, Rosie and Walkerdine, Valerie

Girls and Mathematics: the Early Years
Bedford Way Papers 8, 1983

Walker, Constance

How to Overcome Math Anxiety. The Executive Educator
21-22, January 1981

Widmer, C.C. and Charez, A.

Mathematics Anxiety and Elementary School Teachers.
Education Vol. 102, No. 3, 1982

Wilson, J. and Begle, E. (Eds)

Correlates of attitudes toward mathematics.
NLSMA Reports, 20, 1972

Wine, J.

Test anxiety and the direction of attention.
Psychological Bulletin, 1971, 76, 92-104

Wise, Erica H. and Haynes, Stephen N.

Rational Restructuring Versus attentional training.
Journal of Cognitive Therapy and Research 1983
Vol.7, No. 1

Wittmaier, B.

Test Anxiety and Study Habits
Journal of Educational Research, 352-354, 1972

Zacharias, J.R.

Apples, Oranges and Abstractions.
National Elementary Principal 1976, 56(1). 20-27