CONTEXTUAL FACTORS ASSOCIATED WITH MATHEMATICS ANXIETY: PERCEPTIONS OF TEACHERS AND STUDENTS AT A SECONDARY SCHOOL IN KWAZULU-NATAL.

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To The Almighty, for his infinite blessings and mercies.

To my supervisor, Dr Nithi Muthukrishna, for her unwavering support, guidance and encouragement.

To my dear parents, for permanently being the guiding forces in my life.

To all the subjects who participated willingly and unconditionally in this study.

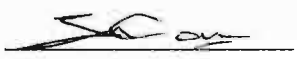
ABSTRACT

This study explores the phenomenon of mathematics anxiety with respect to a group of matric students at a secondary school in KwaZulu-Natal. The contextual factors associated with mathematics anxiety were examined from the perspective of ten mathematics students and three teachers of mathematics. In this study, qualitative research methodology was used. The data was gathered through semi-structured interviews and questionnaires. Various factors, such as the belief in mathematical myths and negative experiences during the early school years, interact to contribute to the phenomenon of mathematics anxiety. The study revealed the need to dispel mathematical myths, to create supportive learning environments for students, and to provide support for mathematics teachers in the form of on-going professional development.

DECLARATION

I declare that this is my own, unaided work. It is being submitted in partial fulfilment of the requirements for the Degree of Master in Education (Psychology of Education) in the School of Education at the University of Natal. It has not been submitted before for any degree or examination in this or any other university.

Fathima Khan



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CHAPTER ONE: INTRODUCTION

1.1. Background and Motivation for The Study

It is well known that in South Africa students perform poorly in the matriculation mathematics examination. Statistics for 1997 reveal that, "Of the 252 617 students who wrote maths exams, only 22 798 passed on the higher grade" ("SA's pupils", 1998). Converted to a percentage, this means that in 1997 only nine percent of the learners actually passed mathematics on the higher grade. Statistics for the 1998 matriculation examination (Shindler and Bot, 1999) are as disappointing in that of the 279 702 candidates who wrote mathematics, only 117 827 passed - a mere 42%. In keeping with previous years, the matric mathematics results in 1999 were exceptionally poor. Only 3,6% of pupils who wrote the examination passed the subject on the higher grade (Copeland, 2000).

Over the years, several reasons have been provided for the poor pass rate in mathematics at matric level. In an unpublished provincial report on the senior certificate mathematics results of 1997 (Van Wyk, 1988), the following reasons have been cited for the poor pass rate in matric mathematics :

- A lack of management in schools. It is believed that there is a close correlation between well managed schools and good senior certificate results in mathematics. The fact is that no learning and teaching has

taken place in an alarmingly large number of schools. There has been much disruption caused by principals and deputy principals taking the retrenchment 'package' offered by the Department of Education, resulting in some schools having no Grade 12 teachers for certain subjects, or having the top structure in schools in an acting capacity.

- For success in mathematics, maximum contact with the subject and the educator are essential. Mathematics is more prone to being affected by lost time than some other subjects. However, in the vast majority of schools, more so those in outlying areas, late-coming or downright absenteeism are the order of the day. There is no respect for time - from the principal downwards. In addition, disruptions are caused by teacher unions. Periodic strikes are called and members of these bodies are frequently away from school as representatives at meetings. The report also found that during the fourth term, there is an absence of valuable revision because Grade 12 learners stay away from school. The general claim is that these learners are 'studying' at home. Matric mathematics papers are written by students without being in contact with educators for over two months.
- A large number of unqualified educators are teaching mathematics at the Senior Certificate level.
- The general trend has been to allow too many candidates into higher grade classes. Learners need to 'earn' the right to do higher grade mathematics through a track record of hard work and independent effort. Even opting for standard grade mathematics is not necessarily

the solution. There is a need to promote standard grade Functional Mathematics as an alternative. Functional Mathematics is the most basic mathematics course offered at matric level.

Since 1996, I have been a member of the mathematics department at Woodhurst Secondary. The dismal mathematics results at matric level generally and more particularly at my own school has motivated me to conduct this study. The study explores mathematics anxiety - a factor neglected in the analysis of the poor pass rate in matric mathematics in KwaZulu-Natal.

Betz (cited in Williams, 1988) found that the higher the level of mathematics anxiety, the lower the mathematics achievement test score. It is indeed interesting to note that mathematics anxiety, defined as "the experience of mental disorganisation, panic and fear that prevents a person from learning mathematics" (Auslander cited in Hawkey, 1986, p.10), is not acknowledged in the provincial report (of the senior certificate mathematics results in KwaZulu-Natal) as a factor contributing to the poor results in matric mathematics (Van Wyk, 1998).

1.2. The Aims of The Study

The present study aims to explore mathematics anxiety with respect to a group of matric students at a secondary school in KwaZulu-Natal. The following are the broad research questions :

- How did students experience mathematics lessons in primary and secondary school?
- To what do students attribute failure and success in mathematics?
- What are some of the myths held by students about mathematics learning?
- What are some of the myths about mathematics learning held by teachers?
- What do students perceive to be the factors associated with their own mathematics anxiety?
- What do teachers perceive to be the factors associated with student mathematics anxiety?
- To what extent does the teaching/learning environment contribute to mathematics anxiety?

CHAPTER TWO: PERSPECTIVES ON MATHEMATICS ANXIETY

2.1. Introduction

Mathematics anxiety was highlighted in the U.S.A. in 1976 by Shiela Tobias who published an article on the subject in an American magazine called 'Ms' (Visser, 1988). Even though no universal definition exists, definitions for this subject-specific anxiety acknowledge that mathematics anxiety is associated with a fear, avoidance or a dread of mathematics - which even affects people who are highly successful in other disciplines.

There is no compelling evidence to indicate that poor performance causes mathematics anxiety. However, in various international studies, mathematics anxiety has been found to have a negative effect on mathematics achievement and to cause mathematics avoidance (Clute, 1984; Fennema and Sherman, 1976; Hembree, 1990; Tobias, 1987 cited in McCoy, 1992). The exact cause of mathematics anxiety cannot be easily identified since it is not a single factor in isolation but the interaction of a variety of factors which contribute to the phenomenon of mathematics anxiety. Various theories are evident in the literature regarding the contextual factors associated with mathematics anxiety and these theories are dealt with in this chapter.

2.2. Contextual Factors associated with Mathematics Anxiety

2.2.1. Examining the nature of mathematics

Compared to other subjects, the language, notation and symbols used in mathematics are unique and "the need to learn this new language before one can understand mathematics is a source of anxiety" (Hawkey, 1986, p.22). Nimier (1993) points out that in mathematics, information is rarely redundant, each sign acquires a sort of absolute necessity governed by rules which admit no exception. Nimier (1993) illustrates this by drawing a comparison with English where failure to respect the rules of spelling does not always interfere with the meaning but failure to respect the rules of mathematics hinders any use of the subject.

In mathematics, attention appears to be directed more towards achievement than effort. An issue that emerges in the literature is the right-wrong dichotomy. Dossel (1993) argues that mathematics appears to have clear goals with success or failure clearly demonstrated. He points out that it is not uncommon to hear a child say, 'I got all of my sums wrong', whereas, in fact, the child may have most of the work correct. The right-wrong dichotomy may be a source of mathematics anxiety since, as Dossel (1993) acknowledges, it takes only one error to produce an incorrect result.

Mathematics constantly builds upon itself. Because of the cumulative learning

process involved in the subject, prior knowledge is of the utmost importance. Frequent absenteeism or a transfer to a new school may result in a gap in students' knowledge. This gap will undoubtedly lead to a lack of mathematical understanding. Hence "until the missing topic is learned, there is a feeling of helplessness and uncertainty which inevitably leads to anxiety" (Hawkey, 1986, p.20). Visser (1988) mentions that a pupil who misses a key concept in mathematics may be left behind permanently. She indicates that the problems of such a pupil may not be immediately noticeable. They are often only manifested after the problems have accumulated to such an extent that failure is imminent, and by then it may be extremely difficult to identify the original stumbling block.

At times of mathematical uncertainty, it is important for students to ask questions. A student "who is too inhibited to ask questions may never get the clarification needed to go on ... the math anxious often refer to this kind of inhibition" (Tobias, 1980, p.59). Considering the fact that mathematics lessons are almost always linked to previous lessons, students' mathematical progress may be seriously hindered if they do not ask the appropriate questions, necessary to clear any misconceptions that they might have. Without clarification, pupils may remain permanently mathematics anxious.

From another perspective, Gourgey (1992) believes that students do not see mathematics as a subject that expresses ideas and relationships, nor do they realize that mathematical formulas reflect underlying principles that are logical.

Often students study mathematics by memorising facts and formulas and practicing procedures in a rote manner. They approach mathematical tasks in a mechanical fashion - by merely trying to recall the most applicable methods instead of adapting methods to different situations. Rote-learning may prove to be useful in the study of other subjects but it is certainly unsuitable for the study of mathematics.

In other subjects, it is possible to successfully talk or write "around the answer" but not in mathematics. In mathematics, a factor that leads to mathematics anxiety is the adoption of poor study skills. Kitchens (1995, p.8) explains "If you don't take notes, if you procrastinate, if you go straight to the problem without studying the notes or reading the book, if you basically fail to think about the concepts before practicing the homework problems, then you miss the primary component of learning : understanding the concepts. If you don't understand the concepts, you won't be able to do well ..."

2.2.2. Belief in Mathematical Myths

" A math myth can be defined as a belief about mathematics that is (potentially) harmful to the person holding that belief because belief in math myths can result in false impressions about how mathematics is done " (Frank, 1990, p.10). Mathematical myths can be communicated to students - either intentionally or unintentionally. In the U.S.A., Merseth (1993) found that parents, schools and the media are responsible for reinforcing myths.

According to Kogelman and Warren (cited in Frank, 1990, p.11), belief in the following myths can contribute to both mathematics anxiety and mathematics avoidance :

- Some people have a mathematics mind and some don't.
- Mathematics requires logic, not intuition.
- You must always know how you got the answer.
- Mathematics requires a good memory.
- There is a best way to do a mathematics problem.
- Mathematics is done by working intensely until the problem is solved.
- Men are better in mathematics than women.
- It's always important to get the answer exactly right.
- Mathematicians do problems quickly in their heads.
- There is a magic key to doing mathematics.
- Mathematics is not creative.
- It's bad to count on your fingers.

2.2.3. Mathematics and Gender

Although the statement that men are better in mathematics than women is nothing more than a mere myth, studies on mathematics and gender will never cease. Two hypotheses surface with regard to mathematics and gender- the "sex-role socialization hypothesis" and the "math experiences hypothesis" (Hunsley and Flessati cited in Flessati and Jamieson, 1991). According to the

sex-role socialization hypothesis, gender differences in mathematics are caused by differences in socialization whereby females are conditioned in society to believe that mathematics is a subject for males. Hence, it is acceptable for females to drop mathematics since the female sex-role (unlike the male sex-role) does not encourage females to excel in mathematics. According to the math experiences hypothesis, gender is insignificant in that mathematics anxiety is due to a person's previous experiences and mathematical skills - irrespective of gender.

A great deal has been written on the role of gender with regard to mathematics achievement and mathematics anxiety. A review of studies on gender and mathematics have revealed that results are not consistent in that studies have found that :

a) females exhibit greater mathematics anxiety than males (Betz, 1978 cited in Hembree, 1990; Hunsley and Flessati, 1988 cited in Flessati and Jamieson, 1991; Meece, Wigfield and Eceles, 1990; Pajares and Miller, 1994; Pintrich and De Groot, 1990; Wigfield and Meece, 1988 cited in Pajares and Urdan, 1996; Hembree, 1990).

b) there is no gender difference in the level of mathematics anxiety between males and females (Flessati and Jamieson, 1991).

The accuracy of the results of studies are always questionable. In the case where females are found to exhibit greater mathematics anxiety than males, there is the possibility that results may have been distorted since females may

have been more willing than their male counterparts to admit to being mathematics anxious. This may be the case since it is socially acceptable for females to report their mathematics anxiety (as implied by the sex-role socialization hypothesis) and embarrassing for males to do so.

Studies (Koehler, 1985; Reyes, 1981; Wilkinson and Marrett, 1985 cited in Fennema and Leder, 1990) reveal that teachers treat males and females differently in the mathematics classroom and that this difference is usually in favour of males. In studies of behaviour within mathematics classrooms (AAUW, Sadker and Sadker cited in Levine, 1995), it has been found that teachers often pay more attention to boys, offer boys more praise and direct more complex questions to boys. Teachers also wait longer for boys' responses and assist boys in shaping responses until they are correct.

Perhaps the different treatment of males and females by parents, teachers and significant others signals to girls that they are mathematically inferior to boys. This is likely to lay the foundation for mathematics anxiety.

2.2.4. The Mathematics Classroom

The atmosphere within the mathematics classroom has a tremendous impact on students' attitudes towards mathematics. To a large extent, it is the teacher's responsibility to maintain an environment that is not anxiety-provoking.

Mathematics anxiety appears to have its roots in the teaching methods which are adopted by teachers (Visser, 1987; Bulmahn and Young, Greenwood, Sovchik, Meconi and Steiner cited in McCoy, 1992; Greenwood cited in Williams, 1994 and Sherman; Krutetskii). Walberg and Horn (cited in Bester and Budhal, 1995) report that much of the students' interest in mathematics depends on the attitudes displayed by teachers, and the manner in which their lessons are delivered. Traditional teaching of mathematics is based on the transmission or absorption view of teaching and learning whereby teaching merely consists of transmitting facts to students who passively "absorb" mathematical structures invented by others and recorded in texts. Teachers who teach using this method convey to students the impression that mathematics is a sequence of facts and procedures which can be rote-learned.

Stodolsky (cited in Gourgey, 1992) has described the effects of traditional mathematics teaching which he describes as "telling math" (teachers tell and students obey). He mentions that the use of this method encourages students to expect that they must be told what to do because they are led to believe that they lack the resources to find out for themselves. Stodolsky (cited in Gourgey, 1992) also mentions that students who see mathematics in this way suffer from aversion and anxiety. Apart from contributing to mathematics anxiety, the "explain-practice-memorize" teaching method which is predominant in traditional mathematics classrooms, promotes memorisation and not understanding which is crucial for mathematical success.

Lack of relevance is a variable that contributes significantly to mathematics anxiety (Quilter and Harper cited in Dossel, 1993). Students are more concerned about situations in daily living than workbook examples. If mathematics lessons are not linked to the real world and to other subjects then it is unlikely that students will ever realize the importance or significance of mathematics. If students "recognize that what they are doing is significant ... will both enjoy it more and work harder" (Buxton, 1981, p.116). On the contrary, if they fail to see the relevance of mathematics in real life, then they will surely remain mathematics anxious.

When the teacher's presentation is "top-down", error-free and perfect with only one solution "path" to the problem, then students incorrectly assume that the teacher's method is the best method for solving the problem. Moreover, students falsely assume that the solution to a problem must be arrived at instantly (in one attempt) without realizing that a particular method may be abandoned in favour of one which leads to the solution. Failure to arrive at an answer immediately leads to mathematics anxiety.

Mathematics anxiety may be linked to negative experiences during the early school years. Lazarus cited in Bester and Budhal (1995) explains that such negative experiences include constant reprimand by a teacher for not succeeding in solving a mathematical problem. Lazarus claims that these negative experiences could lead to mathophobia, which could lead to the development of an emotional and intellectual block, making further progress

and interest development in mathematics and related fields very difficult.

A student with negative mathematical experiences will lack self-confidence and will not excel in mathematics. A student's confidence may be shattered if he/she frequently provides incorrect answers in the mathematics classroom in the presence of his/her more able peers. According to Dossel (1993), the possibilty of appearing foolish in public induces feelings of anxiety, and asking children to answer questions publicly or to demonstrate mathematical working may be quite intimidating for the less confident child. Furthermore, according to Dossel (1993), time pressure also creates mathematics anxiety especially when questions are 'fired' around the room by the teacher. The feeling that an instant answer is required induces a panic reaction.

2.2.5. Social Pressure from Teachers, Parents or Guardians

Teachers and parents (or guardians) exert great influence on the lives of students. Dossel (1993) argues that teacher, parent or guardian pressure is another significant factor in increasing the levels of mathematics anxiety. "Parental disappointment and despair are especially demoralizing for the child because of the value children place on the high positive regard of the parent" (Dossel, 1993, p.5). Parents will obviously desire what is best for their children. Hence their children are pressured to excel in mathematics since parents realize that success in mathematics is essential for entry into a wide variety of lucrative careers.

2.3. Conclusion

This study attempts to explore the factors associated with mathematics anxiety at Woodhurst Secondary in Chatsworth. The research questions have been outlined at the end of the previous chapter.

CHAPTER THREE: RESEARCH DESIGN AND METHODOLOGY

3.1. Qualitative Research Methodology

In this study, a qualitative research methodology was used. Qualitative research is defined as an inquiry process of understanding based on distinct methodological traditions of inquiry that explore a social or human problem. In this research method, the researcher builds a complex, holistic picture, analyzes words, reports detailed views of informants, and conducts the study in a natural setting (Creswell, 1998, p.15). In this study, I explored the phenomenon of mathematics anxiety. The goal was to capture the complexity of the world as it appears to the subjects in the study and to report the events related to the phenomenon of mathematics anxiety. A qualitative approach enables readers who have not experienced mathematics anxiety, to be able to make sense of it (mathematics anxiety) after reading the in-depth experiences of subjects in the study.

In qualitative research, the researcher accepts the research setting as it is, and attempts to understand the situation without imposing his/her preconceived expectations on the study. The aim is to understand phenomena in their natural contexts and "to explore the subjective values, beliefs and thoughts of the individual respondent" (O'Connell and Layder, 1994, p.121). Qualitative research is concerned with "obtaining full and sincere responses to relatively

open-ended enquiries" (O'Connell and Layder, 1994, p.121). Thus, by interacting with subjects during interviews, I explored the various views on mathematics anxiety from the perspective of subjects in the study.

In qualitative research methodology, the language of the subjects is important. This implies that the "actual words of the subjects are thought to be critical to the process of conveying the meaning systems of the participants which eventually become the results or findings of the research" (Filstead, 1979, p.37). In other words, whatever subjects say (during interviews) is crucial since it allows the researcher to discover whatever is important and meaningful to the subjects in the study. The researcher's discoveries are presented as the findings of the research. These findings are then discussed, and conclusions/implications for the study are drawn.

Qualitative researchers believe that human experience cannot be quantified numerically. Since the experience of mathematics anxiety is a complex issue which by no means can be expressed in numerical terms, qualitative research methodology was employed for the purpose of this study. Qualitative research allows events to be captured through the words of the subjects and the intention of this research methodology is to "disclose and reveal, not merely to order and predict" (Van Maanen, 1979, p.256). Sociologist John Lofland (cited in Patton, 1980, p.36) claims that there are four elements in collecting qualitative data:

- The qualitative methodologist must get close enough to the people and

situation being studied to be able to understand the depth and details of what goes on;

- The qualitative methodologist must aim at capturing what actually takes place and what people actually say : the perceived facts;
- Qualitative data consist of a great deal of pure description of people, activities and interactions;
- Qualitative data consist of direct quotations from people, both what they speak and what they write down.

In this study, I found it appropriate to use the qualitative approach since this approach enabled me to understand people in their own terms (Patton, 1980, p.22) - in their natural setting. Qualitative research provides an insight into the life world of people under study. Without the use of qualitative research methodology for this particular study, the researcher would not have been able to extract rich data from the subjects under study. In this case, the researcher attempted to obtain a rich and accurate insight into mathematics anxiety - from the different perspectives of the participants in the study.

3.2. Research Methods

The research method included semi-structured interviews, and questionnaires.

3.2.1. Questionnaires

3.2.1.1. The Mathematics Anxiety Questionnaire

The Mathematics Anxiety Questionnaire which consists of 20 statements, was administered to all Grade 12 mathematics students (83 students) at the school. This questionnaire comprised two sections. In the first section, there are 10 items that depict various student behaviours related to mathematics learning. Some of these items were:

- I am anxious at the thought of taking a mathematics course.
- I am anxious when I open a mathematics book.
- I am anxious when I study mathematics alone.

Students were required to indicate on a rating scale of 1 to 5 how strong their anxiety is with respect to each of the items.

In the second section, students were required to read a list of items that describe student perceptions about how they experience mathematics learning and teaching. The items included :

- I have been uncomfortable with school mathematics.
- I really don't know how to understand, learn, and remember mathematics.
- I was punished for my honest efforts in mathematics.

Students were required to indicate on a rating scale of 1 to 5 the extent to which they engage in the behaviours depicted.

For all the 83 students who completed the questionnaire, the rating scores were totalled. The overall totals were compared, and the ten students with the highest ratings were selected as mathematics anxious subjects for the qualitative research.

The Mathematics Anxiety Questionnaire (see Appendix 1) which was used in this study was adapted from Kitchens' (1995). Unlike the Kitchens' (1995) questionnaire, the word mathematics in the current questionnaire is written in full, to avoid the American terminology "math". Apart from this, the following three statements from the Kitchens' (1995) questionnaire were revised in order to make the questionnaire relevant for students at school level.

Original Questionnaire

I am anxious:
9. When the people at work discuss math.
10. When my parents or spouse explain a math problem to me.
.....
19. I have always gotten nervous when people at work brought up a problem involving numbers.

Revised Questionnaire

I am anxious :
9. When people discuss mathematics.
10. When my parents explain a mathematics problem to me.
.....
19. I have always gotten nervous when people brought up a problem involving numbers.

3.2.1.2. The Belief in Myths Questionnaire

A detailed explanation of mathematical myths, together with 12 examples of myths appears in Chapter 2. The Belief in Myths Questionnaire (see Appendix 4) was constructed using these 12 myths. According to Kogelman and Warren (cited in Frank, 1990, p.11), each statement in the questionnaire is a myth, for example,

- There is a best way to do a mathematics problem.
- Mathematics is not creative.
- There is a magic key to doing mathematics.

The Belief in Myths Questionnaire was administered to the ten students and three teachers during the interviews to ascertain whether they believe in any mathematical myths. I preferred to use a questionnaire for this since the answers did not require any discussion - merely a Yes/No response. I could have asked these questions orally. However, I opted for the use of a questionnaire so that interviewees could "absorb" each statement at their own pace before deciding on an answer. Moreover, questionnaires were administered during the interviews since I feared that if this was not done, then questionnaires may not be returned to me timeously.

3.2.2. Semi-structured Interviews

Semi-structured interviews were used in this study. A semi-structured

interview is "an interview whose purpose is to obtain descriptions of the life world of the interviewee with respect to interpreting the meaning of the described phenomena" (Kvale, 1996, p.5). During the semi-structured interview, the researcher introduces the topic of the interview, asks pertinent questions and follows up new leads depending on the interviewees' responses to his or her questions. Semi-structured interviews were conducted with three senior secondary teachers of mathematics (two males and one female) and ten mathematics anxious students (five boys and five girls). These ten students attained the highest number rating scores in the Mathematics Anxiety Questionnaire. The selection of subjects is explained in section 3.4.1.

3.3. The School Context

The present study was conducted at Woodhurst Secondary School - a co-educational school which is situated in the suburb of Chatsworth, approximately 20 km from Durban. Currently (1999), the learner intake at this public school is 1040, with the total (all Indian) staff number being 30.

The student population at the school is made up of African and Indian learners (mainly from Chatsworth and Umlazi) belonging to the lower socio-economic group. Presently, the school fee at Woodhurst Secondary is R400 per learner per annum.

I am a mathematics teacher at Woodhurst Secondary. Apart from me, only

three other mathematics teachers at the school are familiar with the matric mathematics syllabus. Hence, these three teachers were interviewed as subjects for this study.

As in every other secondary school, mathematics lies within the learning area which is described as : Natural Sciences, Mathematics, Technology and Computer Studies. The existing Head of Department (HOD) in this learning area is a senior Biology educator whose mathematical knowledge is not very sound. Consequently, as one interview reveals, he is not in a position to assist mathematics teachers with the issues related to the teaching and learning of mathematics.

Since my arrival at Woodhurst Secondary in 1996, I recall that the overall matric mathematics pass rate at the school has always been exceptionally poor. Unfortunately, at the time of this study, the school's matric statistics prior to 1998 could not be located.

In 1998, at Woodhurst Secondary, 74 out of 132 (56%) matric learners studied mathematics. Of these learners, 60 pursued the subject on the standard grade and 14 on the higher grade. 75% of the standard grade learners and 14.3% of the higher grade learners failed the 1998 matric mathematics examination. In contrast, the school obtained a 0% failure rate in higher grade English and a 2.8% failure rate in standard grade English, in the very same year. These

statistics are reflected in the school's 1998 analysis of senior certificate results (Woodhurst Secondary School, 1998).

The subjects in this study wrote the matric examinations at the end of 1999. In 1999, the school obtained a 0% failure rate in both higher grade and standard grade English. Yet again, the matric mathematics results were disappointing, with 31% of the higher grade students and 69% of the standard grade students failing the subject. These statistics were computed by the school and appear in the school's 1999 analysis of senior certificate results (Woodhurst Secondary School, 1999).

3.4. The Research Process

3.4.1. Selection of Subjects

The subjects in this study included three senior secondary mathematics teachers and ten mathematics anxious students. Since there are only three senior secondary teachers of mathematics (apart from the researcher) at Woodhurst Secondary, all three teachers were approached to be subjects for the research. The three teachers of mathematics willingly consented to participate in the research.

As mentioned, the Mathematics Anxiety Questionnaire was used to identify students who experience mathematics anxiety. The ten students who were

identified as most mathematics anxious (these students had the largest rating scores) agreed to be subjects for the research. They were assured of confidentiality and anonymity. Coincidentally, five boys and five girls obtained the largest number rating scores in the Mathematics Anxiety Questionnaire.

3.4.2. The Subjects

3.4.2.1. Teachers

All three teachers in this study are qualified teachers of mathematics. The teaching experience of the subjects is as follows (pseudonyms are used) : Sandra - 5 years; Adam - 10 years and Kuben - 25 years.

3.4.2.2. Students

The details of the ten students in this study appear in Table 1.

Table 1 :

NAME	SEX	AGE	RACE
1. Maggie	F	18	Indian
2. Ali	M	17	Indian
3. Rosanna	F	17	Indian
4. Varsha	F	18	Indian
5. Thabo	M	18	African
6. Nadine	F	17	Indian
7. Nathan	M	17	Indian
8. Linda	F	17	Indian
9. Shane	M	18	Indian
10. Fred	M	18	Indian

The overall academic performance for each student in this study differs. (This can be guaged from students' English and Mathematics symbols which appear in Table 2). What is consistent is that all ten students' performance in mathematics is poor compared to their performances in other subjects. From Table 2, a comparison can be drawn between students' English (English was chosen because all students study this subject) and Mathematics symbols in the Senior Certificate Examinations. The grades on which these subjects were written by students (ie. Higher Grade or Standard Grade) is also indicated.

Table 2 :

NAME	ENGLISH		MATHEMATICS	
	H.G.	S.G.	H.G.	S.G.
1. Maggie	D			F
2. Ali	C		E	
3. Rosanna	B		E	
4. Varsha	A		E	
5. Thabo		D		F
6. Nadine	B		E	
7. Nathan	C		D	
8. Linda	B		E	
9. Shane	D		H	
10. Fred	C			F

This study commenced in 1999 and the dissertation is based on research conducted at Woodhurst Secondary in 1999.

CHAPTER FOUR: FINDINGS

4.1. Introduction

The findings of this study were obtained through the use of semi-structured interviews and questionnaires. The findings are presented in this section under three broad categories :

- Perceptions of Students on Mathematics Teaching and Learning;
- Exploring Mathematics Anxiety and
- Exploring Mathematical Myths.

4.2. Perceptions of Students on Prior Experiences of Mathematics Teaching and Learning

As mentioned in Chapter 2, according to several researchers (Visser, 1987; Bulmahn and Young, 1982; Greenwood, 1984; Sovchik, Meconi and Steiner, 1981 cited in McCoy, 1992; Greenwood, 1984 cited in Williams, 1994) the phenomenon of mathematics anxiety appears to have its roots in the teaching methods which are adopted by teachers. Thus for this particular study, student perceptions on their experiences of mathematics teaching and learning were explored, to determine the extent to which the teaching/learning environment may be contributing to mathematics anxiety among learners.

4.2.1. Experiencing primary school mathematics lessons

Since the literature review suggests that mathematics anxiety may be linked to negative experiences during the early school years, this study examined students' mathematical experiences at primary school level.

The data from the ten students who were interviewed revealed that they experienced primary school mathematics in different ways. Seven students stated that they had good experiences of mathematics at primary school level. Their responses seem to suggest that there was little anxiety associated with mathematics. The following were some of the responses :

"easy, fun and did not feel like work". (Shane)

"easy. The teacher was teaching well and I understood everything". (Thabo)

"The work was easy and the teacher joked a lot which made the lesson exciting". (Varsha)

"used to like mathematics and did well in it". (Linda)

Three students did not enjoy mathematics at primary school level. Two students recalled that corporal punishment was used in the mathematics

classroom and one student recalled that the mathematics teacher was critical of student performance and condescending. Some of the responses were :

"I hated bonds and tables which was tested at the beginning of every mathematics lesson. If pupils did not provide correct answers then they were hit with the chalkboard duster and made to stand for the whole session". (Maggie)

"I hated mathematics in primary school. The teachers weren't very co-operative and pupils were slapped for not knowing their work". (Nadine)

"The teacher was fond of criticizing and putting down kids. If students answered incorrectly, he would sternly say : 'How dumb can you get?' ". (Fred)

Considering the responses of students who had good experiences of mathematics at primary school level, a common view was that mathematics was easy at that time. With regard to the responses of students who did not enjoy mathematics at primary school level, it appears that the mathematics teachers' attitude and the adoption of corporal punishment resulted in students not enjoying the subject.

4.2.2. Experiencing Mathematics in Grade 12

During interviews, students discussed their feelings towards the subject mathematics and their experiences of mathematics lessons at Grade 12 level.

4.2.2.1. Attitudes towards mathematics as a subject

All ten students are exceptionally negative about their experiences of mathematics at matric level. Six students indicated that they have an aversion for mathematics. Seven students indicated that mathematics is difficult, and eight students indicated that they do not understand mathematics. Some of the students' responses were :

"Mathematics is definitely hard. The teacher goes too fast. I don't understand the work and I don't even understand the questions". (Varsha)

"hate mathematics since too much of work is pushed in one lesson, and I can't make sense of it". (Ali)

"lost all interest in the subject, can't understand most things and won't bother to study - It's hopeless." (Nathan)

"afraid of the subject. I am not good with numbers. There are far too many variables to work with and mathematics confuses me". (Linda)

4.2.2.2. Student perceptions of the teaching/learning environment

Although eight students stated that they are attentive during their mathematics lessons, these students do not possess a sound understanding of mathematics. One student only pays attention for the first five minutes of the lesson (and then begins to daydream) while another student is playful and disruptive during lessons. With regard to mathematics classwork or homework, eight of the students admitted that they are guilty of copying (the extent of copying differs from student to student), and only two of the students complete the mathematics classwork/homework by themselves.

All ten students are dissatisfied with the atmosphere that prevails within their mathematics classrooms. Four students are dissatisfied with their teachers' attitude. Three students do not understand mathematics as taught by the teacher. Two students are dissatisfied with the pace of work. One student was dissatisfied with the method of teaching and one student indicated that he experiences 'mental blocks' in the mathematics classroom. Some of the students' responses were as follows :

"the teacher's attitude is lackadaisical and uncaring towards pupils and not enough revision is done in each lesson. The mathematics

classroom is boring all the time. Each day the same thing happens, homework is corrected and new homework is given". (Maggie)

"work is really pushed and it's difficult to cope". (Ali)

"I cannot understand the way the teacher teaches it - it is too abstract and the teaching/learning environment is pathetic. Everyone has a playful attitude in class, and the work is not taken seriously - maybe because no one understands mathematics". (Rosanna)

"I listen like I listen in every other subject but I still don't understand what the mathematics teacher is saying. As for Geometry riders, I never know where to start solving them or what theorems to use. I do well in my other subjects but in mathematics I've been experiencing problems right from Grade 10 and I don't know what to do - mathematics is too complicated". (Varsha)

"The teacher makes me feel very inadequate. He is accustomed to paying more attention to the pupils who he thinks will get A's or B's. Instead of focusing on the weak pupils, he focuses on the bright pupils". (Nadine)

"Before I can even attempt a mathematics problem, I get 'mental blocks'. I have a preconceived idea that my problems won't work

out. During mathematics tests and exams, I suffer from anxiety attacks and severe stomach cramps. This does not happen for any other subject. What makes mathematics so stressful is that there is only one right answer always". (Fred)

4.2.2.3. Teachers' Approach to Mathematics Lessons

An examination of each teachers' typical mathematics lesson reveals that the traditional approach to teaching and learning appears to be the dominant mode of instruction. In this mode, students passively "absorb" mathematical concepts which are conveyed to them by their teachers.

A description of each teachers typical mathematics lesson follows :

Sandra's mathematics lesson involves :

- recapping the previous lesson.
- marking previous examples by asking pupils to furnish solutions on the board.
- introducing the new section.
- working out different examples.
- administering homework.

Adam's mathematics lesson involves :

- him doing one or two examples on the board.

- Adam getting pupils to do a few examples in their workbooks.
- Adam doing a few more complex examples on the board.
- giving pupils homework.
- marking previous homework.

Kuben's mathematics lesson involves :

- correcting homework.
- teaching by illustrating examples on the chalkboard (an attempt is made to link with what students had learnt previously).
- administering of homework.

The lesson presentation within the classrooms of all three mathematics teachers is very similar with the same routine being followed : marking of previous homework, teaching of the new section and administering of new homework (not necessarily in that sequence). A traditional environment prevails in all three classrooms in which the teacher assumes the role of the authority who dispenses knowledge. Non-traditional approaches to teaching and learning such as the use of mathematical games, puzzles, and the incorporation of group work are evidently missing. None of the three teachers appear to place importance on a process orientated and interactive approach to mathematics teaching and learning.

4.2.2.4. Perceptions of Factors Associated with Poor Performance/Results in Mathematics

Interviews with students and teachers reveal a variety of reasons for the poor performance/results in mathematics. Parents, teachers and students were blamed for students' poor mathematical performance. Some of the responses from students for poor mathematics performance were :

"teachers not making the lesson exciting. This can be done by giving puzzles, crosswords and using group work". (Maggie)

"not enough practice. Practice makes perfect and students that don't practice won't perform well". (Fred)

"pupils doing mathematics when they are not cut out for the subject". (Shane)

"pupils' perceptions that mathematics is difficult". (Maggie)

Some of the responses from the teachers for the poor mathematics results at matric level were :

"Students lacking a grounding of fundamental sections covered in earlier years (eg. factorisation and multiplication by inspection). As

a result new concepts which build on old concepts are not understood by students". (Kuben)

"Parents are also to blame. They do not monitor homework and for status they insist on their children doing higher grade mathematics when the children can't cope". (Adam)

"Teachers not being creative. Mathematics teachers need to move with the times, to stimulate interest and regenerate enthusiasm that has been lost in the subject". (Kuben)

In summary, with regard to the factors associated with poor performance, the study found that in mathematics, teachers, parents and students have been blamed.

Students suggested that pupils tend to perceive mathematics as a difficult subject, do not practice enough or pursue mathematics when they are not cut out for the subject. The criticism levelled against teachers was that they do not make the lesson exciting.

Teachers indicated that students lack pre-knowledge in mathematics, parents do not monitor homework and teachers are not creative in the presentation of their mathematics lessons.

4.2.2.5. Student Perceptions of Reasons for Success in Mathematics

Responses of students reveal that success in mathematics may be attributed to both teachers and learners. During the interviews, five of the students suggested that mathematical success results from an innate ability to perform well in the subject. Students' responses for attaining mathematical success were :

"pupils having a flair for the subject". (Shane)

"pupils working hard at the subject and putting in the extra effort to do well". (Maggie)

"paying attention in class and being self motivated to do well". (Ali)

"the teacher making the subject fun and not just getting on with the syllabus". (Nadine)

(students') "sound understanding of mathematics and exposure to different types of mathematical problems". (Linda)

Although five students indicated that mathematical success results from an inborn ability to perform well in the subject, there were two students in this study who acknowledged that the responsibility for students' succeeding

mathematically may be attributed to the efforts of teachers and learners.

4.3. Exploring Mathematics Anxiety

The main aim of administering the Mathematics Anxiety Questionnaire was to select ten students who would be the subjects for the qualitative study. The questionnaire was administered to 83 grade 12 matric mathematics students (the entire mathematics student population in grade 12). The ratings were summed across the items for each of the students. The ten students with the highest scores, which depicted the highest mathematics anxiety ratings, were included in the study. Results were analyzed separately by gender. The overall scores ranged from 23 to 74 for male students, and from 37 to 83 for female students. Ten students with the highest scores were selected. The five female students' responses in this study yielded scores of 83; 74; 73; 72 and 71. The five male students overall scores were 74; 73; 71; 63 and 58.

A detailed discussion of the Mathematics Anxiety Questionnaire is unnecessary for the purpose of this study. The sole aim of this particular questionnaire was to identify ten mathematics anxious students for the study.

4.3.1. Perceptions of Factors that Contribute to Mathematics Anxiety

During interviews, the perceptions of all subjects (teachers and students) were explored regarding the factors that contribute to mathematics anxiety.

Students cited various reasons for their anxiety in mathematics. The unique nature of mathematics, the perception that mathematics is a difficult subject, the teacher's attitude and the method of teaching, appear to be factors that induce mathematics anxiety among students. Some of the responses by students on their own anxiety in mathematics were:

"There is no one cut and dried method in mathematics". (Maggie)

"No two problems in mathematics are identical. Each problem is brand new and requires a lot of reasoning. No other subject works like this. In other subjects it is convenient to just get by, by learning what is given". (Maggie)

"The teacher's a pain. She doesn't respect pupils and insults them for no reason. She is supposed to give us encouragement and she doesn't do this". (Ali)

"Mathematics is difficult. Most people just do it for the sake of doing it - because to get a good job, you need mathematics". (Rosanna)

"Mathematics is not taught in a fun way. It is taught abstractly and is made out to be a subject which is very complex and scary". (Nadine)

The teachers of mathematics have also cited various reasons for mathematics anxiety among students. The nature of mathematics, the nature of text books, overcrowded classrooms, parental pressure, and the media's portrayal of mathematics as a subject of unimportance and irrelevance to the real world (refer to Appendix 6 - article included in Kuben's interview) have all been blamed for inducing mathematics anxiety among students. All three teachers of mathematics believe that the teaching/learning environment can also contribute to mathematics anxiety. Some of the responses by the teachers were:

"The fact that mathematics is not a swotting subject creates a problem". (Sandra)

"Mathematics text books are not pupil friendly. Any pupil cannot just pick up a text book and read it with understanding. Text books need to be differentiated to cater for different levels". (Adam)

"Mathematics is a thinking subject that involves precision. A large volume of work is covered in mathematics and the numbers in class, over 42 in most classes, do not allow for individual attention. Even worse is that two grades, higher and standard grades are taught in one class". (Adam)

"Students are pressurised by their parents to do well in the subject". (Kuben)

"Mathematics is sometimes portrayed in the media as a subject of unimportance and irrelevance". (Kuben)

"In this day and age, the educational system is content driven. Teachers are pressurised to complete the syllabus on time. With a matric mathematics syllabus that is very long, there is hardly any time for teachers to focus on areas of difficulty experienced by pupils. Creative teaching methods too, like group work which is time consuming have to be cast aside so that the syllabus is completed on time". (Kuben)

4.3.2. Reducing Mathematics Anxiety

Students and teachers were also requested, during interviews, to suggest ways in which mathematics anxiety may be reduced. Responses indicated subjects believe that the school, parents, teachers and students all have a collective role to play in reducing mathematics anxiety.

Some of the students' responses were :

"the teacher varying the teaching methods in the classroom and

introducing group work. It is easier to learn from friends than the teacher". (Maggie)

"encouragement from parents and teachers". (Ali)

"taking the subject seriously, paying more careful attention in class and doing one's work by one's self". (Rosanna)

"not having higher and standard grade mathematics students in the same class. Students of different grades must be taught separately in different classes". (Linda)

Some of the teachers' responses were :

"encouraging pupils to study by themselves and rewarding pupils for the completion of homework by giving them marks for this". (Adam)

"being positive about pupils' mathematical success. The teacher's positive attitude will automatically rub off on to his kids and their anxiety will be reduced". (Kuben)

"motivating students and keeping away from negative talk like 'mathematics is difficult' or 'tuition will help'". (Kuben)

4.4. Exploring Mathematical Myths Held by Teachers and Students

Beliefs in mathematical myths were examined both with respect to the three teachers and the ten mathematics students. This was explored both through the interviews and the Belief in Myths Questionnaire.

In the analysis of interview data obtained from the three teachers, there was no evidence of mathematical myths held by teachers. However, in the analysis of the Belief in Myths Questionnaire, responses indicate that teachers believe in some myths.

According to the Belief in Myths Questionnaire, none of the teachers believe in the following mathematical myths :

- Men are better in mathematics than women.
- There is a magic key to doing mathematics.
- Mathematics is not creative.
- It's bad to count on your fingers.

One out of the three teachers, revealed a belief in the following myths :

- Mathematics requires logic, not intuition.
- You must always know how you got the answer.
- Mathematics requires a good memory.
- There is a best way to do a mathematics problem.
- It's always important to get the answer exactly right.

- Mathematicians do problems quickly in their heads.

Two of the three teachers believe in the following mathematical myths :

- Some people have a mathematics mind and some don't.
- Mathematics is done by working intensely until the problem is solved.

To a certain extent, teachers may be responsible for conveying these myths to their students (subliminally or otherwise). However, there is no concrete evidence in this study to indicate that the belief in these myths are transmitted from teachers to students.

With respect to the students, the interview data revealed that five out of the ten students believe in people having an innate ability to succeed in mathematics. Two responses were:

> **"certain people have a natural inborn ability to do well in mathematics".** (Nadine)

> **"In mathematics, you either have it or don't, it's an inbred thing".** (Shane)

The data obtained through the Belief in Myths Questionnaire that students

completed yielded the following number of students that believe in each particular myth:

- Some people have a mathematics mind and some don't : 10
- Mathematics requires logic, not intuition : 7
- You must always know how you got the answer : 9
- Mathematics requires a good memory : 8
- There is a best way to do a mathematics problem : 6
- Mathematics is done by working intensely until the problem is solved : 7
- Men are better in mathematics than women : 2
- It's always important to get the answer exactly right : 4
- Mathematicians do problems quickly in their heads : 6
- There is a magic key to doing mathematics : 3
- Mathematics is not creative : 6
- It's bad to count on your fingers : 1

The following myths seem to be most commonly held by the students in the study (a minimum of six students believe in each of these myths):

- Some people have a mathematics mind and some don't.
- Mathematics requires logic, not intuition.
- You must always know how you got the answer.
- Mathematics requires a good memory.
- There is a best way to do a mathematics problem.
- Mathematics is done by working intensely until the problem is solved.

- Mathematicians do problems quickly in their heads.
- Mathematics is not creative.

Students' beliefs in myths may be influenced by the teaching methodology and the practices that exist within their mathematics classroom. It is indeed alarming to note that all ten students believe that some people have a mathematics mind and some don't. Belief in this particular myth can seriously hinder students' progress in mathematics, since students will automatically assume that they do not possess mathematics minds and hence are incapable of excelling in mathematics.

CHAPTER FIVE: DISCUSSION OF FINDINGS

5.1. Introduction

The findings of this study highlight the contextual factors associated with mathematics anxiety among learners at a secondary school in KwaZulu-Natal. The perspectives of three mathematics teachers and ten matric students of mathematics were taken into account. Results suggest that a variety of factors interact to contribute to the phenomenon of mathematics anxiety. In this chapter, attempts will be made to discuss the findings in light of current literature on mathematical myths and their impact on mathematics learning. It will also explore how supportive classroom environments can be developed to displace some of the myths students develop over the years.

5.2. Students' beliefs about how mathematics is learnt

"Math-anxious students may often hold unrealistic assumptions about the learning process that can erode their confidence and impede their progress" (Gourgey, 1992, p.12). With regard to unrealistic assumptions, Kogelman and Warren (cited in Frank, 1990) claim that the belief in mathematical myths can contribute to both mathematics anxiety and mathematics avoidance. Therefore, classroom discussions on myths are essential in eliminating false beliefs, building mathematical confidence, and in reducing mathematics anxiety among students.

A discussion on some of the mathematical myths that teachers can incorporate within their mathematics lessons follows :

a) "Some people have a mathematics mind and some don't."

During interviews, six students indicated that mathematics is a difficult subject and in the Belief in Myths Questionnaire, all ten students indicated that "Some people have a mathematics mind and some don't". These beliefs are not only confined to students in this particular study. According to Merseth (1993, p.549), "Perhaps the most crippling belief about mathematics in our society is that it is a difficult subject that can be mastered only by a very small minority - those with special gifts or abilities. A predominant view in America is that one either "has it" or one doesn't". To aid in dispelling this myth, teachers could inform their students that "Many studies and programs in math education have shown that success in math is more often determined by one's attitude and feelings toward the subject than by any innate aptitude for math" (Hembree, 1999, cited in Herbert and Furner, 1997, p.166).

Two students in this study stated that they do not pay careful attention during lessons, and eight students admitted to copying classwork/homework. Students need to be made aware of the fact that there is no substitute for hard work, commitment and dedication when it comes to achieving in mathematics. The importance of becoming actively involved in their own learning, listening attentively and reflecting on tasks/problems during lessons, questioning,

seeking clarification, completing classwork/homework, and reading the textbook must be emphasised - especially since past and present mathematical knowledge forms the basis of future knowledge in mathematics.

b) "Mathematics requires a good memory."

According to literature reviewed in Chapter 2, students often study mathematics by memorising facts and formulas and practicing procedures rotely. In this particular study, eight students indicated that mathematics requires a good memory. This is probably because, as Gourgey (1992) points out, students do not see mathematics as a subject that expresses ideas and relationships, nor do they realize that mathematical formulas reflect underlying principles that are logical. Teachers should emphasise to students that in mathematics, a sound understanding is crucial since mathematical concepts, formulas and derivations need to be understood (not memorised) and applied when solving problems.

The incorporation of group work in mathematics lessons may aid in dispelling the myth that mathematics requires a good memory. Buerk (1985, cited in Frank, 1990) found that when students work actively and problem solve in small groups, they have the opportunity to see and discuss various ways of conceptualizing and problem solving. Mathematics becomes something to analyze, evaluate, and talk about instead of just a set of rules to be memorized.

c) "There is a best way to do a mathematics problem."

In this study, six students believe that there is a best way to do a mathematics problem. The method adopted by the teacher or the one illustrated in the text book may be incorrectly perceived to be the best way of solving a mathematics problem. Very often in mathematics, several methods lead to the solution to a single problem. Teachers need to encourage students to use their own methods and solution paths in problem solving - so long as the methods they use are sound, logical and lead to the solution to the problem. Hawkey (1986) recommends the use of group work during mathematics lessons. He explains that the value of various methods could be expounded during a mathematics lesson by pupils working in groups, and by allowing pupils to discuss the different methods they use in solving problems. In support of group work, Benander, Cavanaugh and Rubenzahl (1990, p.28) explain that "With the group invested in solving a common problem, many students easily share their ideas for the solution. They realize that there are many ways to solve each problem. They enthusiastically discuss the pros and cons of various solutions, ... gaining an appreciation for different approaches to problem solving".

With the incorporation of group work in mathematics lessons, students can discover for themselves that there is no such thing as a best way to do a mathematics problem, and that several methods are acceptable and of value.

d) Gender and mathematics.

As mentioned in the literature review, studies (Koehler, 1985; Reyes, 1981; Wilkinson and Marrett, 1985 cited in Fennema and Leder, 1990) reveal that teachers treat males and females differently in the mathematics classroom, and that this difference is usually in favour of males. With regard to the present study, there is no evidence to indicate that male students receive any preferential treatment from their mathematics teachers. Considering that none of the teachers in this study indicated that "Men are better in mathematics than women" (in the Belief in Myths Questionnaire), the probable implication is that all three teachers have identical mathematical expectations for their male and female students of mathematics.

In the Belief in Myths Questionnaire, only two students indicated that "Men are better in mathematics than women". Even though none of the teachers believe in this particular myth, "Teachers must be vigilant in their classroom practice to guard against unintentional gender imbalances" (Levine, 1995, p.44). Students are exposed mainly to male mathematicians such as Pythagoras and Euclid in the curriculum. Hence, this may influence some students to believe that mathematics is a subject for men. Teachers need to acknowledge and create an awareness of female mathematicians (such as Maria Gaetana Agnesi, Sophie Germain and Mary Somerville) whose contributions to the field of mathematics seem to have been completely ignored.

5.3. Creating a Supportive Learning Environment

Literature reviewed in Chapter 2, suggests that mathematics anxiety may be linked to negative experiences during the early school years (Lazarus cited in Bester and Budhal, 1995). Lazarus claims that these negative experiences could lead to mathophobia. This, in turn could lead to the development of an emotional and intellectual block, making further progress and interest development in mathematics and related fields very difficult. In this study, two students recalled that corporal punishment was administered in their primary school mathematics classrooms. According to the South African Schools Act of 1996, corporal punishment is illegal in South African schools. This may contribute to the development of non-threatening classroom environments conducive to effective teaching and learning.

All three teachers in this study adopt a traditional approach to teaching and learning. In this approach, students are the passive recipients of mathematical knowledge that is dispensed by the teacher. The traditional approach which is sometimes referred to as the 'transmission model' has been criticized since it "enables students to reproduce information taught, but does not develop the ability to apply the information in different contexts" (Muthukrishna and Borkowski, 1996, p.65). In the traditional approach, teachers provide a maximum of explanation to students. Blais (1988) contends that by the teacher giving a maximum of explanation implies the creation of a listener-follower role for students. He mentions that such a role contributes to

dependence, eliminates the need to think for oneself, and fosters the growth of learned helplessness.

Recent literature suggests that constructivist approaches to teaching and learning foster active learning in students (Cobb, Wood and Yackel, 1991; Confrey, 1991; Muthukrishna and Rocher, 1999). Lochhead (1985, cited in Blais, 1988, p.624) explains that:

> "What I see as critical to the new cognitive science is the recognition that knowledge is not an entity which can be simply transferred from those who have to those who don't ... Knowledge is something which each individual learner must construct for and by himself. This view of knowledge as an individual construction ... is usually referred to as constructivism."

Constructivists do not encourage the transference of knowledge from teachers to students. They "stress peer collaboration as integral to the learning process and to the accomplishment of math tasks" (Muthukrishna and Borkowski, 1996, p.69). Constructivists believe that learning is a social process and that learners must construct knowledge through their own experiences, explorations and social interactions.

Social interactions involving the use of group work during lessons has been reported to be beneficial in facilitating interest in mathematics. Clements and Battista (1990) claim that through interaction with mathematical tasks and other students, the student's own intuitive mathematical thinking gradually becomes more abstract and powerful. The teachers in this study need to

incorporate group work in their mathematics lessons. With the incorporation of group work during lessons, students will be able to assist one another in identifying and exploring strategies to solve mathematical problems. According to Wang and Haertel (1995), cooperative learning experiences promote higher achievement than do competitive groups or individual learning activities. This may be because "The experience appears to dissolve the sense of isolation often felt by our students in the traditional classroom setting. Students share ideas more freely and build a sense of group identity ... this is especially important for the many students who have a history of being passive learners" (Benander, Cavanaugh and Rubenzahl, 1990, p.28).

Constructivists Kamii and Lewis (1990) encourage the use of games and situations in daily living. They believe that paper and pencil exercises cause social isolation, mechanical repetition, and dependence on the teacher to know if an answer is correct. According to them, games give rise to compelling reasons for pupils to think and to agree or disagree with each other. Games are fun and entertaining and if used in the classroom, may aid in gripping students' interest in mathematics. With careful planning and consideration, teachers can easily structure mathematics lessons to include games and examples from real life (situations in daily living). Once mathematics lessons are linked to real life/daily living, the subject will be meaningful to learners and they will realise the importance/significance of studying mathematics.

Bester and Budhal (1995) mention that the child's interest in mathematics

depends on the teacher's attitude towards the subject, and the manner in which their lessons are delivered. Williams (1988) claims that the classroom teacher can do the following to help lessen or prevent mathematics anxiety in some students :

- Accommodate various learning styles, for example, cooperative learning. The belief is that there are many students who learn well in peer-oriented situations.
- Make math relevant and involve students in problem solving by presenting applications at all grade levels.
- Examine the classroom atmosphere to determine if students are freely asking questions. If not, a change of the classroom atmosphere from one of tension and/or competition may result in more willingness of students to ask questions.
- Provide for positive mathematics experiences, for example, assign some problems to weaker students that practically guarantee that the students will be successful in solving them.
- Use games that require original thinking, encourage the use of intuition and build confidence.

All ten students in this study are exceptionally negative about their experiences of mathematics at matric level, and eight students indicated that they do not understand mathematics. Teachers need to assist students in developing a positive mathematical self concept. This can be accomplished by including a discussion of mathematical myths in the mathematics classroom, and by

emphasising to students that mathematical success is within the reach of each and every individual. "Confidence has been shown to be a key factor in prevention and reduction of mathematics anxiety" (House, 1989, cited in Hadfield, Martin and Wooden, 1992, p.174). Bester and Budhal (1995) explain that the mathematics teacher should convince the mathematics pupil that mathematics is a subject not only for the very bright pupil, and that mathematics can be mastered with enough effort. Once the pupil has developed this level of confidence, he/she will approach the subject more positively.

One student's opinion which was expressed during the interview is worthy of mention. The

> **"teacher makes me feel very inadequate. He is accustomed to paying more attention to the pupils who he thinks will get A's or B's. Instead of focusing on the weak pupils, he focuses on the bright pupils".**

Clearly, "Teacher expectations are one of several school and classroom climate variables that are related to student outcomes" (Wang and Haertel, 1995, p.174). Students tend to rise to the expectations of their teachers. This means that students who get the impression from their teachers that they are capable of excelling in mathematics will be motivated to persevere and strive for mathematical success. On the other hand, students who believe that their teachers view them as unworthy students of mathematics may lose confidence in their ability to succeed mathematically and may also lose interest in the

subject. If students believe that their teachers have low mathematical expectations for them, then they will surely perform poorly and perhaps remain mathematics anxious. During lessons, teachers need to transmit high expectations for all students of mathematics and every effort needs to be made to pay the same amount of attention to all learners, whether they are "bright" or not.

The mathematics teachers' responsibility within the classroom extends beyond the demonstration of mathematical problems and the timeous completion of the syllabus. The teacher plays an important role in motivating and supporting students within a caring environment. Learners need to realize that they too have their own responsibilities which are pre-requisites for mathematical success, such as, the responsibility of paying attention during lessons, reading the mathematics text book, completing assigned mathematical tasks and asking questions to clarify misconceptions.

5.4. Support for Teachers

One of the teachers in this study stated that

> **"Teachers are in need of on-going mathematical staff development programs and regular training especially to identify and remediate mathematics anxiety".**

In this study, the three teachers of mathematics have not ever received any support from their school (in the form of on-going professional development).

One of the teachers (Sandra) mentioned that her Head of Department is a senior Biology educator who is in no position whatsoever to assist her with the mathematics that she teaches. If the Head of Department was knowledgeable about current trends in mathematics teaching, he would have been of assistance to the mathematics teachers in his department. He could have provided constructive criticism and guidance in terms of the presentation of mathematics lessons, selection of appropriate teaching methodologies, and in addressing teachers' concerns/problem areas within the mathematics syllabus.

The Mathematical Sciences Education Board (MSEB) points out that mathematics teachers, like other professionals, must engage in life-long programs of professional development. The MSEB believes that as professionals who must keep up with a rapidly changing and technically complex field, mathematics teachers especially need time and opportunity to read, to reflect, to plan, and to exchange ideas with other mathematics teachers (Mathematical Sciences Education Board National Research Council, 1990). Teachers of mathematics can learn with and from other teachers of mathematics. As a matter of fact, Bradley et. al. (1994) have in mind days set aside for professional development within schools, and links with colleagues in other schools.

Bagwandeen and Louw (1993) claim that it would be short-sighted for any school to suggest that it cannot learn from other schools. To provide on-going professional development, Woodhurst Secondary should consider working

closely with other schools in the area and scheduling convenient times for mathematics teachers (and Heads of Department who are educators of mathematics) to meet, exchange ideas and share resources. This will assist in promoting pleasant classroom environments in which mathematics anxiety may be reduced.

CHAPTER SIX: CONCLUSIONS

6.1. Limitations and Strengths of the Study

Being a member of the staff at Woodhurst Secondary, allowed the researcher easy access to both teachers and students. If this particular study was conducted in any other school, then it would have been inconvenient for the researcher to set up interviews (with teachers and students) and it would also have been inconvenient to travel a distance to meet the subjects. In the case of this study, interviews were conducted on the school premises, and at times that suited the subjects and the researcher.

Research methods such as observation and document analysis were beyond the scope of the present study. It would have been of interest to observe at first hand the practices and teaching methodologies that exist within the classrooms of all three mathematics teachers. It would have also been of interest to examine students' work books and text books to see if these books are anxiety provoking in any way.

The Belief in Myths Questionnaire was designed to elicit a mere Yes/No response from teachers and students to see if they believe in any mathematical myths. The researcher should have probed further to find out why the subjects in the study believe in the myths to which they responded "Yes" (in the Belief in Myths Questionnaire). By doing this, the researcher would have gained

insight into how these myths (which contribute to mathematics anxiety) are perpetuated at this particular school.

6.2. Implications of the Study

Because of the unique nature of mathematics whereby pre-knowledge is of the utmost importance and used as a basis for future mathematics learning, assessment and intervention measures need to be put in place at each grade to ensure that pupils' mathematical knowledge is adequate for the level of work required in the next grade.

It is critical for higher and standard grade mathematics students to be taught in separate classes. Learners are disadvantaged when both higher and standard grade mathematics students are taught in the same class, since students of one grade do not have instant access to the mathematics teacher, who may be engaged in teaching students belonging to the other grade. The education department should consider shouldering the responsibility of employing and appointing mathematics teachers to schools in which their services are needed.

The Department of Education needs to facilitate on-going professional development for educators of mathematics. Regular school based workshops may assist teachers in improving the quality of mathematics education at their schools, and perhaps in improving the mathematics performance of their

students.

Private mathematics tuition is readily available in the community at a price. This implies that tuition is only accessible to those who can afford the fee. There is a need for schools to work with the community in establishing community based extension classes in mathematics. Classes of this nature would be of benefit to learners, especially to those who cannot afford to pay exorbitant fees.

6.3. Recommendations for Future Research

The present study explored the phenomenon of mathematics anxiety at Woodhurst Secondary. Mathematics anxiety is widespread and not unique to the school in this study. The incidence of mathematics anxiety in the broader South African context is well worth investigating - especially since the overall matric mathematics results in South Africa are always very poor. Over and above this, South African students appear to be lagging behind in mathematics, compared to their counterparts in other countries.

In the Third International Mathematics and Science Study (TIMMS) conducted in 41 countries and at three levels of the school system (equivalent to South African Grades 4/5; Grades 7/8 and Grade 12), the results show that the overall scores of South African students were significantly lower than in other countries. South Africa's results did not indicate any areas in mathematics in

which students performed well. In fact, in many of the test items South Africa performed worst ("SA's pupils", 1998).

The dismal performance of South African students in mathematics is of great concern and warrants serious investigation. Future research should focus on mathematics anxiety in South Africa as a whole, and on ways in which the overall mathematics results in our country can be improved.

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APPENDIX 1

Mathematics Anxiety Questionnaire : Students

NAME : _____

Circle a number from one to five to indicate how strong your anxiety is for each item below.

	No 1	2	Sometimes 3	4	Yes 5
I am anxious:					
1. At the thought of taking a mathematics course.	1	2	3	4	5
2. When I go into a mathematics class.	1	2	3	4	5
3. When I open a mathematics book.	1	2	3	4	5
4. When I study mathematics alone.	1	2	3	4	5
5. When I do mathematics with others watching.	1	2	3	4	5
6. When the teacher watches me doing mathematics.	1	2	3	4	5
7. When anyone in my family is discussing a mathematics problem.	1	2	3	4	5
8. When making change at the store.	1	2	3	4	5
9. When people discuss mathematics.	1	2	3	4	5
10. When my parents explain a mathematics problem to me.	1	2	3	4	5

Which of the following describe you? Again, circle one to five.

11. I have been uncomfortable with school mathematics.	1	2	3	4	5
12. I really don't know how to understand, learn, and remember mathematics.	1	2	3	4	5
13. I memorize well.	1	2	3	4	5
14. I never really liked mathematics.	1	2	3	4	5
15. I have never read a mathematics book in school	1	2	3	4	5
16. I had upsetting experiences with mathematics.	1	2	3	4	5
17. I was punished for my honest efforts in mathematics.	1	2	3	4	5
18. As far back as I can remember, I got nervous when family members brought up a problem involving numbers.	1	2	3	4	5
19. I have always gotten nervous when people brought up a problem involving numbers.	1	2	3	4	5
20. I don't see myself as part of the problem.	1	2	3	4	5

NUMBER RATING SCORE (Ignore) : ___

APPENDIX 2

Interview Questions : Students

1. Describe your primary school mathematics experience.
2. How do you feel about :
   a) mathematics now?
   b) the teaching / learning environment in your mathematics classroom?
3. Describe your behaviour during mathematics lessons.
4. Describe in detail, your reaction when mathematics classwork or homework is assigned to you.
5. What do you perceive to be the factors associated with your own anxiety in mathematics?
6. How do you think mathematics anxiety can be reduced?
7. What do you think is the cause of :
   a) poor mathematics performance?
   b) favourable mathematics performance?
8. Have you ever received any mathematical support :
   - at home,
   - at school,
   - anywhere within the community?

APPENDIX 3

Interview Questions : Teachers

1. What do you think is the cause of poor mathematics results at matric level?
2. What do you perceive to be the factors associated with mathematics anxiety among students? (In your opinion, can the teaching/learning environment contribute to mathematics anxiety in any way?)
3. How can mathematics anxiety be reduced?
4. Have you ever received any support from your school or the Department of Education and Culture, especially in presenting non-anxiety provoking mathematics lessons?
5. Are you aware of any mathematical support systems/extension programmes that exist for learners within the home, school or community?
6. Describe a typical mathematics lesson in your class.

APPENDIX 4

Belief in Myths Questionnaire : Students and Teachers

Name : _____

Do you believe in any of the following statements (related to mathematics)? Place a cross(X) in the appropriate block.

	Y	N
1. Some people have a mathematics mind and some don't.		
2. Mathematics requires logic, not intuition.		
3. You must always know how you got the answer.		
4. Mathematics requires a good memory.		
5. There is a best way to do a mathematics problem.		
6. Mathematics is done by working intensely until the problem is solved.		
7. Men are better in mathematics than women.		
8. It's always important to get the answer exactly right.		
9. Mathematicians do problems quickly in their heads.		
10. There is a magic key to doing mathematics.		
11. Mathematics is not creative.		
12. It's bad to count on your fingers.		

APPENDIX 5

Responses to Mathematics Anxiety Questionnaire : Students

NAME : **Maggie**

Circle a number from one to five to indicate how strong your anxiety is for each item below.

	No 1	2	Sometimes 3	4	Yes 5
I am anxious:					
1. At the thought of taking a mathematics course.	1	2	3	4	(5)
2. When I go into a mathematics class.	1	2	3	(4)	5
3. When I open a mathematics book.	1	2	3	(4)	5
4. When I study mathematics alone.	1	2	3	4	(5)
5. When I do mathematics with others watching.	1	2	3	4	(5)
6. When the teacher watches me doing mathematics.	1	2	3	4	(5)
7. When anyone in my family is discussing a mathematics problem.	1	2	3	4	(5)
8. When making change at the store.	1	2	(3)	4	5
9. When people discuss mathematics.	1	2	3	4	(5)
10. When my parents explain a mathematics problem to me.	1	2	3	4	(5)

Which of the following describe you? Again, circle one to five.

11. I have been uncomfortable with school mathematics.	1	2	3	(4)	5
12. I really don't know how to understand, learn, and remember mathematics.	1	2	3	4	(5)
13. I memorize well.	1	(2)	3	4	5
14. I never really liked mathematics.	1	2	3	(4)	5
15. I have never read a mathematics book in school	1	2	3	4	(5)
16. I had upsetting experiences with mathematics.	1	2	(3)	4	5
17. I was punished for my honest efforts in mathematics.	(1)	2	3	4	5
18. As far back as I can remember, I got nervous when family members brought up a problem involving numbers.	1	2	3	4	(5)
19. I have always gotten nervous when people brought up a problem involving numbers.	1	2	3	4	(5)
20. I don't see myself as part of the problem.	1	2	(3)	4	5

NUMBER RATING SCORE (Ignore) : (83)

NAME : **Ali**

Circle a number from one to five to indicate how strong your anxiety is for each item below.

	No		**Sometimes**		**Yes**
	1	**2**	**3**	**4**	**5**
I am anxious:					
1. At the thought of taking a mathematics course.	1	2	(3)	4	5
2. When I go into a mathematics class.	1	2	(3)	4	5
3. When I open a mathematics book.	1	(2)	3	4	5
4. When I study mathematics alone.	1	2	3	(4)	5
5. When I do mathematics with others watching.	1	2	(3)	4	5
6. When the teacher watches me doing mathematics.	1	2	3	(4)	5
7. When anyone in my family is discussing a mathematics problem.	1	2	3	(4)	5
8. When making change at the store.	1	2	(3)	4	5
9. When people discuss mathematics.	1	2	(3)	4	5
10. When my parents explain a mathematics problem to me.	1	2	3	(4)	5

Which of the following describe you? Again, circle one to five.

11. I have been uncomfortable with school mathematics.	1	2	(3)	4	5
12. I really don't know how to understand, learn, and remember mathematics.	1	2	3	(4)	5
13. I memorize well.	1	2	3	(4)	5
14. I never really liked mathematics.	1	2	3	4	(5)
15. I have never read a mathematics book in school	1	2	3	4	(5)
16. I had upsetting experiences with mathematics.	1	2	3	4	(5)
17. I was punished for my honest efforts in mathematics.	1	(2)	3	4	5
18. As far back as I can remember, I got nervous when family members brought up a problem involving numbers.	1	2	3	4	(5)
19. I have always gotten nervous when people brought up a problem involving numbers.	1	2	3	4	(5)
20. I don't see myself as part of the problem.	1	2	(3)	4	5

NUMBER RATING SCORE (Ignore) : (74)

NAME : **Rosanna**

Circle a number from one to five to indicate how strong your anxiety is for each item below.

	No		**Sometimes**		**Yes**
	1	**2**	**3**	**4**	**5**
I am anxious:					
1. At the thought of taking a mathematics course.	1	2	3	4	(5)
2. When I go into a mathematics class.	1	2	3	(4)	5
3. When I open a mathematics book.	1	2	(3)	4	5
4. When I study mathematics alone.	1	2	3	(4)	5
5. When I do mathematics with others watching.	1	2	3	(4)	5
6. When the teacher watches me doing mathematics.	1	2	3	(4)	5
7. When anyone in my family is discussing a mathematics problem.	1	2	3	4	(5)
8. When making change at the store.	1	2	(3)	4	5
9. When people discuss mathematics.	1	2	(3)	4	5
10. When my parents explain a mathematics problem to me.	1	2	3	4	(5)

Which of the following describe you? Again, circle one to five.

11. I have been uncomfortable with school mathematics.	1	2	3	(4)	5
12. I really don't know how to understand, learn, and remember mathematics.	1	2	3	(4)	5
13. I memorize well.	1	2	(3)	4	5
14. I never really liked mathematics.	1	2	(3)	4	5
15. I have never read a mathematics book in school	1	2	3	4	(5)
16. I had upsetting experiences with mathematics.	1	2	(3)	4	5
17. I was punished for my honest efforts in mathematics.	1	2	(3)	4	5
18. As far back as I can remember, I got nervous when family members brought up a problem involving numbers.	1	2	3	(4)	5
19. I have always gotten nervous when people brought up a problem involving numbers.	1	2	3	(4)	5
20. I don't see myself as part of the problem.	(1)	2	3	4	5

NUMBER RATING SCORE (Ignore) : (74)

NAME : **Varsha**

Circle a number from one to five to indicate how strong your anxiety is for each item below.

	No		**Sometimes**		**Yes**
	1	**2**	**3**	**4**	**5**
I am anxious:					
1. At the thought of taking a mathematics course.	1	2	3	(4)	5
2. When I go into a mathematics class.	1	2	3	(4)	5
3. When I open a mathematics book.	1	2	3	(4)	5
4. When I study mathematics alone.	1	2	3	(4)	5
5. When I do mathematics with others watching.	1	2	(3)	4	5
6. When the teacher watches me doing mathematics.	1	2	3	4	(5)
7. When anyone in my family is discussing a mathematics problem.	1	2	3	4	(5)
8. When making change at the store.	1	2	3	4	(5)
9. When people discuss mathematics.	1	2	3	4	(5)
10. When my parents explain a mathematics problem to me.	1	2	3	4	(5)

Which of the following describe you? Again, circle one to five.

11. I have been uncomfortable with school mathematics.	1	2	(3)	4	5
12. I really don't know how to understand, learn, and remember mathematics.	1	2	(3)	4	5
13. I memorize well.	1	2	3	(4)	5
14. I never really liked mathematics.	1	2	(3)	4	5
15. I have never read a mathematics book in school	1	2	3	4	(5)
16. I had upsetting experiences with mathematics.	1	2	(3)	4	5
17. I was punished for my honest efforts in mathematics.	(1)	2	3	4	5
18. As far back as I can remember, I got nervous when family members brought up a problem involving numbers.	1	2	(3)	4	5
19. I have always gotten nervous when people brought up a problem involving numbers.	1	2	(3)	4	5
20. I don't see myself as part of the problem.	(1)	2	3	4	5

NUMBER RATING SCORE (Ignore) : (73)

NAME : **Thabo**

Circle a number from one to five to indicate how strong your anxiety is for each item below.

	No		**Sometimes**		**Yes**
	1	**2**	**3**	**4**	**5**
I am anxious:					
1. At the thought of taking a mathematics course.	1	2	3	(4)	5
2. When I go into a mathematics class.	1	2	(3)	4	5
3. When I open a mathematics book.	1	2	3	(4)	5
4. When I study mathematics alone.	1	2	(3)	4	5
5. When I do mathematics with others watching.	1	2	3	(4)	5
6. When the teacher watches me doing mathematics.	1	2	3	(4)	5
7. When anyone in my family is discussing a mathematics problem.	1	2	3	4	(5)
8. When making change at the store.	1	2	3	4	(5)
9. When people discuss mathematics.	1	2	(3)	4	5
10. When my parents explain a mathematics problem to me.	1	2	3	(4)	5

Which of the following describe you? Again, circle one to five.

11. I have been uncomfortable with school mathematics.	1	2	3	4	(5)
12. I really don't know how to understand, learn, and remember mathematics.	1	2	(3)	4	5
13. I memorize well.	1	(2)	3	4	5
14. I never really liked mathematics.	1	2	3	4	(5)
15. I have never read a mathematics book in school	1	2	3	4	(5)
16. I had upsetting experiences with mathematics.	1	2	(3)	4	5
17. I was punished for my honest efforts in mathematics.	(1)	2	3	4	5
18. As far back as I can remember, I got nervous when family members brought up a problem involving numbers.	1	2	3	(4)	5
19. I have always gotten nervous when people brought up a problem involving numbers.	1	2	3	(4)	5
20. I don't see myself as part of the problem.	1	(2)	3	4	5

NUMBER RATING SCORE (Ignore) : (**73**)

NAME : **Nadine**

Circle a number from one to five to indicate how strong your anxiety is for each item below.

	No		**Sometimes**		**Yes**
	1	**2**	**3**	**4**	**5**
I am anxious:					
1. At the thought of taking a mathematics course.	1	2	3	(4)	5
2. When I go into a mathematics class.	1	2	3	(4)	5
3. When I open a mathematics book.	1	2	3	(4)	5
4. When I study mathematics alone.	1	2	(3)	4	5
5. When I do mathematics with others watching.	1	2	(3)	4	5
6. When the teacher watches me doing mathematics.	1	2	(3)	4	5
7. When anyone in my family is discussing a mathematics problem.	1	2	3	(4)	5
8. When making change at the store.	1	2	(3)	4	5
9. When people discuss mathematics.	1	2	(3)	4	5
10. When my parents explain a mathematics problem to me.	1	2	(3)	4	5

Which of the following describe you? Again, circle one to five.

11. I have been uncomfortable with school mathematics.	1	2	3	4	(5)
12. I really don't know how to understand, learn, and remember mathematics.	1	2	(3)	4	5
13. I memorize well.	1	2	3	(4)	5
14. I never really liked mathematics.	1	2	3	(4)	5
15. I have never read a mathematics book in school	1	2	3	4	(5)
16. I had upsetting experiences with mathematics.	1	(2)	3	4	5
17. I was punished for my honest efforts in mathematics.	1	(2)	3	4	5
18. As far back as I can remember, I got nervous when family members brought up a problem involving numbers.	1	2	3	4	(5)
19. I have always gotten nervous when people brought up a problem involving numbers.	1	2	3	4	(5)
20. I don't see myself as part of the problem.	1	2	(3)	4	5

NUMBER RATING SCORE (Ignore) : (72)

NAME : **Nathan**

Circle a number from one to five to indicate how strong your anxiety is for each item below.

	No		**Sometimes**		**Yes**
	1	**2**	**3**	**4**	**5**
I am anxious:					
1. At the thought of taking a mathematics course.	1	2	3	4	(5)
2. When I go into a mathematics class.	1	2	(3)	4	5
3. When I open a mathematics book.	1	2	(3)	4	5
4. When I study mathematics alone.	1	2	3	(4)	5
5. When I do mathematics with others watching.	1	2	3	4	(5)
6. When the teacher watches me doing mathematics.	1	2	3	4	(5)
7. When anyone in my family is discussing a mathematics problem.	1	2	(3)	4	5
8. When making change at the store.	1	2	(3)	4	5
9. When people discuss mathematics.	1	2	(3)	4	5
10. When my parents explain a mathematics problem to me.	1	2	(3)	4	5

Which of the following describe you? Again, circle one to five.

11. I have been uncomfortable with school mathematics.	1	2	3	(4)	5
12. I really don't know how to understand, learn, and remember mathematics.	1	2	3	(4)	5
13. I memorize well.	1	2	3	(4)	5
14. I never really liked mathematics.	1	2	(3)	4	5
15. I have never read a mathematics book in school	1	2	3	4	(5)
16. I had upsetting experiences with mathematics.	1	2	(3)	4	5
17. I was punished for my honest efforts in mathematics.	1	(2)	3	4	5
18. As far back as I can remember, I got nervous when family members brought up a problem involving numbers.	1	2	(3)	4	5
19. I have always gotten nervous when people brought up a problem involving numbers.	1	2	(3)	4	5
20. I don't see myself as part of the problem.	1	2	(3)	4	5

NUMBER RATING SCORE (Ignore) : (71)

NAME : **Linda**

Circle a number from one to five to indicate how strong your anxiety is for each item below.

	No		**Sometimes**		**Yes**
	1	**2**	**3**	**4**	**5**
I am anxious:					
1. At the thought of taking a mathematics course.	1	2	3	(4)	5
2. When I go into a mathematics class.	1	2	(3)	4	5
3. When I open a mathematics book.	1	2	(3)	4	5
4. When I study mathematics alone.	1	2	3	4	(5)
5. When I do mathematics with others watching.	1	2	3	4	(5)
6. When the teacher watches me doing mathematics.	1	2	3	4	(5)
7. When anyone in my family is discussing a mathematics problem.	1	2	(3)	4	5
8. When making change at the store.	1	(2)	3	4	5
9. When people discuss mathematics.	1	2	3	(4)	5
10. When my parents explain a mathematics problem to me.	1	2	3	(4)	5

Which of the following describe you? Again, circle one to five.

11. I have been uncomfortable with school mathematics.	1	2	3	(4)	5
12. I really don't know how to understand, learn, and remember mathematics.	1	2	(3)	4	5
13. I memorize well.	1	2	3	4	(5)
14. I never really liked mathematics.	1	2	(3)	4	5
15. I have never read a mathematics book in school	1	2	(3)	4	5
16. I had upsetting experiences with mathematics.	1	2	(3)	4	5
17. I was punished for my honest efforts in mathematics.	(1)	2	3	4	5
18. As far back as I can remember, I got nervous when family members brought up a problem involving numbers.	1	2	3	(4)	5
19. I have always gotten nervous when people brought up a problem involving numbers.	1	2	3	(4)	5
20. I don't see myself as part of the problem.	1	2	(3)	4	5

NUMBER RATING SCORE (Ignore) : (**71**)

NAME : **Shane**

Circle a number from one to five to indicate how strong your anxiety is for each item below.

	No		**Sometimes**		**Yes**
	1	**2**	**3**	**4**	**5**
I am anxious:					
1. At the thought of taking a mathematics course.	1	2	3	4	(5)
2. When I go into a mathematics class.	1	2	(3)	4	5
3. When I open a mathematics book.	1	2	(3)	4	5
4. When I study mathematics alone.	1	2	(3)	4	5
5. When I do mathematics with others watching.	1	2	(3)	4	5
6. When the teacher watches me doing mathematics.	1	2	(3)	4	5
7. When anyone in my family is discussing a mathematics problem.	1	2	(3)	4	5
8. When making change at the store.	(1)	2	3	4	5
9. When people discuss mathematics.	1	2	3	(4)	5
10. When my parents explain a mathematics problem to me.	1	2	3	(4)	5

Which of the following describe you? Again, circle one to five.

11. I have been uncomfortable with school mathematics.	1	2	(3)	4	5
12. I really don't know how to understand, learn, and remember mathematics.	1	2	3	(4)	5
13. I memorize well.	1	2	(3)	4	5
14. I never really liked mathematics.	1	2	(3)	4	5
15. I have never read a mathematics book in school	1	(2)	3	4	5
16. I had upsetting experiences with mathematics.	1	(2)	3	4	5
17. I was punished for my honest efforts in mathematics.	1	(2)	3	4	5
18. As far back as I can remember, I got nervous when family members brought up a problem involving numbers.	1	2	3	4	(5)
19. I have always gotten nervous when people brought up a problem involving numbers.	1	2	3	4	(5)
20. I don't see myself as part of the problem.	1	(2)	3	4	5

NUMBER RATING SCORE (Ignore) : (63)

NAME : **Fred**

Circle a number from one to five to indicate how strong your anxiety is for each item below.

	No		**Sometimes**		**Yes**
	1	**2**	**3**	**4**	**5**
I am anxious:					
1. At the thought of taking a mathematics course.	1	2	3	(4)	5
2. When I go into a mathematics class.	1	2	(3)	4	5
3. When I open a mathematics book.	1	2	(3)	4	5
4. When I study mathematics alone.	1	(2)	3	4	5
5. When I do mathematics with others watching.	1	(2)	3	4	5
6. When the teacher watches me doing mathematics.	1	(2)	3	4	5
7. When anyone in my family is discussing a mathematics problem.	1	2	(3)	4	5
8. When making change at the store.	(1)	2	3	4	5
9. When people discuss mathematics.	1	2	(3)	4	5
10. When my parents explain a mathematics problem to me.	1	2	(3)	4	5

Which of the following describe you? Again, circle one to five.

11. I have been uncomfortable with school mathematics.	1	2	(3)	4	5
12. I really don't know how to understand, learn, and remember mathematics.	1	2	(3)	4	5
13. I memorize well.	1	(2)	3	4	5
14. I never really liked mathematics.	1	2	(3)	4	5
15. I have never read a mathematics book in school	1	2	3	4	(5)
16. I had upsetting experiences with mathematics.	1	2	(3)	4	5
17. I was punished for my honest efforts in mathematics.	1	(2)	3	4	5
18. As far back as I can remember, I got nervous when family members brought up a problem involving numbers.	1	2	(3)	4	5
19. I have always gotten nervous when people brought up a problem involving numbers.	1	2	(3)	4	5
20. I don't see myself as part of the problem.	1	2	3	4	(5)

NUMBER RATING SCORE (Ignore) : (**58**)

APPENDIX 6

Interviews : Students and Teachers

1. Interview - Student : Maggie

In primary school, Maggie "didn't really like mathematics". She "hated bonds and tables which was tested at the beginning of every mathematics lesson. If pupils did not provide correct answers then they were hit with the chalkboard duster and made to stand for the whole session".

Although Maggie is pursuing matric mathematics on the standard grade, she still finds the subject "difficult". She claims that "the teacher's attitude is lackadaisical and uncaring towards pupils and not enough revision is done in each lesson. The mathematics classroom is boring all the time. Each day the same thing happens, homework is corrected and new homework is given".

Maggie is "quiet" during her mathematics lessons and does not ask any questions. She is "used to not understanding". Whenever classwork or homework is assigned to her, she "tries to complete the work by going through the teacher's notes or reading the text". She does admit though that she often "copies" her "friend's work".

Maggie is mathematics anxious because :

- "There is no one cut and dried method in mathematics" and she is "unsure of the method to use".
- "No two problems in mathematics are identical. Each problem is brand new and requires a lot of reasoning. No other subject works like this. In other subjects it is convenient to just get by, by learning what is given".

Mathematics anxiety can be reduced by :

- "the teacher varying the teaching methods in the classroom and introducing group work. It is easier to learn from friends than the teacher".
- "changing pupils' perceptions that mathematics is difficult. As soon as mathematics is mentioned, the first thing that everyone thinks is 'difficult' ".

Poor mathematics performance is caused by :

- "pupils not practicing examples".
- "pupils' perceptions that mathematics is difficult".
- "teachers doing limited examples in class instead of doing a variety".
- "teachers not making the lesson exciting. This can be done by giving puzzles, crosswords and using group work".

Favourable mathematics performance is caused by :

- "pupils working hard at the subject and putting in the extra effort to do well".
- "teachers making the subject interesting".

Maggie's parents are concerned about her mathematics results. At home, they "tape the mathematics lessons on TV" for her and also "purchase the newspaper whenever a mathematics guide is published".

Maggie does not receive any mathematical support from her school. In the community, private mathematics tuition is available. In an effort to improve her mathematics performance, her parents enrolled her for "tuition". She "dropped out after one week" because she "was not learning anything. With the large numbers it was like being in school all over again".

2. Interview - Student : Ali

As a primary school student, Ali "liked" mathematics. He "paid attention" and "understood whatever was taught". Now in matric, he claims to "hate mathematics since too much of work is pushed in one lesson and I can't make sense of it".

With regard to the teaching/learning environment within the mathematics classroom, Ali states that "nothing is wrong with the class or the teacher. The only problem is that work is really pushed and it's difficult to cope". During mathematics lessons, Ali "pays attention for the first five minutes" and then his "mind goes astray". He points out that he "cannot control" his "daydreaming" and "gets lost during lessons".

When mathematics classwork or homework is assigned to Ali, he "gets it done". Not by himself though. He is "too lazy to do the work", so he merely "copies" the work from "someone else". He attributes his anxiety in mathematics to his mathematics teacher (even though he claimed that "nothing is wrong with ...the teacher). "The teacher's a pain. She doesn't respect pupils and insults them for no reason. She is supposed to give us encouragement and she doesn't do this". Ali believes that mathematics anxiety can be reduced by "encouragement from parents and teachers".

According to Ali, poor mathematics performance is caused by "a lack of

understanding. People don't understand mathematics in Grades 9 and 10. Mathematics is carried over each year and people are lost by the time they come to matric". Favourable mathematics performance on the other hand is caused by "paying attention in class and being self motivated to do well".

Ali does not receive any mathematical support from his school (except for a few friends who lend him their homework). At home, his parents "push" him "to do well" and they have now enrolled him for mathematics tuition on Saturdays. "Mathematics tuition helps a bit but the hours are long" (8.30 am to 12.30 pm with a half hour break). Even during mathematics tuition, Ali admits that his "concentration drifts after a while" but he does "understand some of the work".

Despite Ali's claim that his "results have improved after enrolling for mathematics tuition", an investigation of his mathematics marks has not revealed any improvement in performance.

3. Interview - Student : Rosanna

Rosanna found mathematics to be "easy" in primary school. At that stage, "pupils were spoonfed and given examples in class similar to those in the exams. The paper was basically given to pupils then and now that it doesn't happen, it's hard".

Presently as a matriculant, Rosanna finds mathematics "difficult". She "cannot understand the way the teacher teaches it - it is too abstract and the teaching/learning environment is pathetic. Everyone has a playful attitude in class and the work is not taken seriously - maybe because no one understands mathematics".

During mathematics lessons, Rosanna "listens attentively to the teacher". Despite her attentiveness, she "still has a problem in understanding mathematics" and is "only able to solve simple problems. The more difficult problems, just can't be done" by her. When mathematics classwork or homework is assigned, Rosanna "does it" even though she "does not like it". She answers "the easy questions" by herself. The one's that she "can't do", she "just copies".

Rosanna is mathematics anxious because "mathematics is difficult. Most people just do it for the sake of doing it - because to get a good job, you need mathematics. Mathematics anxiety is difficult to reduce but maybe it can be

reduced by taking the subject seriously, paying more careful attention in class and doing one's work by one's self".

According to Rosanna, poor mathematics performance is caused by "pupils not learning" and "teachers not teaching properly". On the contrary, favourable mathematics performance is caused by "pupils being dedicated to the subject - but being naturally intelligent helps a lot".

Rosanna has not received any mathematical support from the community. At home, her uncle who is an accountant assists her with the mathematics taught at school. He "explains the solutions to mathematical problems" to her. Rosanna confesses that she "understands the problems when he explains it" to her but when left on her own, she encounters difficulty and "does not know what to do". At school, she does not receive any mathematical support from anyone. The mathematics teacher, however, "is approachable and is always willing to help in providing explanations to pupils".

4. Interview - Student : Varsha

Varsha "simply loved" mathematics in primary school. "The work was easy and the teacher joked a lot which made the lesson exciting". Now, "mathematics is definitely hard. The teacher goes too fast. I don't understand the work and I don't even understand the questions".

Varsha is "not happy" with the teaching/learning environment in her mathematics classroom. "I listen like I listen in every other subject but I still don't understand what the mathematics teacher is saying. I do well in my other subjects but in mathematics I've been experiencing problems right from Grade 10 and I don't know what to do - mathematics is too complicated".

Varsha "listens to what is being said" during mathematics lessons. Despite "listening", she has reached a stage where she "simply can't understand anything" ("As for Geometry riders, I never know where to start solving them or what theorems to use"). Consequently, when mathematics classwork or homework is assigned to her, Varsha "completes it reluctantly by often copying from a brighter pupil".

Varsha claims that she "cannot pinpoint" the factors associated with her anxiety in mathematics. Moreover, she has "not a clue" as to how the phenomenon of mathematics anxiety can ever be reduced. According to her, poor mathematics performance is caused by "pupils who can't comprehend or

understand the subject" and favourable mathematics performance is caused by "a proper understanding of everything in mathematics".

Varsha has not received any mathematical support from the community. At school however, a friend "explains the teacher's lesson" to her "in easier terms" - "sometimes in vain" and at home, her sister who is studying towards a Bachelor of Commerce degree "tries to help" by providing "step by step" explanations which Varsha sadly admits is not always understood by her.

5. Interview - Student : Thabo

"Mathematics was easy in primary school. The teacher was teaching well and I understood everything. Mathematics is not nice now. I don't understand it especially geometry and trigonometry. It's confusing".

The teaching/learning environment in Thabo's mathematics classroom "is okay - or it looks like it is okay. Everybody acts like they understand everything - but they don't know anything. I don't like mathematics and whatever happens in the mathematics classroom - because I don't understand what the teacher is teaching".

Whenever mathematics classwork or homework is assigned to Thabo, he claims that he "attempts the work honestly" and only when "in the mood" does he "ask the teacher to explain the problems" to him. This however, he admits, occurs very seldom.

Thabo is unable to provide any factors associated with his anxiety in mathematics. He acknowledges that he "doesn't know and can't explain what happens to the brain especially in geometry and trigonometry - It doesn't work at all" (his brain). Although Thabo may not know what contributes to his anxiety in mathematics, he does point out that mathematics anxiety can be reduced by "practicing mathematics examples all the time."

According to Thabo, poor mathematics performance is caused by "pupils taking advantage because they think mathematics is difficult, so they don't try to do the work". Favourable mathematics performance on the other hand is caused by "Intelligence. Pupils that are intelligent do well and pupils that are not intelligent - they don't do well".

Thabo "could do with help in mathematics". As yet, he has not received any mathematical support at home, from his school or anywhere within the community.

6. Interview - Student : Nadine

Nadine "hated mathematics in primary school. The teachers weren't very co-operative and pupils were slapped for not knowing their work. In terms of actual teaching only one way of solving a problem was shown. Other ways were not shown".

Now in matric, Nadine "still hates" mathematics. As far as she is concerned, the subject is "very hard" and the "teacher makes me feel very inadequate. He is accustomed to paying more attention to the pupils who he thinks will get A's or B's. Instead of focusing on the weak pupils, he focuses on the bright pupils".

During mathematics lessons, Nadine "tries to pay attention but it's of no use". Almost always, she does not understand the work that is being explained. Whenever classwork or homework is assigned to her in mathematics, Nadine completes the work that she understands. The work that she does not understand, she copies from her friends.

Nadine is mathematics anxious because "mathematics is not taught in a fun way. It is taught abstractly and is made out to be a subject which is very complex and scary". Mathematics anxiety can be reduced by "allowing everyone to work at their own pace. Some people are slow learners and they need more time to grasp concepts before moving on to further concepts. Pupils

should not be pressured to work at the same pace".

According to Nadine, poor mathematics performance is caused by "a lack of understanding of mathematical concepts taught" and by "not practicing mathematical problems".

Favourable mathematics performance on the other hand is caused by :

- "pupils consistently working out a variety of mathematical problems".
- "intellect. Certain people have a natural inborn ability to do well in mathematics".
- "the teacher making the subject fun and not just getting on with the syllabus".

At school, Nadine has not ever received any mathematical support. In the community, "there isn't any mathematical support available except for private mathematics tuition and you have to pay dearly for this".

At home, her parents have "always backed" and supported her. They have purchased for her a collection of "mathematics guides" to work with and have also enrolled her for mathematics tuition. "Tuition is not at all helpful. It is like school. No individual attention is given and pupils are loaded with tons of worksheets to do at home - which defeats the purpose of tuition". Nadine 'just gives up' and does not ever succeed in completing the worksheets that her tutor provides.

7. Interview - Student : Nathan

Nathan's primary school mathematics experience "was enjoyable". "It was all very easy in those days" and he "was always able to understand all the work. That was then". Now in matric, "mathematics is terrible" (ever since Grade 10 his symbols have been "falling"). He has "lost all interest in the subject, can't understand most things and won't bother to study" (symptoms peculiar to mathematics only) - "It's hopeless".

Presently, the teaching/learning environment in Nathan's mathematics classroom is "okay". "The teacher's okay - only the understanding is not okay - it's never okay" (on Nathan's part). Nathan is quick to point out that he has only himself to blame for his lack of mathematical understanding. He admits that he is "playful and disruptive" during mathematics lessons. Together with other boys in his mathematics class, he is "often scolded by the teacher for not paying attention and disturbing the lesson. Only the girls pay attention and know what's happening all the time - They are nerds".

Whenever mathematics classwork or homework is assigned to Nathan, he "wishes it weren't given" and completes it effortlessly by "copying one of the girls". He is mathematics anxious and has not ever received any mathematical support at home, at school or anywhere within the community. He claims that his mathematics anxiety is caused by knowing that he "will do badly" while his "friends and sister (in Grade 11) will do well in the subject".

According to Nathan, poor mathematics performance is caused by "a lack of learning" while favourable mathematics performance is caused by "understanding the work, paying careful attention and being at it (mathematics) all the time". He mentions that mathematics anxiety can be reduced "by enjoying the subject and you can only enjoy the subject when you know what's happening in mathematics".

8. Interview - Student : Linda

In primary school, Linda "used to like mathematics and did well in it". At that time, the subject "was simple and easy to understand". They "were all asked to stand on a daily basis. The teacher walked around the classroom with a stick, asked questions and drilled the work". Linda "did not resent" this practice which was for her "own good". They were "kept on their toes" and she "learnt in this way". Group work was also practised regularly in Linda's primary school mathematics classroom (with each group working on a different mathematics problem). "That was enjoyable". Now, "group work doesn't take place at all" in her mathematics classroom.

As a matriculant, Linda finds mathematics "tough and frightening". She is "afraid of the subject. I am not good with numbers. There are far too many variables to work with and mathematics confuses me. The teaching/ learning environment in her mathematics classroom is "fine" except that "the teacher does not allow room for mistakes and expects pupils to get everything right all the time".

During mathematics lessons, Linda is on her "best behaviour". She "listens" but does not "absorb". Whenever mathematics classwork or homework is assigned to her, she copies the solutions "from her cousins mathematics books". (Her cousin was a matric student at the same school, in the previous year. After matriculating, she had generously handed over all her work books

to Linda. Hence, for Linda "it is quite simple to copy".)

Linda has not ever received any mathematical support at home (her parents did not complete their schooling and are in no position whatsoever to assist her mathematically. Moreover, they cannot afford to send her for private mathematics tuition), at school ("except for the teacher in class") or anywhere within the community.

Linda's mathematics anxiety is caused by "not having a proper mathematical foundation". She admits that there are "huge holes" in her knowledge and she "is unable to use past knowledge" for present work.

She claims that mathematics anxiety can be reduced by :

- "increasing the time for mathematics on the timetable. With more time, concepts can be explained more fully and students will have more time to practice and ask the teacher questions".
- "not having higher and standard grade mathematics students in the same class. Students of different grades must be taught separately in different classes". [In Linda's mathematics class, there are both higher and standard grade students. "The teacher spends the entire lesson in teaching the different syllabi and students who are completing exercises can't immediately ask for help when stuck" (the teacher may be teaching students belonging to the other grade.)]

According to Linda, poor mathematics performance is caused by "a lack of understanding" and "failing to go through past year papers" while favourable mathematics performance is caused by "a sound understanding of mathematics and exposure to different types of mathematical problems".

9. Interview - Student : Shane

In primary school, mathematics was "easy, fun and did not feel like work". Now in Shane's final year at school, the subject is "very intricate and very challenging". Presently in his mathematics classroom, the teaching/learning environment is 'tiring' - "work goes on until the buzzer sounds". Shane "is forced to concentrate for the entire period" - which is "an impossibility". "There is only so much that can be taken in, in one period". In direct contrast to the atmosphere that prevails in his other classes, the atmosphere within Shane's mathematics classroom is "very formal and very disciplined". "In other lessons, there's quite a bit of joking and opinionating that goes on - not in the mathematics lesson. In mathematics, the subject matter is very rigid and there is nothing to laugh about".

During mathematics lessons, Shane is "alert" and "attentive". Despite his attentiveness, there are times when his teacher's explanations are not understood by him. (During these times, Shane does not make any attempt whatsoever to question his teacher - he feels "awkward" doing so). Whenever mathematics classwork or homework is assigned to him, Shane completes it "honestly" (by himself) - "even if it is wrong". His mathematics teacher finds it "very strange" that he prefers to complete his work in pencil. Shane is "quite free with a pencil" and does not find it "restricting" since he "can easily erase mistakes - unlike in ink". He regrets though that he is only able to solve mathematical problems successfully, when supplied with similar worked

examples which he can imitate.

Shane's anxiety in mathematics is caused by "a lack of confidence" in his own mathematical ability and by "trying too hard and still not achieving". (At home, he devotes one and a half hours each day to mathematics - more than the time he spends on any other subject. When he fails to understand mathematical derivations and theorems, he "has no alternative" but to memorize these aspects "like a parrot".)

Mathematics anxiety can be reduced by "approaching the subject in a calm, logical and positive manner". Shane emphasises that "mathematics should not ever be taught in the last period (especially on a Friday). This is not the best time of the day for a subject that requires a lot of thinking. Mathematics must be taught early in the morning, when everyone's fresh and awake".

According to Shane, poor mathematics performance is caused by "teachers teaching the subject in a monotonous manner that does not promote understanding" and "pupils doing mathematics when they are not cut out for the subject". Favourable mathematics performance on the other hand is caused by "pupils grasping all mathematical concepts and having a flair for the subject".

Shane does not receive any mathematical support from his school or the community. At home, however, his parents take a special interest in his

mathematics performance (they had enrolled him for mathematics tuition which he "gave up" after a short while "because it made no difference" to him) and only for this particular subject, do they constantly enquire from him as to whether he is "coping". Although Shane's parents do not understand the matric mathematics syllabus, they "see to it" that he completes his mathematics homework everyday.

Shane does "not believe" in mathematics tuition because the "top students" in his school do not attend tuition - and they perform "brilliantly". Shane is "disheartened" that "no matter how hard" he tries, he "still won't be as good as those natural geniuses. It's so unfair. In mathematics, you either have it or don't, it's an inbred thing".

10. Interview - Student : Fred

Fred "hated" his primary school mathematics teacher. "The teacher was fond of criticizing and putting down kids. If students answered incorrectly, he would sternly say 'How dumb can you get?' ". Even though Fred hated his primary school mathematics teacher, he found mathematics in those years to be "easy" and "reflex action". Now in matric, mathematics is a "killer subject" and he has to "put a lot of effort" in his learning.

The teaching/learning environment in Fred's mathematics classroom is "stressful". "Before I can even attempt a mathematics problem, I get 'mental blocks'. I have a preconceived idea that my problems won't work out. During mathematics tests and exams, I suffer from anxiety attacks and severe stomach cramps. This does not happen for any other subject. What makes mathematics so stressful is that there is only one right answer always".

During mathematics lessons, Fred "makes sure" that he sits at the front of the class so that he "won't be distracted". He "pays careful attention while the teacher is teaching". Once classwork or homework is assigned to Fred, he completes the work by himself only if it is Algebra or Trigonometry. However, if it is Geometry, he copies the work from another student. "The aim is to show the completed work to the teacher". Fred "freezes" when presented with a Geometry diagram and finds "unknowns" (x's and y's etc.) in geometric figures a "turn off". He experiences great difficulty in "figuring out what's important

(angles, sides etc.) in solving Geometry riders".

Fred is anxious about mathematics since he does "not want to disappoint" his parents. Furthermore, "mathematics does not come easily" to him - even though he "tries and tries and tries". He believes that mathematics anxiety can be reduced by "students obtaining individual attention in mathematics". In his own case, he points out that he "permanently needs someone who can sit with" him "to provide mathematical help and guidance on a one-to-one basis". Fred acknowledges that this is "not practical" but that is exactly what he "desperately needs - individual attention" - to reduce his mathematics anxiety.

According to Fred, poor mathematics performance is caused by :

- "not enough practice. Practice makes perfect and students that don't practice, won't perform well".
- "not getting the impression in school that mathematics is important, so students disregard the subject".

Favourable mathematics performance on the other hand is caused by "some people just having it".

Unfortunately, Fred has not received any mathematical support at school or at home (apart from his parents "nagging" him to do well in mathematics). In the community, he attends private mathematics tuition "just to please" his parents. Tuition "is not beneficial, is very exhausting (on a Monday afternoon for 2 hours after school) and is a waste of good money".

1. Interview - Teacher : Sandra

Poor mathematics results at matric level are caused by : "Poor understanding on the part of kids. Mathematics is a subject that requires lots of work. Kids are not prepared to work so they don't understand. Also, the content of the syllabus is very extensive and teachers rush with the syllabus. That's when pupils experience problems in understanding".

Students are anxious about mathematics since "mathematics is perceived to be a difficult subject and the fact that it is not a swotting subject creates a problem".

The teaching and learning environment can contribute to mathematics anxiety. "A poor teacher will not be able to get across the problem to the pupil. This causes the pupil not to understand. Probably if problems are simplified and examples put across in an easier manner then pupils will grasp what is being taught".

Mathematics anxiety can be reduced by "the teacher doing lots of extra work like making worksheets to encourage or develop mathematical skills in pupils. Group work should also be encouraged in class. Pupils should work together. This is better for them instead of always listening to the teacher teaching".

Sandra points out that her HOD is a senior Biology educator who is in no

position whatsoever to assist her with the mathematics that she teaches at school. She has not ever received any support from her school or the Department of Education and Culture. Sandra believes that each year the department needs to distribute exam type question papers ("mock papers") so that a uniform standard is maintained throughout the region.

Sandra is not aware of any mathematical support systems/extension programmes that exist for learners within the school. At home though "mathematics lessons on TV are helpful. William Smith never makes a problem difficult. He breaks problems into parts and then solves it. Children who listen to him will see how simple mathematics is". In the community "mathematics tuition is the in thing - like a fashion - but I don't think it is helpful. Classes are overcrowded and pupils don't get individual attention. Children's individual problem areas are not addressed properly. Those pupils who are not prepared to work - even if they do go for tuition - their grades don't improve. Tutors are out to make money - not to get the best results from the child".

A typical mathematics lesson in Sandra's class involves :

- recapping the previous lesson.
- marking previous examples by asking ("more like begging") pupils to furnish solutions on the board.
- introducing the new section.
- working out different examples.
- administering homework.

2. Interview - Teacher : Adam

Poor mathematics results at matric level are caused by "Pupils not working. Mathematics is a subject that needs at least 2 hours of work a day and pupils don't put in the extra effort. Parents are also to blame. They do not monitor homework and for status they insist on their children doing higher grade mathematics when the children can't cope.

The foundation for mathematics is laid down in primary school. Each year, the mathematics teacher adds a layer to the foundation. If one layer is weak then the pupil will encounter problems in mathematics".

Students are anxious about mathematics since "mathematics text books are not pupil friendly. Any pupil cannot just pick up a text book and read it with understanding. Text books need to be differentiated to cater for different levels.

Mathematics is a thinking subject that involves precision. A large volume of work is covered in mathematics and the numbers in class, over 42 in most classes, do not allow for individual attention. Even worse is that two grades, higher and standard grades are taught in one class".

The teaching and learning environment can contribute to mathematics anxiety. "The teacher can be going too fast and doing too much in one lesson. Pupils get tired after the first half of the period and stop concentrating. One hour

periods are too long".

Mathematics anxiety can be reduced by "encouraging pupils to study by themselves and rewarding pupils for the completion of homework by giving them marks for this.

The teacher can also help to reduce mathematics anxiety by going slowly and not doing too much of work in one lesson. Emphasis should be on quality work, not quantity."

Adam has not received any support from his school or the Department of Education and Culture. He has made requests to purchase new text books - separate ones for higher grade and standard grade pupils. Unfortunately, the school is not in a position to finance these books.

Adam is not aware of any mathematical support systems/extension programmes that exist for learners at school. At home "children need to record the mathematics lessons that appear on TV on the learning channel". In the community, "Natal University offers Winter classes but the lessons are quite expensive and only affordable to the elite".

A typical mathematics lesson in Adam's class involves :

- him doing one or two examples on the board.
- Adam getting pupils to do a few examples in their work books.

- Adam doing a few more complex examples on the board.
- giving pupils homework.
- marking previous homework.

3. Interview - Teacher : Kuben

Poor mathematics results at matric level are caused by :

- "Students being absent frequently and missing out on important mathematical explanations".
- "Students lacking a grounding of fundamental sections covered in earlier years (eg. factorisation and multiplication by inspection). As a result new concepts which build on old concepts are not understood by students".
- "A low attention span on the part of kids. After 10 minutes, they switch off. Naturally then, they miss out on important concepts and fail to understand mathematics".
- "Poor study methods. Kids do not consolidate work at home. They are too lazy to tackle problems and do not even believe in their own ability. Once the mathematics period is over they are not prepared to work and probably return to the next mathematics lesson with homework that has been copied".
- "Teachers not being creative. Mathematics teachers need to move with the times, to stimulate interest and regenerate enthusiasm that has been lost in the subject".

Students are anxious about mathematics since :

- "there is a stigma attached to mathematics that it is a difficult subject, beyond the reach of pupils".
- "students are pressurised by their parents to do well in the subject".

- "mathematics is sometimes portrayed in the media as a subject of unimportance and irrelevance" (see "Trivial Pursuits" article below, provided by Kuben).

EN PASSANT

Trivial pursuits

I OFTEN wonder why we weren't taught useful things at school. Take maths and algebra, for example. I had mastered basic arithmetic at primary school (majoring in the eleven times table) and was quite looking forward to mathematics until I discovered what a lot of hogwash it was. If it takes three men two days to dig a ditch 18m long, 3m wide and 1,5m deep then how long would it take five men to dig a ditch half that size?

Who the hell cares? I could never work out why they were even digging the ditch in the first place. I know that, strictly speaking, it isn't relevant but some of us have inquiring minds. Strangely, I have never once applied my mind to ditch-digging problems since I left school. Should I suddenly feel an inexplicable urge to have a ditch dug I'm sure I'll wish I had paid more attention.

Algebra was also a colossal waste of time, with bizarre and senseless questions like: if the value of A is 23 and B is seven, then what is the value of X? Then there were all those things to the power of something else, the dreadful coded squiggles and those horrific impenetrable equations where you had to multiply things inside the brackets which were already inside other brackets. What on earth did it all mean?

As an English scholar I took great exception to the intrusion of numeracy into what I regarded as a private game reserve of letters. How dare the number 23 suddenly decide to call itself A? If the reverse happened and letters went around masquerading as numbers, language would become ch23otic. The only value of X as far as I was concerned was as a triple-letter score in the game of Scrabble. I never once had the faintest idea what algebra was all about and it would have been nice if someone had even bothered to explain why it was so important. They never did, probably because nobody could think of a good reason for it to be taught as part of the general curriculum. So I have gone through life with absolutely no understanding of algebraic equations and I'm relieved to say it hasn't made the slightest difference. If restaurants had menus which said, "If A is a plate of *osso bucco* and B is a bottle of red wine, what is the value of X which is today's dessert", then I would have found life difficult. Fortunately for most of us they don't.

I have to admit that I quite enjoyed Latin classes but that was probably because we had a mad, sadistic Latin master with a broad Ulster accent. Realising that he was teaching a dead language and would soon be redundant, he amused himself by making the dimmer students dance on their desk tops — something that would have the social workers kicking the door in today but which seemed quite acceptable behaviour at a fee-paying school in those days. The problem with learning a little schoolboy Latin is that it had very little outside application. Believe me, being able to say, "Caesar, having conquered the Gauls, returned to Rome" in Latin isn't a great pick-up line in Italy today. Even fellow students who went on to become doctors and lawyers would have had very little use for Caesar's exploits.

Instead of drumming all this useless information into our skulls, it might have been more beneficial if we had spent time learning what modern educationists call "life skills". How to mix a decent martini, for example, and how to undo a girl's bra with one hand while dancing a tango would have been much more help than all that nonsense about quadratic equations. I might even have stayed for extra tuition if the subjects had been more interesting. ■

— David Bullard

According to Kuben, mathematics anxiety can be reduced by the teacher :

- "being positive about pupils' mathematical success. The teacher's positive attitude will automatically rub off on to his kids and their anxiety will be reduced".
- "motivating students and keeping away from negative talk like 'mathematics is difficult' or 'tuition will help' ".

The teaching/learning environment can contribute to mathematics anxiety. "In this day and age, the educational system is content driven". Hence, "teachers are pressurised to complete the syllabus on time". "With a matric mathematics syllabus that is very long, there is hardly any time for teachers to focus on areas of difficulty experienced by pupils. Creative teaching methods too, like group work which is time consuming, have to be cast aside so that the syllabus is completed on time".

Kuben has not received any support in mathematics from his school or the Department of Education and Culture. He indicates that "teachers are in need of on-going mathematical staff development programs and regular training especially to identify and remediate mathematics anxiety".

He is not aware of any mathematical support systems/extension programmes that exist for learners within the home or school. However, in the community, "matric extension classes were introduced at Chatsworth Teachers' Centre towards the end of last year. These lessons were free of charge and focused on

solving typical exam type questions". Kuben has "no idea" as to whether these extension classes will be held in future years.

A typical mathematics lesson in Kuben's class involves :

- correcting homework.
- teaching by illustrating examples on the chalkboard (a link is created with what students had learnt previously).
- administering of homework.

APPENDIX 7

Responses to Belief in Myths Questionnaire : Students

Name : **Maggie (Student)**

Do you believe in any of the following statements (related to mathematics)? Place a cross(X) in the appropriate block.

	Y	N
1. Some people have a mathematics mind and some don't.	**X**	
2. Mathematics requires logic, not intuition.	**X**	
3. You must always know how you got the answer.	**X**	
4. Mathematics requires a good memory.	**X**	
5. There is a best way to do a mathematics problem.		**X**
6. Mathematics is done by working intensely until the problem is solved.		**X**
7. Men are better in mathematics than women.		**X**
8. It's always important to get the answer exactly right.	**X**	
9. Mathematicians do problems quickly in their heads.		**X**
10. There is a magic key to doing mathematics.		**X**
11. Mathematics is not creative.		**X**
12. It's bad to count on your fingers.		**X**

Name : **Ali (Student)**

Do you believe in any of the following statements (related to mathematics)? Place a cross(X) in the appropriate block.

	Y	N
1. Some people have a mathematics mind and some don't.	**X**	
2. Mathematics requires logic, not intuition.	**X**	
3. You must always know how you got the answer.	**X**	
4. Mathematics requires a good memory.	**X**	
5. There is a best way to do a mathematics problem.	**X**	
6. Mathematics is done by working intensely until the problem is solved.	**X**	
7. Men are better in mathematics than women.		**X**
8. It's always important to get the answer exactly right.		**X**
9. Mathematicians do problems quickly in their heads.	**X**	
10. There is a magic key to doing mathematics.	**X**	
11. Mathematics is not creative.	**X**	
12. It's bad to count on your fingers.		**X**

Name : **Rosanna (Student)**

Do you believe in any of the following statements (related to mathematics)? Place a cross(X) in the appropriate block.

	Y	N
1. Some people have a mathematics mind and some don't.	X	
2. Mathematics requires logic, not intuition.	X	
3. You must always know how you got the answer.	X	
4. Mathematics requires a good memory.	X	
5. There is a best way to do a mathematics problem.	X	
6. Mathematics is done by working intensely until the problem is solved.	X	
7. Men are better in mathematics than women.		X
8. It's always important to get the answer exactly right.		X
9. Mathematicians do problems quickly in their heads.		X
10. There is a magic key to doing mathematics.		X
11. Mathematics is not creative.	X	
12. It's bad to count on your fingers.		X

Name : **Varsha (Student)**

Do you believe in any of the following statements (related to mathematics)? Place a cross(X) in the appropriate block.

	Y	N
1. Some people have a mathematics mind and some don't.	X	
2. Mathematics requires logic, not intuition.	X	
3. You must always know how you got the answer.	X	
4. Mathematics requires a good memory.	X	
5. There is a best way to do a mathematics problem.	X	
6. Mathematics is done by working intensely until the problem is solved.	X	
7. Men are better in mathematics than women.		X
8. It's always important to get the answer exactly right.		X
9. Mathematicians do problems quickly in their heads.	X	
10. There is a magic key to doing mathematics.	X	
11. Mathematics is not creative.	X	
12. It's bad to count on your fingers.		X

Name : **Thabo (Student)**

Do you believe in any of the following statements (related to mathematics)? Place a cross(X) in the appropriate block.

	Y	N
1. Some people have a mathematics mind and some don't.	**X**	
2. Mathematics requires logic, not intuition.	**X**	
3. You must always know how you got the answer.	**X**	
4. Mathematics requires a good memory.	**X**	
5. There is a best way to do a mathematics problem.	**X**	
6. Mathematics is done by working intensely until the problem is solved.	**X**	
7. Men are better in mathematics than women.		**X**
8. It's always important to get the answer exactly right.	**X**	
9. Mathematicians do problems quickly in their heads.	**X**	
10. There is a magic key to doing mathematics.		**X**
11. Mathematics is not creative.	**X**	
12. It's bad to count on your fingers.	**X**	

Name : **Nadine (Student)**

Do you believe in any of the following statements (related to mathematics)? Place a cross(X) in the appropriate block.

	Y	N
1. Some people have a mathematics mind and some don't.	X	
2. Mathematics requires logic, not intuition.	X	
3. You must always know how you got the answer.		X
4. Mathematics requires a good memory.	X	
5. There is a best way to do a mathematics problem.		X
6. Mathematics is done by working intensely until the problem is solved.	X	
7. Men are better in mathematics than women.		X
8. It's always important to get the answer exactly right.	X	
9. Mathematicians do problems quickly in their heads.	X	
10. There is a magic key to doing mathematics.		X
11. Mathematics is not creative.		X
12. It's bad to count on your fingers.		X

Name : **Nathan (Student)**

Do you believe in any of the following statements (related to mathematics)? Place a cross(X) in the appropriate block.

	Y	N
1. Some people have a mathematics mind and some don't.	X	
2. Mathematics requires logic, not intuition.		X
3. You must always know how you got the answer.	X	
4. Mathematics requires a good memory.	X	
5. There is a best way to do a mathematics problem.	X	
6. Mathematics is done by working intensely until the problem is solved.	X	
7. Men are better in mathematics than women.		X
8. It's always important to get the answer exactly right.		X
9. Mathematicians do problems quickly in their heads.	X	
10. There is a magic key to doing mathematics.		X
11. Mathematics is not creative.	X	
12. It's bad to count on your fingers.		X

Name : **Linda (Student)**

Do you believe in any of the following statements (related to mathematics)? Place a cross(X) in the appropriate block.

	Y	N
1. Some people have a mathematics mind and some don't.	**X**	
2. Mathematics requires logic, not intuition.		**X**
3. You must always know how you got the answer.	**X**	
4. Mathematics requires a good memory.	**X**	
5. There is a best way to do a mathematics problem.		**X**
6. Mathematics is done by working intensely until the problem is solved.		**X**
7. Men are better in mathematics than women.		**X**
8. It's always important to get the answer exactly right.		**X**
9. Mathematicians do problems quickly in their heads.		**X**
10. There is a magic key to doing mathematics.		**X**
11. Mathematics is not creative.		**X**
12. It's bad to count on your fingers.		**X**

Name : **Shane (Student)**

Do you believe in any of the following statements (related to mathematics)? Place a cross(X) in the appropriate block.

	Y	N
1. Some people have a mathematics mind and some don't.	X	
2. Mathematics requires logic, not intuition.		X
3. You must always know how you got the answer.	X	
4. Mathematics requires a good memory.		X
5. There is a best way to do a mathematics problem.		X
6. Mathematics is done by working intensely until the problem is solved.		X
7. Men are better in mathematics than women.	X	
8. It's always important to get the answer exactly right.		X
9. Mathematicians do problems quickly in their heads.		X
10. There is a magic key to doing mathematics.		X
11. Mathematics is not creative.		X
12. It's bad to count on your fingers.		X

Name : **Fred (Student)**

Do you believe in any of the following statements (related to mathematics)? Place a cross(X) in the appropriate block.

	Y	N
1. Some people have a mathematics mind and some don't.	**X**	
2. Mathematics requires logic, not intuition.	**X**	
3. You must always know how you got the answer.	**X**	
4. Mathematics requires a good memory.		**X**
5. There is a best way to do a mathematics problem.	**X**	
6. Mathematics is done by working intensely until the problem is solved.	**X**	
7. Men are better in mathematics than women.	**X**	
8. It's always important to get the answer exactly right.	**X**	
9. Mathematicians do problems quickly in their heads.	**X**	
10. There is a magic key to doing mathematics.	**X**	
11. Mathematics is not creative.	**X**	
12. It's bad to count on your fingers.		**X**

APPENDIX 8

Responses to Belief in Myths Questionnaire : Teachers

Name : **Sandra (Teacher)**

Do you believe in any of the following statements (related to mathematics)? Place a cross(X) in the appropriate block.

	Y	N
1. Some people have a mathematics mind and some don't.	**X**	
2. Mathematics requires logic, not intuition.	**X**	
3. You must always know how you got the answer.	**X**	
4. Mathematics requires a good memory.		**X**
5. There is a best way to do a mathematics problem.		**X**
6. Mathematics is done by working intensely until the problem is solved.	**X**	
7. Men are better in mathematics than women.		**X**
8. It's always important to get the answer exactly right.	**X**	
9. Mathematicians do problems quickly in their heads.		**X**
10. There is a magic key to doing mathematics.		**X**
11. Mathematics is not creative.		**X**
12. It's bad to count on your fingers.		**X**

Name : **Adam (Teacher)**

Do you believe in any of the following statements (related to mathematics)? Place a cross(X) in the appropriate block.

	Y	N
1. Some people have a mathematics mind and some don't.	**X**	
2. Mathematics requires logic, not intuition.		**X**
3. You must always know how you got the answer.		**X**
4. Mathematics requires a good memory.	**X**	
5. There is a best way to do a mathematics problem.	**X**	
6. Mathematics is done by working intensely until the problem is solved.		**X**
7. Men are better in mathematics than women.		**X**
8. It's always important to get the answer exactly right.		**X**
9. Mathematicians do problems quickly in their heads.	**X**	
10. There is a magic key to doing mathematics.		**X**
11. Mathematics is not creative.		**X**
12. It's bad to count on your fingers.		**X**

Name : **Kuben (Teacher)**

Do you believe in any of the following statements (related to mathematics)? Place a cross(X) in the appropriate block.

	Y	N
1. Some people have a mathematics mind and some don't.		**X**
2. Mathematics requires logic, not intuition.		**X**
3. You must always know how you got the answer.		**X**
4. Mathematics requires a good memory.		**X**
5. There is a best way to do a mathematics problem.		**X**
6. Mathematics is done by working intensely until the problem is solved.	**X**	
7. Men are better in mathematics than women.		**X**
8. It's always important to get the answer exactly right.		**X**
9. Mathematicians do problems quickly in their heads.		**X**
10. There is a magic key to doing mathematics.		**X**
11. Mathematics is not creative.		**X**
12. It's bad to count on your fingers.		**X**