THE RELATIONSHIP BETWEEN LEARNERS' ATTITUDES AND ACHIEVEMENT IN MATHEMATICS IN A MULTICULTURAL CONTEXT

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DECLARATION

"I declare that '**The Relationship between Learners' Attitudes and Achievement in Mathematics in a Multicultural Context'** is my own work and that all the sources I have used or quoted have been indicated and acknowledged by means of complete references."

A.E. Kimble.

Miss A.E. Kimble

12 - 11 - 2000

Date

DEDICATION

I wish to dedicate this research project to my mother and father whom I love very much.

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SUMMARY

Knowledge of mathematics is necessary for all members of society. It is also fundamental to the development of economic strength of a country. Mathematics is a subject which serves as a filter for entry into tertiary education and career opportunities, and therefore, achievement in the subject is essential.

The aim of this research project is to determine if a relationship exists between a learner's achievement in mathematics and his/her attitude towards the subject. A literature review on the topics *attitude* and *achievement* was undertaken. Attitudes have interested psychologists for many years, and resulted in many definitions of the concept. *Attitude towards mathematics* has consequently also been defined in a number of ways. The following factors are included in the research project as aspects affecting mathematics achievement: gender, language (ethnicity), the teacher and attitudes.

The empirical investigation involved 451 learners in total. There were 130 Grade 7 learners, 185 Grade 9 learners and 136 Grade 11 learners. The results of a reliable and valid questionnaire indicate that a significant positive correlation exists between attitude towards mathematics and achievement in mathematics for Grade 7, 9 and 11 learners.

DIE VERHOUDING TUSSEN LEERDERS SE HOUDINGE EN PRESTASIE IN WISKUNDE IN 'N MULTIKULTURELE KONTEKS

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SAMEVATTING

Kennis van wiskunde is vir alle mense in die samelewing noodsaaklik. Daar word ook erken dat opvoeding in wiskunde grondliggend is vir die ontwikkeling van 'n land se ekonomiese krag. Wiskunde as vak dien as 'n filter vir die toetrede tot tersiêre opvoeding en loopbaangeleenthede. Prestasie in die vak is dus noodsaaklik.

Die doel van hierdie navorsingsprojek is om te bepaal of daar 'n verhouding bestaan tussen 'n leerder se prestasie in wiskunde en sy/haar houding daarteenoor. 'n Literatuurstudie is onderneem oor die onderwerpe *houding* en *prestasie*. Houdings was vir baie jare die belangstelling van sielkundiges en het verskeie definisies oor die konsep tot gevolg gehad. *Houding teenoor wiskunde* is gevolglik ook op baie maniere gedefinieer. Die volgende faktore is ingesluit in die navorsingsprojek as faktore wat 'n invloed op wiskundeprestasie het: geslag, taal (etnisiteit), die onderwyser en houdinge.

Die empiriese ondersoek het in totaal 451 leerders betrek. Daar was 130 Graad 7 leerders, 185 Graad 9 leerders en 136 Graad 11 leerders. Die resultate van 'n betroubare en geldige vraelys dui op 'n betekenisvolle positiewe korrelasie tussen houding teenoor wiskunde en prestasie daarin vir Graad 7, 9 en 11 leerders.

KEY WORDS

Attitude
Mathematics
Mathematical attitude
Achievement
Learner
Multicultural context
Grade
Gender
Ethnicity
Language

SLEUTELWOORDE

Houding
Wiskunde
Wiskunde-houding
Prestasie
Leerder
Multikulturele konteks
Graad
Geslag
Etnisiteit
Taal

TABLE OF CONTENTS

CHAPTER FIVE EMPIRICAL RESEARCH

LIST OF TABLES

LIST OF APPENDICES

CHAPTER 1

INTRODUCTORY ORIENTATION

Knowledge of mathematics is essential for all members of our society. To participate fully in our democratic process and to be unrestricted to career choice and advancement, people must be able to understand and apply mathematical ideas.

(Reyes & Stanic, 1988: 26)

CHAPTER 1

INTRODUCTORY ORIENTATION

1.1 INTRODUCTION

Education is commonly accepted as contributing substantially to a country's economic prosperity and general well being. It is the opinion of Howie (1997: 4) that at the start of the twenty-first century the demand for mathematical, scientific and technological understanding and expertise is greater than ever before. Learners need to develop critical thinking, processing and interpreting skills far beyond those required a decade earlier and competence in mathematics becomes crucial as learners leave school to enter higher education and the workplace.

The importance of mathematics in any society cannot be overemphasised. According to Meece, Wigfield & Eccles (1990: 60), a strong background in mathematics is critical for many career and job opportunities in today's increasingly technological society. Visser (1989: 212) states that adequate preparation in mathematics is aptly being called the 'critical filter' in the job market.

Maree (1992: 42) reports that the importance of mathematics is further emphasised by the following:

- Mathematics is a powerful instrument, which allows one to communicate with others.
- The use of the language of mathematical symbols is indispensable to any society.
- Mathematics is a vital, supporting subject for other sciences.
- Mathematics has an infinite number of indispensable applications in industry.
- Mathematics enables man to understand, order and influence his environment.
- School mathematics enables one to pursue the career of one's choice.

In South Africa, poor matriculation results dominate the news at the end of every school year. In 1995, the best school attendance figures were noted, but poor results were nonetheless evident. The same story was once again repeated in 1996, despite changes and reforms in the Department of Education (Howie, 1997: 19).

Even though it is obvious to the community that competence in mathematics is essential, many learners experience difficulty in mathematics and drop it as a subject in Grade 10. According to Atkinson (1994: 179), many children enjoy mathematics at primary school, but change their minds and begin to fear it at secondary school.

It seems that some people are naturally good at mathematics, whereas others find it difficult. Atkinson (1994: 2) reports that some people say:

- *I was no good at maths at school. It was all irrelevant.*
- *I could do maths at primary school, but at secondary school I didn't have a clue what they were on about.*
- *Maths has nothing to do with life. I don't use division, fractions, Pythagoras or quadratic equations in my daily life, so I don't know why we had to learn them.*
- *We had these table tests every Friday when I was seven and I was always bad at them. I never liked maths from then on.*
- *I was really good at maths until I did A level and that was a disaster. I failed it, so I lost my place at university.*

Stuart (2000: 330) reports the following statement of Zaslavsky (1994): "It is ironic that the subject seen as the most logical and intellectual is also the one that ignites so many passionate emotions. Many people think of mathematics as a punishment or something that induces stress."

Masqud & Khalique (1991: 377) refers to Webb's address at the Annual Congress of South African Mathematical Society, in which he stated that the general public regard mathematics as a subject to be avoided. He added that ignorance of the subject is often a point of pride. Steinback & Gwizdala (1995: 36) are of the opinion that "society views good performance in mathematics as the exception rather than the rule."

Lazarus (1974) as cited in Visser (1989: 212) states: "It is unusual for a well-educated person to admit to an intellectual deficiency. Nevertheless, when the subject of mathematics comes up, people of all intellectual estates often speak freely of their own difficulties with the subject in school and of their current inabilities to handle mathematical matters." According to McLeod (1992: 575), the improvement of mathematics education will require changes in the affective responses of both children and adults.

Ma & Kishor (1997: 27) maintain that The National Council of Teachers of Mathematics (NCTM) (1989) and the National Research Council (1989) have encouraged mathematics educators to incorporate affective factors with cognitive factors in mathematics teaching and learning. They have put considerable emphasis on the need to change the public's beliefs and attitudes towards mathematics. According to Cheung (1988: 209), a high achievement of cognitive skills and the formation of favourable attitudes towards learning are universally acclaimed outcomes of schooling.

Achievement in mathematics is influenced by cognitive *and* affective factors. According to Leder & Forgasz (1992: 16), the relevance of the affective domain to learning mathematics is increasingly being recognised. Affective variables include learners' attitudes towards mathematics, their self-confidence, enjoyment and perceived ability in the discipline. According to McLeod (1992: 575), affective issues play a central role in the teaching and learning of mathematics. When teachers talk about their mathematics classes, they seem just as likely to mention their learners' enthusiasm or hostility toward mathematics, as they are to mention their cognitive achievements. Similarly, learners produce cognitive as well as affective responses (McLeod, 1992: 575). According to Kloosterman (1994: 3642), the affective domain is an important area in mathematics education both in its own right and because affective factors have considerable influence on learning.

When surveyed to determine whether the academic or affective components of teaching are more important, Putney & Cass (1998: 627) assert that teachers and learners describe the affective attitudes (opposed to academic perceptions) as being more important. Citing Meyer & Koehler (1990), Steinback & Gwizdala (1995: 36) state that studies have revealed the very significant role of attitudes in the learning of mathematics. They continue by saying, through their experiences in school mathematics, children learn (or sometimes fail to learn) knowledge, skills and ideas as a result of the work they do. At the same time, they develop attitudes towards the subject. Costello (1991: 122) adds that the teaching, discussion, activities developed and indeed the entire curriculum, convey messages about mathematics, which deliberately or not, influence attitudes.

According to Anderson (1994: 380), attitudes, interests and values are central to education, both as ends and as means. Depending on whether they are positively or negatively directed towards a particular object, they are considered to either promote

or inhibit learner behaviour. Hills (1982: 81) adds that attitudes are considered very important since they affect the learning process. It is therefore, understandable that "the development of favourable attitudes toward particular objects is an established goal of most educational programs" (Anderson, 1994: 380).

As summarised by Putney & Cass (1998: 627), the National Research Council (1989) and the Commission on Standards for School Mathematics (1989), report that the National Council of Teachers of Mathematics (NCTM) recognises the importance of attitudes and states that changes in attitudes of both learners and teachers are critical to the improvement of mathematics education. The NCTM has included goals in their national standards which address the issues of confidence and mathematical disposition. According to Putney & Cass (1998: 628), "attitude change must precede instructional change."

1.2 PROBLEM ANALYSIS

1.2.1 Awareness of the problem

The researcher, a qualified mathematics teacher with eight years experience of teaching extra mathematics, realised that there was more to achievement in mathematics than ability only. During her internship year at the Centre for Child and Adult Guidance, the researcher became increasingly aware of the significant role that affective factors play in learners' achievement in school mathematics. This consequently generated an interest into the degree of influence of affective factors in achievement.

There certainly are many different affective factors that may have an influence on mathematics achievement. The researcher however, directed the research project on attitudes and their influence on mathematics achievement.

1.2.2 Exploration of the problem

Tocci & Engelhard (1991: 280) argue that affective variables are as important as cognitive variables in impacting learning outcomes. As reported by Papanastasiou (2000: 28), Oliver & Simpson (1988) found that affective behaviours in the classroom are strongly related to achievement. According to McLeod (1992: 575), affective issues play a central role in mathematics learning and instruction and there are a

variety of large-scale studies (for example The Second International Mathematics Study) that provide substantially enough information to indicate good reason to be concerned about affective factors.

According to Vanayan, White, Yuen & Teper (1997) cited in Papanastasiou (2000: 28), many studies have examined learners' attitudes and beliefs towards mathematics. Researchers and educators have studied affective differences in conjunction with learner achievement and it has been found that attitudes play important roles in both learning mathematics and in maintaining a continued interest in the subject (Papanastasiou, 2000: 28).

Literature reviews that were studied in a meta-analysis conducted by Ma & Kishor (1997: 26) indicate that little consensus exists in the research literature concerning the relationship between attitude towards mathematics and achievement in mathematics.

In South Africa little research has been done on the relationship between attitudes and achievement in mathematics over different grade levels. A review of the NEXUS Database System reflected nine related studies. Table 1.1 provides a list of such studies. It is evident from the table that this topic is relatively new, and that it will hopefully contribute to the on-going research in this field.

TABLE 1.1

REVIEW OF THESES AND DISSERTATIONS IN SOUTH AFRICA

RESEARCHER	TOPIC	YEAR	PURPOSE
Joseph, J	Attitudes and abilities of mathematics educators towards Curriculum 2005.	1998	M.Ed.
Ismael, A	The effect of the use of cultural games in the teaching of probability on students' performance, motivation and attitudes towards mathematics.	1998	M.Ed.
Cherinda, M	Influences of the weaving board on discovering formulas for the general terms of numerical sequences and on pupils' attitudes towards learning mathematics.	1998	M.Ed.
Roos, M	'n Vergelyking tussen persoonlikheidstrekke van laerskool wiskunde-onderwysers en hulle houding teenoor twee verskillende benaderings in wiskunde.	1998	M.Ed.
Mathe, MM	Attitudes and achievement in Mathematics in Soweto senior secondary schools.	1998	D.Ed.
Monyana, HJ	An intervention programme to improve the self-concept and attitudes of prospective mathematics teachers.	1997	D.Ed.
Cassy, B	Gender performance and attitudes toward mathematics in buscep students at Universidade Eduardo Mondiane.	1996	M.A.
Sibaya, DC	Pupils with learning difficulties in mathematics: a consideration of attitudes, curriculum and methods of teaching.	1996	D.Ed.
Osei, CM	Attitudes towards mathematics and mathematics achievement: A case study of the first year students of junior primary teacher's diploma (JPTD) colleges in Transkei.	1995	M.Ed.

1.3 PROBLEM STATEMENT

The purpose of this research project is to explore the relationship between attitude towards mathematics and achievement in mathematics. To this end, the following main question may be posed:

Is there a relationship between attitudes towards mathematics and achievement in mathematics of South African learners in Grades 7, 9 and 11?

The following attitudes will be measured:

- The learners' confidence in mathematics
- The learners' motivation in mathematics
- The learners' perception of the usefulness of mathematics
- The learners' perception of teachers' behaviour and attitudes

The following questions will also be addressed:

- Do the attitudes differ with each grade level?
- Are there gender differences in attitudes at each grade level?
- Are there ethnic differences in attitudes at each grade level?
- Are there gender differences in achievement at each grade level?
- Are there ethnic differences in achievement at each grade level?

1.4 AIM OF RESEARCH

1.4.1 Specific aim

The aim of this research project is to establish whether there is a relationship between attitudes towards mathematics and achievement in mathematics among learners of Grades 7, 9 and 11, with specific reference to the different grade levels, gender and ethnic groups.

1.4.2 General aim

As noted earlier, the importance of knowledge and competence in mathematics cannot be overemphasised by any society. According to Howie, Marsh, Allummoottil, Glencross, Deliwe, & Hughes (2000: 62), "mathematics education is fundamental to

the development of economic strength." Mathematics is also a critical factor for entry into higher education, career and job opportunities: "Adequate preparation in mathematics is aptly being called the 'critical filter' in the job market" (Visser, 1989: 212).

According to the results of the Third International Mathematics and Science Study (TIMSS), South Africa's achievement test scores were very low in comparison with the other participating countries (Howie, 1997: 10). Based on this study, a few points were noted which need to be attended to regarding mathematical achievement in South Africa. One in particular that was noted, among others, was that there should be emphasis on improving learners' attitudes towards mathematics (Howie et al., 2000: 75).

As reported by Steyn (1999: 66), Windham (1988) states that the effectiveness and efficiency of the school system obviously depends on the actual teaching, managing and administrative processes, *as well as* on the attitudes and achievements of the learners.

Anderson (1994: 389) who discusses measurement of attitudes recommends that "the measurement of attitudes should become more common in schools, particularly since they influence future participation in schooling and subject choice." McLeod (1992: 575) states that affective issues need to occupy a more central position in the minds of researchers.

1.5 DEFINITION OF CONCEPTS

1.5.1 Attitude

The concept *attitude* is a "psychological tendency that is expressed by evaluating a particular entity with some degree of favour or disfavour" (Eagly & Chaiken, 1993: 1).

1.5.2 Attitude towards mathematics

For this research project, an *attitude towards mathematics* is a psychological tendency that is expressed by evaluating mathematics with some degree of favour or disfavour.

This *attitude towards mathematics* is divided into the following four facets:

- Confidence in mathematics
- Motivation in mathematics
- Perception of the usefulness of mathematics
- Perception of teachers' behaviour and attitudes

1.5.2.1 Confidence in mathematics

According to *The Concise Oxford Dictionary* (1996: 279), the term *confidence* is defined as "a firm trust or a feeling of reliance or certainty". For the purpose of this research project, *confidence in mathematics* refers to a learner's certainty or self-reliance in learning mathematics, his or her personal enjoyment of mathematics and the related anxiety when confronted with mathematics.

1.5.2.2 Motivation in mathematics

Grossnickle, Reckzeh, Perry & Ganoe (1983: 18) define *motivation* as "an emotional state that provides the driving force to cause an individual to learn and make the effort to achieve." In this research project, *motivation in mathematics* includes the above idea and thus refers to a learner's willingness to become involved in mathematics and his or her motivation to do more mathematics than is actually required.

1.5.2.3 Perception

The Concise Oxford Dictionary (1996: 1014) defines the term *perception* as "an interpretation or impression based on one's understanding of something".

1.5.2.4 Perception of the usefulness of mathematics

For the purpose of this research project, *perception of the usefulness of mathematics* refers to a learner's perception and/or recognition of the usefulness of mathematics, in other words, it's value, importance and relevance for oneself and for society in general.

1.5.2.5 Perception of teachers' behaviour and attitudes

For the purpose of this research project, a learner's *perception of teachers' behaviour and attitudes* refers to the learner's own interpretation or impression of the teacher's behaviour and attitudes.

1.5.3 Achievement

The Concise Oxford Dictionary (1996: 11) defines *achievement* as "something achieved". For the purpose of this research project, the *something achieved* is regarded as the learner's final second term marks.

1.5.4 Multicultural context

According to Pederson & Carey (1994: 174), multiculturalism consists of a number of widely differing groups to which individuals belong. For the purpose of this research project, a *multicultural context* consists of individuals of different races, languages, cultural groups, faiths and socio-political backgrounds.

1.5.5 Learner

The Concise Oxford Dictionary (1996: 774) defines a *learner* as "a person who is learning a subject or skill." For the purpose of this research project, a *learner* is a person who is learning the subject of mathematics in mainstream education in Grade 7, 9 or 11.

1.5.5.1 Grade 7 learner

Middle childhood ranges from six to twelve years of age. The Grade 7 learner therefore, falls mainly in this stage. Major developments in this age period include the following:

- Peers assume central importance
- Children begin to think logically, although largely concretely
- Egocentrism diminishes
- Memory and language skills increase
- Cognitive gains improve the ability to benefit from formal schooling
- Self-concept develops, affecting self-esteem

- Physical growth slows down
- Strength and athletic skills improve (Papalia & Olds, 1992: 7).

These major developments must be noted as they could influence the learner's attitudes and attitude development. For example, since peers begin to assume central importance in the lives of these learners, it is important to bear in mind that peers can influence attitude development.

Erikson's psychosocial stages of human development are discussed as each stage is precipitated by a 'crisis' that needs to be coped or dealt with, which may in turn affect a child's development as a human being. The researcher hypothesises that the result of dealing with each 'crisis' may affect his or her development of attitudes towards mathematics.

During the middle and late childhood years (six to twelve) the stage of *Industry vs. Inferiority* is reached. During this stage a child is eager to learn. The danger in the elementary school years is a sense of inferiority – feeling incompetent and inadequate (Allen & Santrock, 1993: 236). The researcher believes that if a learner believes he or she is inferior (incompetent or inadequate) in mathematics at this stage, his or her present and future attitudes towards mathematics will be affected. According to the researcher, it is thus important when looking at attitudes, to take cognisance of where the child is in his or her development.

1.5.5.2 Grade 9 and Grade 11 learner

Adolescence ranges from eleven/thirteen years to seventeen/twenty-one years of age. In this research project, the Grade 9 and Grade 11 learners fall into the category of adolescence. Major developments in this age period include:

- Rapid and profound physical changes
- Reproductive maturity
- Search for identity becomes central
- Development of the ability to think abstractly and use scientific reasoning
- Adolescent egocentrism persists in some behaviours
- Peer groups help to develop and test self-concept
- Relationships with parents are generally good (Papalia & Olds, 1992: 7).

During the adolescent years, adolescents enter Erikson's fifth stage of *Identity vs. Identity confusion.* The development of identity involves finding out "who we are, what we are all about, and where we are headed in life" (Allen & Santrock, 1993: 268). The researcher presumes that if an adolescent learner develops a certain academic identity towards mathematics, it may influence his or her attitude. For example, a child who has been struggling with mathematics for a while will eventually develop and identity of 'I am a struggler with mathematics.' This identity will hence certainly influence his or her attitude towards mathematics.

1.5.6 Gender

For the purpose of this research project, the term *gender* is used to indicate whether a learner is either male or female.

1.5.7 Ethnicity

The Concise Oxford Dictionary (1996: 463) defines the term *ethnic* as "relating to a race or culture". Byrne (1996: 47) refers to *ethnicity* as "a common cultural tradition and sense of identity that defines a subgroup of individuals within a larger society". Santrock (1992: 73) defines *ethnicity* as "based on a cultural heritage, nationality characteristics, religion and language". Davey (1994: 130) adds that members of a group are set apart or set themselves apart by various distinguishing features such as language, music, etc. For the purpose of this research project, the term *ethnicity* therefore, refers to different subgroups of people which are set apart by differing home languages.

1.6 RESEARCH REPORT

This research project is organised into the following chapters:

Chapter 1: Introductory orientation

Chapter 1 provides an introduction into the context in which the research was undertaken. The purpose of the research, aims and definitions of some of the concepts are presented.

CHAPTER 2

LITERATURE REVIEW: ATTITUDES

Attitudes are everywhere and everything in life! You simply can't go through a single day without them. Your attitude today creates your actions, which produce your results.

(Yanna, 1996: 3)

Chapter 2: Literature review: Attitudes

Chapter 2 provides a literature review of attitudes, namely definitions, development, functions and attitudes in relation to behaviour. Mathematical attitudes are also discussed.

Chapter 3: Literature review: Achievement

Chapter 3 briefly reviews some of the factors affecting achievement in this research project. Literature of previous research studies on the relationship between attitude and mathematics achievement is also discussed.

Chapter 4: Research design

Chapter 4 explains the manner in which the research was carried out.

Chapter 5: Empirical research

Chapter 5 presents and discusses the results of the research project.

Chapter 6: Findings, conclusion and recommendations

Chapter 6 summarises findings and provides recommendations.

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CHAPTER 2

LITERATURE REVIEW: ATTITUDES

2.1 INTRODUCTION

Attitudes have been the focal point of research for many years. The attitude concept has remained in wide use in social psychology and has been the focus of extensive theoretical and empirical development since the 1920's (Eagly & Chaiken, 1993: 1). Gordon Allport once referred to attitude as "the most distinctive and indispensable concept in contemporary social psychology" (Petty, Wegener & Fabrigar, 1997: 2). The statement made by Allport may be as valid today as it was fifty years ago. This is due to the fact that people's evaluations of social policies such as abortion, feminism, political conservatism etc. - which have major consequences in their social environments – are often based on collective attitudes toward these social policies.

As shown in Chapter 1, mathematics achievement can significantly influence a person's career path – either positively or negatively. Therefore, a learner's evaluation of mathematics and consequent attitudes towards mathematics and the hypothesised negative or positive consequences on achievement, would certainly influence his or her future.

This chapter is divided into two sections: The first section involves a literature review around the theory of attitudes. Definitions of attitudes, development of attitudes, functions of attitudes and the relation between attitudes and behaviour is discussed. In the second section of the chapter, attitudes are related to mathematics. A definition that is used specifically for this research project is presented, and other factors related to attitude and mathematics are discussed.

2.2 DEFINING ATTITUDE

Attitudes have been defined in a variety of ways over time. Fishbein & Ajzen (1975: 1) have asserted that the term is characterised by an embarrassing degree of ambiguity and confusion. The following serves as an illustration of the various definitions of the concept attitude that have been produced over time (cited in Fishbein, 1967: 7):

- [An attitude is] readiness for attention or action of a definite sort (Baldwin, 1901 – 1905).

- An attitude is a complexity of feelings, desires, fears, convictions, prejudices or other tendencies that have given a set or readiness to act to a person because of varied experiences (Chave, 1928).

- [An attitude] denotes the general set of the organism as a whole toward an object or situation which calls for adjustment (Lundberg, 1929).

- An attitude is a tendency to act toward or against something in the environment which becomes thereby a positive or negative value (Bogardis, 1931).

- ...a more or less permanently enduring state of readiness of mental organisation which predisposes an individual to react in a characteristic way to any object or situation with which it is related (Cantril, 1934).

- Attitudes are literally mental postures, guides for conduct to which each new experience is referred before a response is made (Morgan, 1934).

- An attitude is a mental and neural state of readiness, organised through experience, exerting a directive or dynamic influence upon the individual's response to all objects and situations with which it is related (Allport, 1935).

Oskamp (1991: 7) pointed out various common aspects that were present in various definitions:

- Attitude as a mental set or disposition
- Attitude as a readiness to respond
- The physiological basis of attitudes
- Their permanence
- Their learned nature
- Their evaluative nature

The Concise Dictionary of Education (1982: 19) defines attitude as "a general disposition or mental set with regard to any persons, beliefs, or other entities".

The Concise Oxford Dictionary (1996: 80) defines attitude as "a settled opinion or way of thinking" with "behaviour reflecting this."

Kerlinger (1984) as cited in Abu-Hilal (2000: 76) defines attitudes as "enduring and organised structures of social beliefs that predispose an individual to think, feel, perceive and behave selectively toward referents or cognitive objects".

According to the *Dictionary of Empirical Education* (1988: 26), attitudes prepare people for action, are learned from experience, and exert a motivating force on behaviour. They are cognitively and emotionally toned dispositions, acquired through maturation and experience and they influence a person's approach-avoidance behaviour toward persons, objects, events and ideas. All attitudes are learned consciously or unconsciously and usually become stronger and long lasting. Some attitudes may be modified or discarded. An attitude always involves a relationship and will ultimately involve a certain disposition or action. The cognitive component is the factual information one has and the affective component is the emotion associated with the attitude.

Tesser & Shaffer (1990: 481) state that attitudes are evaluations based on beliefs, feelings and/or past behaviour. They also state that the primary purpose of holding an attitude is object appraisal, i.e. making evaluative judgements about an attitude object that will have clear behavioural implications.

Aiken (1994: 230) states that an attitude is a learned predisposition to respond positively or negatively to a certain object, situation, institution, or person. As such, it consists of cognitive (knowledge or intellective), affective (emotional and motivational), and behavioural (performance or action) components. Ruffell, Mason & Allen (1998: 2) state that attitude is a multi-dimensional construct with three interwoven components, namely: cognitive, affective and conative.

According to Petty, Wegener & Fabrigar (1997: 2), the notion of evaluation is at the core of the concept attitude. Attitudes are thus commonly viewed as summary evaluations of objects (e.g. oneself, other people, issues etc.) along a dimension ranging from positive to negative.

Eagly & Chaiken (1993: 1) state that an "attitude is a psychological tendency that is expressed by evaluating a particular entity with some degree of favour or disfavour." For the purpose of this research project, this definition is used as a basic definition.

According to Eagly & Chaiken (1993: 3), their definition has certain advantages in that it encompasses attitudes that are "learned and others that may not be learned, attitudes that are enduring or changeable, and attitudes that are important or unimportant". Eagly & Chaiken (1993: 3) state that although it is many theorists' assumption that attitudes are learned they however, decided it is best not to include this in the definition, since it has been suggested that some attitudes may arise from genetic sources (see paragraph 2.3.3).

For the purpose of better understanding, this definition is best understood in its parts.

2.2.1 Attitude as a psychological tendency

A psychological tendency refers to a state that is internal to the person. It predisposes an individual toward responding evaluatively. This internal state lasts for at least a short time.

2.2.2 Attitude object

Entities that are evaluated are known as attitude objects. Virtually anything can be evaluated and therefore, function as an attitude object. Some attitude objects are abstract (e.g. liberalism), and others are concrete (e.g. a particular person, a chair). Behaviours (e.g. playing volleyball) and classes of behaviours (e.g. participating in athletic events) can also function as attitude objects. In this research project, the subject of mathematics can be regarded as an attitude object.

2.2.3 Evaluation

Evaluation is defined as the attribution of some degree of goodness or badness to an entity. An attitude cannot develop until the person responds evaluatively to an entity and therefore, an attitude develops on the basis of an evaluative response. Evaluations can be divided into three classes or components:

- **Cognitive component**

The cognitive category contains *thoughts* that people have about the attitude object. These thoughts are often conceptualised as beliefs, where beliefs are understood to be associations or linkages that people establish between the attitude object and various attributes (Eagly & Chaiken, 1993: 11).

- **Affective component**

Evaluative responses of the affective type consist of *feelings, moods, and emotions* that people experience in relation to attitude objects. The affective responses can range from being extremely positive to extremely negative.

- **Behavioural component**

Evaluative responses of the behavioural type may consist of *overt actions* that people exhibit in relation to the attitude object and also *intentions* to act that are not necessarily expressed with overt behaviour.

Evaluating therefore, refers to all classes of evaluative responding, whether overt or covert, cognitive, affective, or behavioural. These evaluations can differ in direction as well as intensity. For example, they can express approval or disapproval, favour or disfavour, liking or disliking, approach or avoidance, attraction or aversion, or similar reactions.

2.2.4 Expression of an attitude

Attitudes themselves are not directly observable but can be inferred from observable responses. The responses are elicited in conjunction with particular stimuli which serve as attitude objects.

The energy from one's thoughts and feelings may compel one to communicate one's attitude through words and/or actions. One can communicate one's attitude in three different ways:

- The words one uses (what one says, and, what one does not say)
- The tone of voice one uses (how one says what one says)

- Body language and facial expressions (what one does) (Yanna, 1996: 18).

Listed below are some of the most common words conveyed by a positive, negative and neutral attitude as reported by Yanna (1996: 19):

- **Positive language:**

* I can (do mathematics)
* I will (do my mathematics homework)
* I expect it
* I will make it
* Positively
* I'm sure
* I choose to
* Go

- **Negative language:**

* I can't (do mathematics)
* I won't
* No way
* I don't have time (for mathematics)
* Not
* I'm afraid (of mathematics)
* You made me
* Stop

- **Neutral language:**

* I don't want to (try)
* I might (fail mathematics)
* I doubt it
* I'll see if I have time
* Maybe (I'll do my homework)
* I don't know
* I didn't

2.2.5 Antecedents of attitudes

"Consonant with the idea that attitudinal responses can be divided into three classes is the assumption that attitudes have three different types of antecedents. The idea that attitudes are formed through cognitive, affective and behavioural processes has been proposed in numerous discussions of attitudes" (Eagly & Chaiken, 1993: 14).

- **Cognitive learning process as antecedent**

A cognitive learning process is assumed to occur when people gain information about an attitude object and thereby form beliefs. Information is gained by direct or indirect experience with the attitude object (Eagly & Chaiken, 1993: 14).

- **Affective process as antecedent**

The assumption that attitudes are formed through an affective process states that an attitude is a product of the pairing of an attitude object (conditioned stimulus) with a stimulus that elicits an affective response (unconditioned stimulus). As a result of repeated association, the attitude object comes to elicit the affective response, and an attitude is thereby formed (Eagly & Chaiken, 1993: 15).

- **Behavioural responses as antecedents**

As reported by Eagly & Chaiken (1993: 16) the idea that evaluations are based on behavioural responses is central in research by Bem (1972), who argues that people tend to infer attitudes that are consistent with their prior behaviour. Bem (1972) also argues that people take into account the conditions under which they perform behaviours, with the result that they form attitudes more readily on the basis of behaviour when they do not think that external forces compelled them to engage in the behaviour.

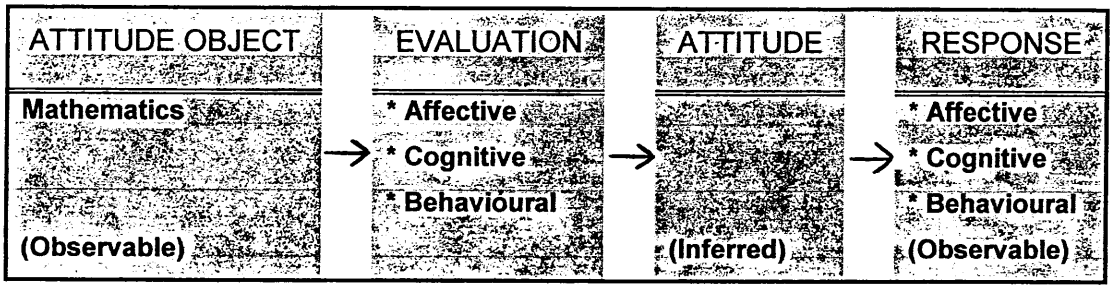
2.2.6 Implications of cognitive, affective and behavioural components as evaluative responses *and* antecedents to attitudes

A question may now arise as to whether attitudes must have all three aspects, either at the point of attitude formation or at the point of attitudinal responding. The answer to this question is *no* (Eagly & Chaiken, 1993: 16).

Attitudes can be formed primarily or exclusively on the basis of any one of the three types of processes. It is not universal that all people respond to attitude objects by cognitive, affective and behavioural reactions.

People may hold beliefs about an attitude object but never engage in overt behaviour with respect to it. Similarly, people may not have emotional reactions to an attitude object. Other attitudes may be emotion laden or action inducing in the sense that they induce primarily affective or behavioural responses.

The process of attitude can be represented graphically as follows:



2.3 DEVELOPMENT AND FORMATION OF ATTITUDES

There are a number of ways in which a person acquires certain attitudes. Baron & Byrne (1994: 131) reports that attitudes can be acquired through the following sources:

- Social learning
- Direct experience
- Genetic factors

Oskamp (1991: 160) reports other factors that influence the development of attitudes: the role of parents, schools, peer groups, mass media and persuasion.

2.3.1 Social learning

Attitude formation through social learning implies that many of our views are formed from situations in which we interact with others or observe their behaviour.

- **Classical conditioning**

One source of attitude development is through the process of classical conditioning. It is a basic principle of psychology that when one stimulus regularly precedes another, the one that occurs first may soon become a signal for the one that occurs second. In other words, when the first stimulus is presented, individuals come to

expect that the second will follow. As a result, they may gradually show the same kind of reactions to the first stimulus as they do to the second, especially if the second stimulus is one that induces fairly strong reactions when encountered (Baron & Byrne, 1994: 132). Krosnick, Betz, Jussim, and Lynn (1992) cited in Baron & Byrne (1994: 133) conducted research and provided evidence that subliminal conditioning of attitudes is also possible.

- **Instrumental conditioning**

A second way in which attitudes may be acquired from others is through the process of instrumental conditioning. Behaviours which are followed by positive outcomes are strengthened and will tend to be repeated. Therefore, by rewarding a child with smiles, agreement or approval for stating the 'right' views, a parent is playing an active role in shaping the child's attitudes (Baron & Byrne, 1994: 135).

- **Modelling**

Another way in which attitudes are acquired is through the process of modelling. Individuals acquire new forms of behaviour and views through observation of other people's behaviour. For example, if a child were to see his/her mother react a certain way when encountering a certain object, place or being, the child might gradually come to adopt the same behaviour as his/her mother in similar circumstances and thus develop an attitude towards these objects.

2.3.2 Direct experience

Attitudes are also acquired through direct personal experience. As reported by Baron & Byrne (1994: 136), Fazio & Zanna (1981) are of the opinion that research findings suggest that attitudes formed through direct experience are stronger than ones formed through social learning.

2.3.3 Genetic factors

According to Petty, Wegener & Fabrigar (1997: 5), a recent development in attitude research is the recognition among some psychologists that attitudes can have some genetic basis.

Baron & Byrne (1994: 136) are of the opinion that the idea of genetic factors influencing attitudes is a little easier to imagine if one remembers that thought occurs within the brain and that a person's brain structure, like every other part of our physical being, is certainly influenced by genetic factors.

McGuire (1985) cited in Oskamp (1991: 156) is of the opinion that the most plausible way that genetics might operate in attitude formation is in the process where they might establish a predisposition for the development of particular attitudes. Waller, Koietin, Bouchard, Lykken & Tellegen (1990) cited in Baron & Byrne (1994: 137) stated that most research involves comparisons between identical (monozygotic) and nonidentical (dizygotic) twins. The attitudes of identical twins correlate more highly than those of nonidentical twins.

Needless to say, this research can be questioned on several grounds. For example, twins are an unusual group and therefore, results cannot always be generalised to other groups of people. It is however, hard to ignore the findings and it appears therefore, that some of our attitudes are possibly influenced – at least to a degree – by genetic factors (Baron & Byrne, 1994: 136).

2.3.4 Parental influence

According to Oskamp (1991: 160), parents have great power in shaping a child's attitudes, particularly since the infant has no pre-existing attitudes which would be contrary to the parental influence. A child's attitudes are largely shaped by the child's own life experiences but much of these experiences are comprised of explicit teaching and implicit modelling of parental attitudes.

2.3.5 School

Second to parental influences in determining children's attitudes is school teaching and indoctrination (Oskamp, 1991: 164).

2.3.6 Peer group

Another major determinant of attitudes is the child's peer group. Youniss (1980) cited in Oskamp (1991: 165) states that where peer group norms agree with parental or school standards, previously existing attitudes and values may be strengthened.

Peers however, also frequently introduce and reinforce new viewpoints, attitudes, and behavioural patterns (Yankelovich, 1981 cited in Oskamp, 1991: 165).

2.3.7 Mass media

Newspapers, magazines, books, movies, radio and television unquestionably have an enormous impact on society and therefore, on people's beliefs and attitudes.

2.4 FUNCTIONS OF ATTITUDES

Katz (1960) cited in Eagly & Chaiken (1993: 19) states that attitudes serve four functions:

- Knowledge function
- Adjustment or utilitarian function
- Ego-defensive function
- Value-expressive function

2.4.1 Knowledge function

The knowledge function involves the idea that attitudes allow people to organise and simplify their experiences. Katz (1960) cited in Eagly & Chaiken (1993: 19) believes that people make sense out of, and understand their experience using their attitudes.

2.4.2 Adjustment or utilitarian function

The adjustment or utilitarian function presumes that attitudes enable people to maximise rewards in their environment and to minimise punishments by means of the tendency for people to form favourable attitudes toward stimuli associated with satisfaction of needs, and unfavourable attitudes toward stimuli associated with punishment.

2.4.3 Ego-defensive function

According to Katz's (1960) ego-defensive function, attitudes also enable people to protect themselves from unpleasant realities. Attitudes are held because they help people protect themselves from unflattering truths about themselves or others who

are important to them. For example, by despising homosexuals, some men are able to enhance their own feelings of masculinity and self-worth (Petty & Cacioppo, 1981: 8).

2.4.4 Value-expressive function

According to the value-expressive function, attitudes allow people to express their personal values and self-concept.

2.5 ATTITUDES AND BEHAVIOUR

One would think that attitudes and behaviour are often closely linked and that the one would lead to the other. The assumption may for example be: a positive attitude towards mathematics would lead to positive study behaviour in mathematics. This is not always the case. The relationship between attitude and behaviour is far more complex and the strength of the relation between them is determined by various factors. The following factors determine the strength of the attitude-to-behaviour link, in other words, when attitudes might lead to behaviour:

- **Attitude specificity**: Specific attitudes are better predictors of overt behaviour than more general attitudes (Baron & Byrne, 1994: 138). For example, an attitude of disliking factorisation in mathematics is more specific that an attitude of disliking mathematics as a whole.

- **Attitude components:** The components (cognitive, affective, and behavioural) are not always highly consistent and therefore, when inconsistency arises, one of them may be more closely related to specific forms of behaviour than the other. It is the one that is more closely related, that is the best predictor of behaviour (Baron & Byrne, 1994: 138).

- **Attitude strength:** Stronger attitudes predict behaviour better than weaker attitudes. Stronger attitudes are formed through direct experience with the attitude object.

- **Vested interest:** When a certain event, object or issue has a strong effect on a person's life, the strength between attitudes and behaviour increases.

- **Self-awareness:** Heightened self-awareness increases the degree of consistency between privately held attitudes and overt behaviour. According to Hutton & Baumeister (1992) cited in Baron & Byrne (1994: 139), there are two reasons for this:
    (1) Self-awareness increases access to our own attitudes and the more readily we can bring our attitudes to mind, the greater the possibility of attitudes affecting behaviour.
    (2) Self-awareness can bring attitudes more sharply into focus and guide behaviour when overt behaviour is required.

- **Attitude accessibility:** This term refers to the ease with which specific attitudes can be recalled from memory and brought into consciousness where they can influence and guide behaviour. According to the 'Attitude Accessibility Model' proposed by Fazio (1989) cited in Baron & Byrne (1994: 140), the ease with which attitudes can be retrieved from memory plays a key role in the attitude-to-behaviour link. When the evaluation readily comes to mind in the presence of the attitude object, the behaviour is likely to be quite consistent with the evaluation. On the other hand, attitudes that are less accessible tend to play a less important role in guiding behaviour (Fazio & Williams, 1986 cited in Baron & Byrne, 1994: 141). Two factors seem to affect the ease of attitude accessibility:
    1) Direct experience with the attitude object. Attitudes formed through direct experience with the attitude object are strong.
    2) The frequency of expression. Attitudes expressed more frequently will be brought to consciousness more readily.

From the above, it seems evident that attitude strength, specificity, vested interest and self-awareness all influence accessibility of an attitude. Therefore, the kinds of attitudes that are closely related to behaviour are the ones that are most accessible. For example, the attitudes which are strong, specific, and personally relevant (Krosnick, 1989 cited in Baron & Byrne, 1994: 142).

2.6 ATTITUDES AND MATHEMATICS

2.6.1 The Influence of affect on mathematics learning

According to McLeod (1992: 578), there appears to be at least three major facets of learners' affective experiences:

- First, learners hold certain beliefs about mathematics and about themselves that play an important role in the development of their affective responses to mathematical situations.

- Second, since interruptions and blockages are an inevitable part of the learning of mathematics, learners will experience both positive and negative emotions as they learn mathematics.

- Third, learners will develop positive or negative attitudes toward mathematics (or parts of the mathematics curriculum) as they encounter the same or similar mathematical situations repeatedly.

2.6.2 Defining an attitude towards mathematics

As stated earlier, researchers assume different definitions of the term *attitude* and consequently also the term *attitude towards mathematics*. The Third International Mathematics and Science Study (TIMSS) used the concept *attitude* as a mental concept that depicts favourable or unfavourable feelings toward an object. Therefore, statements such as 'I like mathematics' or 'I enjoy mathematics' were defined as attitudes (Papanastasiou, 2000, 28).

As stated earlier, the definition of Eagly & Chaiken (1993: 1) is used as a foundation for the definition used in this research project as it is comprehensive. The definition of a mathematical attitude can therefore, be stated as follows:

Attitude towards mathematics is a psychological tendency that is expressed by evaluating mathematics with some degree of favour or disfavour.

According to Anderson (1981) cited in Ma (1997: 224), the multiplicity of meaning given to the concept of attitude towards mathematics is the primary culprit of the inconsistencies in the literature on attitude towards mathematics. According to Aiken (1970: 28), a reasonable solution to the problem of inconsistencies in the literature on attitude towards mathematics is to measure attitude toward specific mathematical activities rather than a generalised attitude towards mathematics.

Some researchers define attitude more specifically by dividing it into various facets. For example, Neale (1969) cited in Ma & Kishor (1997: 27) defines attitude toward mathematics as an aggregated measure of a "liking or disliking of mathematics, a tendency to engage in or avoid mathematical activities, a belief that one is good or bad at mathematics, and a belief that mathematics is useful or useless". Ma & Kishor (1997: 26) extend Neale's definition to include learners' affective responses to the 'easy/difficult' scale of mathematics as well as the 'importance/unimportance' scale of mathematics.

According to McLeod (1992: 581), there are many different kinds of mathematics, for example, algebra and geometry and consequently, a variety of feelings develop about each type of mathematics. Kloosterman (1994: 3640) notes that it is important to remember that affective reactions in mathematics vary with the content of the mathematics being taught.

Due to the fact that this research project focuses on learners attitudes at different grade levels, measuring attitudes towards different content areas in mathematics will not be possible. The concept 'attitude towards mathematics' is however, divided into various facets. *Attitude towards mathematics* is therefore, divided into the following facets:

- Confidence in mathematics
- Usefulness of mathematics
- Motivation in mathematics
- Perception of teachers' attitudes

2.6.3 Development of attitudes towards mathematics

According to McLeod (1992: 581), attitudes towards mathematics appear to develop in two different ways:

(1) Mandler (1989) cited in McLeod (1992: 581) states that attitudes may result from the automatising of a repeated emotional reaction to mathematics. For example, if a learner believes that story problems should make sense and should have a reasonable answer than can be obtained in a minute or two, and the learner is unable to obtain a satisfactory answer in a reasonable time, the failure to solve the problem will likely lead to some arousal. The interpretation of this arousal is likely to be negative. If negative reactions to story problems occur repeatedly, the response to story problems will eventually become automatic and stable. In this situation the learner would develop a negative attitude toward story problems.

(2) Another way attitudes towards mathematics develop is through the assignment of an already existing attitude to a new but related task. For example, a learner who has a negative attitude toward geometric proofs may attach the same attitude to proofs in algebra.

The study of Poffenberger & Norton (1959: 171-176) is of interest. Based on research conducted with first year and college learners' impressions and recollections, they concluded that attitudes toward mathematics are a culminative phenomenon, and that one experience builds on another. Poffenberger & Norton (1959: 175) are of the opinion that attitudes are developed in the home and in some cases before the child enters school. In the first and second grades the child is affected by his teachers, his mathematical readiness and by the attitudes of his parents. The child carries these attitudes that have been formed through the grades into secondary school. Mudeliar (1987: 3) also concludes that attitudes are developed in the home and in some instances before the child begins school. Parents who have been negatively conditioned towards mathematics by both their own parents and by the school in turn transfer these feelings to their children.

Based on a study conducted by Aiken (1986: 4538-4544), he concludes that attitudes towards mathematics begin developing as soon as children are exposed to the subject. Callahan (1971) cited in Aiken (1976: 296) conducted similar research and concluded that although lasting attitudes are developed at each grade level, the late elementary grades and the junior secondary grades are of greatest importance in developing attitudes.

Sherman & Christian (1999: 97) state that some researchers, for example, Peterson & Fennema (1985) and Williams (1988) suggest that the development of a poor attitude towards mathematics develops primarily from the relationship between learners and their teachers. Klebanov & Brooks-Gun (1992: 97) point out that parents as well as teachers are important socialisers of attitudes. According to Stuart (2000: 331), family and peer attitudes may positively or negatively influence learners' attitudes towards mathematics.

Citing the work of Duranczyk (1997), Higbee & Thomas (1999: 13) state that many learners who have negative attitudes towards learning mathematics have had these attitudes for a long time, often going back to some precipitating event or particularly negative experience.

2.6.4 Factors affecting the development of attitudes towards mathematics

- **Parents**

Poffenberger & Norton (1959: 171) state that parents affect the child's attitudes and achievement in three ways:

1. By parental expectations of their child's achievement
2. By parental encouragement
3. By the parents' own attitudes

According to Klebanov & Brooks-Gunn (1992: 94), parental expectations of their children's achievement in mathematics are not only found to be significantly related to learners' achievement in mathematics, but also to learners' self-expectations, self-concepts and attitudes regarding mathematics. Phillips (1987) and Parsons, Adler & Kaczala (1982) cited in Jacobs (1991: 518) state that parents' beliefs about children's abilities have been found to have an even greater influence on children's achievement attitudes than does previous achievement.

Tocci & Engelhard (1991: 285) are of the opinion that adolescents' perceptions of their parents' reactions to mathematics and the amount of encouragement from their parents to study and perform well in mathematics, affects their attitudes towards mathematics. It was thus concluded that parental behaviours appear to be related to learner attitudes towards mathematics (Tocci & Engelhard, 1991: 285).

- **Teachers**

According to Aiken (1970: 572), the results of research suggest that the teacher, perhaps even more than the parents, is an important determiner of learner attitudes. Capps & Cox (1969) cited in Addleman (1972: 17) state that there is evidence to support the fact that a positive correlation exists between the attitudes teachers possess, and the attitudes their learners acquire.

Dungan & Thurlow (1989: 10) believe that learners derive their attitudes from those of their teachers and therefore, if teachers hold negative attitudes towards mathematics so do their learners. This in turn adversely affects learners' achievement in mathematics. According to Ruffell, Mason & Allen (1998: 1), the teachers' attitude towards mathematics is increasingly put forward as a dominant factor in learners' attitudes towards mathematics. Putney & Cass (1998: 627) add: "Negative, non-productive attitudes held by teachers can be transferred to their students directly or indirectly by comments, actions, and omissions."

In addition to the research that teachers' attitudes' towards the subject influence learners' attitudes, Sayers (1994: 397) is of the opinion that teachers' attitudes towards the learners themselves *also* influence the learners' attitudes towards mathematics.

The learners' perceptions of teachers' attitudes influences the learners' attitudes towards mathematics (Putney & Cass, 1998: 628). According to Mudeliar (1987: 40) and Dungan & Thurlow (1989: 9), a learner's like or dislike of a teacher may also influence him or her towards that subject.

The following statement serves as a conclusion to the above: "Teachers may have a strong positive or negative influence on students' attitudes and achievement in mathematics. In some situations, the teacher may build upon positive attitudes already established by the parents, and may create an even stronger interest and higher achievement in mathematics. Conversely, by having a negative attitude towards mathematics, teachers may be contributing to a student's lack of achievement" (Kolstad & Hughes, 1994: 45).

- **Peer group**

According to research conducted by Dungan & Thurlow (1989: 10) and Masqud & Khalique (1991: 377), the peer group's attitudes towards mathematics were significantly related to the learners' attitudes towards mathematics and their mathematics achievement. Campbell & Mandel (1990: 65) found that the peer group reinforces socio-psychological forces like perceived usefulness of a subject. Marsh (1989: 193) is of the opinion that sex-role stereotypes like viewing mathematics as a male domain are drawn from the peer group.

- **Conclusion**

The following statement serves as an applicable conclusion to the above ideas: "An unhealthy attitude toward arithmetic [mathematics] may result from a number of causes. Parental attitude may be responsible...Repeated failure is almost certain to produce a bad emotional reaction to the study of arithmetic [mathematics]. Attitude of his or her peers will have their effects upon the child's attitude. But by far the most significant contributing factor is the attitude of the teacher. The teacher who feels insecure, who dreads and dislikes the subject, for whom arithmetic [mathematics] is largely rote manipulation and devoid of understanding, cannot avoid transmitting her feeling to the children...On the other hand, the teacher who has confidence, understanding, interest, and enthusiasm for arithmetic [mathematics] has gone a long way toward insuring success" (Banks, 1964 cited in Aiken, 1970: 589).

2.6.5 Attitudes related to mathematics

Dossey, Mullis, Lindquist & Chambers (1988) cited in McLeod (1992: 576) report that in the United States learners become less positive about mathematics as they proceed through school. Both confidence about and enjoyment of mathematics appear to decline as learners move from elementary school to secondary school.

Aiken (1986) cited in Cheung (1988: 209) asserts that during the junior secondary years (ages eleven to thirteen) negative attitudes towards mathematics become noticeable. It is not clear whether the increase in negative attitudes at this stage of development is due to greater abstractions of the mathematical material to be learned, or to social factors, gender preoccupations or to some other factors (Cheung, 1988: 210).

Costello (1991: 123) reports that Assessment of Performance Unit (APU) surveys included extensive information about children's attitudes, both to mathematics as a whole and to different topics within mathematics. The following was found:

- In comparison between different school subjects, mathematics usually occupies a low position on the liking scale. However, a large proportion of learners are identified as believing mathematics to be useful.

- Amongst eleven-year-old children, faith in the usefulness of mathematics is well established, but other aspects of attitudes towards mathematics are less consistent. Liking and difficulty are not so much associated with the whole subject but rather with specific activities, topics and forms of presentation which occur in mathematics lessons. There is little identifiable difference in attitude between males and females at this stage.

- During the secondary school years, attitudes towards mathematics deteriorate amongst all groups of learners. Mathematics is accepted as being useful, but learners become more inclined to dislike mathematics and describe it as being hard. In all these dimensions, the deterioration is more pronounced amongst females than amongst males.

According to Sherman & Christian (1999: 96), a poor attitude toward the discipline is thought to plague learners at every level of schooling.

2.6.6 Gender differences in attitudes towards mathematics

According to Tocci & Engelhard (1991: 280), gender differences in attitudes towards mathematics have been reported in several studies. Results of various studies will be discussed with specific reference to confidence in mathematics, perceived usefulness of mathematics and motivation in mathematics.

Eccles (1984) cited in Iben (1991: 141) states that during the elementary years males and females report about equal confidence in their mathematics ability. Of the secondary school learners, fewer females than males consider themselves 'good at mathematics' (Dossy, Mullis, Lindquist & Chambers, 1988 cited in Iben, 1991: 141). A study conducted by Steinback & Gwizdala (1995: 36-41) into gender differences in

mathematics attitudes (specifically confidence in mathematics) indicated that 58% of males as compared to 48% of females said they were good at mathematics. Meyer & Koehler (1990: 61) summarised a number of quantitative studies of self-confidence and noted that gender differences favouring males are commonly found on self-confidence measures.

Meyer & Koehler (1990: 61) also found that studies of secondary school learners show that when male learners have higher achievement, they also see mathematics as being more useful than female learners do. Tocci & Engelhard (1991: 284) carried out a study where small, but significant gender differences occurred in attitudes towards mathematics in mainly two areas – perceived usefulness of mathematics to society and anxiety about mathematics. The Fourth NAEP Mathematics Assessment reported that secondary learners viewed mathematics as important in society, but less important for themselves (Brown, Carpenter, Kouba, Lindquist, Silver & Swafford, 1988 cited in Steinback & Gwizdala, 1995: 38). According to Iben (1991: 142), Chinese and Japanese children find mathematics a much less enjoyable subject than children in the United States but they believe that mathematics is a more helpful subject than the United States children.

A study conducted by Shashaani (1995: 32-38) which examined the extent to which attitudes towards mathematics differ for males and females, indicated that gender differences exist. Males continued with more mathematics than females. Females were less interested in mathematics and had less confidence in their ability in mathematics. A study carried out in (west) German secondary schools indicated that there are gender differences in interest in mathematics, importance of high attainment in mathematics and willingness to consider entering a career involving mathematics and mathematical activities (Kaiser-Messmer, 1993: 209).

Visser (1989: 213) reports that in a study carried out by the Human Sciences Research Council (HSRC) during 1981, it was found that the attitudes of females become more negative in the period between Grade 7 and Grade 9. They become more anxious about their mathematics studies, begin to doubt the usefulness of the subject for their personal futures, and display considerably less confidence and enjoyment with regard to mathematical activities. Their interest in the subject wanes and they are consequently not interested in the challenge of mastering mathematical skills. No such pattern of increasingly negative attitudes was found for males. The

attitudes of males were consistently more positive towards mathematics. Few gender differences in attitudes were found among the Grade 11 learners.

2.6.7 Perceptions of the nature of mathematics

Another aspect of attitudes is people's perception of what mathematics is. People have different ideas about what mathematics is and this will influence their attitude towards mathematics. The following are a few perceptions of mathematics cited in Costello (1991: 125):

- Mathematics is a set of facts and standard rules that need to be learned, often by rote, and remembered. Correct methods and procedures and ways of setting things out are all important, as is precision in the use of language and symbolism.

- Mathematics is a way of understanding the real world better: it provides frameworks and models to describe reality and enables us to solve problems in these real situations.

- Mathematics is about recognising and classifying structures and patterns and relationships.

- Mathematics is the ability to use calculators, microcomputers and other technological aids.

- Mathematics provides a means of communication, which is powerful, concise and unambiguous.

According to Costello (1991: 126), it seems as though people's perceptions of mathematics are formed by their experiences of learning the subject. Therefore, many regard the subject as a collection of established knowledge and procedures, calculations, proofs and standard methods. It is either seen as a school subject or as a set of utilitarian skills which are needed for adult life. It is rarely seen as an activity that is interesting and worthwhile in itself such as literature, music, art, and craft, which is pursued for intrinsic satisfaction. A common perception of mathematics is

that it is closely associated with failure, and that being bad at mathematics is quite acceptable.

The utilitarian value of mathematics is one of the most recognised attributes. This perception leads to the recognition that some kind of qualification in the subject is an essential ticket to many careers or courses of higher education (Costello, 1991: 126).

2.7 CONCLUSION

The concept *attitude* and the term *attitude towards mathematics* have been defined in a variety of ways. Based on the literature review, the researcher decided that the definition of *attitude* provided by Eagly & Chaiken (1993: 1), is useful as a basis definition because of its comprehensiveness. The researcher subsequently formulated a definition specifically for this research project. Thus, when using the term *attitude towards mathematics* the researcher refers to *a psychological tendency that is expressed by evaluating the subject of mathematics with some degree of favour or disfavour.* This attitude is divided into the following four facets:

- Confidence in mathematics
- Perception of the usefulness of mathematics
- Motivation in mathematics
- Perception of teachers' attitudes

It is hypothesised that a learners' attitude towards mathematics (specifically the four areas that are to be measured) relate to achievement in mathematics.

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CHAPTER 3

LITERATURE REVIEW: ACHIEVEMENT

3.1 INTRODUCTION

According to Steen (1987: 251), mathematics is a foundation discipline for science and therefore, the state of mathematics education is a crucial predictor of future national strength and economic competitiveness. Howie, Marsh, Allummoottil, Glencross, Deliwe & Hughes (2000: 64) state that South Africa's ability to compete in the global economy is directly dependent on its capacity as a nation to understand, harness and develop technology. This technological sophistication is dependent upon mathematical competence. Rech & Stevens (1996: 346) state that given the increasingly technological nature of our society, deficits in the area of mathematics lessens the ability of people to compete for jobs, pursue careers that require prerequisites in mathematics, or attend institutions of higher learning. According to Visser (1989: 212), achievement in school mathematics is one of the best predictors of success in tertiary studies.

Given the key role of mathematics in tertiary education and in most vocations, this subject has become an area of concern among both parents and teachers. Achievement in mathematics is often the subject of discussion between learners, teachers and parents. Many thousands of parents are concerned and sometimes disappointed about their children's achievement in mathematics. Poor achievement in this subject area seems to prevail in South Africa.

"Pupils' poor results were and still are common in mathematics and science subjects" (Sibaya & Sibaya, 1997: 9). According to results of the Third International Mathematics and Science Study (TIMSS), South Africa's achievement test scores for Grade 7, Grade 8 and Grade 12 were very low in comparison with those of other participating countries. There were 45 participating countries with more than 500 000 learners involved (Howie, 1997: 10).

Arnott, Kubeka, Rice & Hall (1997: 12) confirm that South Africa's achievement in the subject of mathematics is low: "In 1995, of every 100 pupils enrolled in mathematics, 71 wrote exams, and only 33 pupils passed the subject...Mathematics and science

CHAPTER 3

LITERATURE REVIEW: ACHIEVEMENT

I have come to a frightening conclusion. I am the decisive element in the classroom. It is my personal approach that creates the climate. It is my daily mood that makes the weather. As a teacher I possess tremendous power to make a child's life miserable or joyous. I can be a tool of torture or an instrument of inspiration. I can humiliate or humour, hurt or heal. In all situations it is my response that decides whether a crisis will be escalated or de-escalated, a child humanized or dehumanized.

(Ginott cited in Ryan & Cooper, 1988: 247)

matric results are lower than the national pass rates for other subjects...Science pass rates are (however) on average higher than mathematics pass rates."

3.2 FACTORS AFFECTING MATHEMATICS ACHIEVMENT

A number of factors influence mathematics achievement and the influence of a diversity of factors has been investigated at both the primary and secondary school levels. Some factors that have been researched as influencing achievement have included the following:

- Gender
- Expectation, self-image, self-concept, self-esteem
- Ethnicity
- Teacher feed-back
- Mathematics study orientation
- Confidence
- Mathematics anxiety and test anxiety
- Motivation
- Locus of control
- Preferred learning styles
- Visual and spatial ability
- Home background
- Intelligence, etc.

In the TIMSS study a variety of factors were believed to play a role in learners' achievement test scores. These factors included the availability of educational and technological resources in the home, the number of books in the home, parents' educational levels, home language *and* the learner's attitude towards mathematics (Howie, 1997: 8).

For the purpose of this research project, only the following factors affecting achievement will be discussed: gender, language (ethnicity), attitudes and the learners' perception of their teachers' attitudes. It is important to note that all of the above factors almost certainly also influence mathematics achievement of the sample group however, for this research project they are not discussed.

3.2.1 GENDER

During the past 25 years concern with gender and mathematics has permeated the educational community (Fennema & Hart, 1994: 650). Gender differences in learning and achievement in mathematics has attracted much attention and extensive research has been done over the past two decades in countries such as the United States, England, Canada and Australia (Barnard & Cronjé, 1996: 1).

In a review that covered many publications, Fennema (1993) cited in Fennema & Hart (1994: 650) concluded that research showed the following trends:

- Gender differences in mathematics existed in:
    - The learning of complex mathematics
    - Personal beliefs in mathematics
    - Career choices that involve mathematics

- Gender differences in mathematics vary by:
    - Socio-economic status
    - Ethnicity
    - School
    - Teacher

Based on the literature review, gender differences seem to mainly appear with regard to participation in further study of mathematics, achievement in mathematics and attitudes towards mathematics. It will thus be discussed under these headings.

3.2.1.1 Participation in further study of mathematics

Leder (1992: 607) states that numerous studies conducted in America and Australia indicate that more males than females continue with mathematics in secondary school. The consequences of these different participation rates are far-reaching, as mathematical qualifications are commonly used as a critical entry barrier to tertiary courses, further training and apprenticeships.

According to Arnott, Kubeka, Rice & Hall (1997: 11), enrolment in mathematics at the Grade 12 level in South Africa is dropping further from its historically low base. The gender pattern of enrolment in mathematics is however, changing and more females are enrolled in mathematics at the Grade 12 level than previously found.

However, proportionally fewer females than males are still likely to enrol in mathematics. On average, across seven provinces in South Africa, 46% of all matric males and 39% of all matric females enrol in mathematics in Grade 12 (Arnott et al., 1997: 12). According to Maree (1999: 475), fewer females than males take mathematics after Grade 9. Gray (1991: 102) asserts that mathematics is regarded as being a 'killer' subject and therefore, enrolments are low in Grades 10-12.

Visser (1989: 212) reports that among the white population group in South Africa 20% to 25% fewer females than males continue with mathematics until Grade 12. During 1980, 72% of the Grade 12 males as opposed to 48% of the females in the previous Transvaal schools studied mathematics. The corresponding figures for 1987 were 83% for males and 59% for females.

According to Maree (1999: 474), the unsatisfactory general school environment and home environment of African language-speaking learners contribute to so many African language-speaking learners dropping mathematics after Grade 9. Those who take the subject after Grade 9 appear to have higher motivation and less mathematics anxiety.

3.2.1.2 Achievement

There is evidence to suggest that there are differences in achievement in mathematics between males and females. Secada (1992: 628) suggests that achievement disparities increase over time as learners grow older.

Costello (1991: 145) claims that at the primary school stage the differences are minimal and that the differences in achievement develop during adolescence. Surveys that tested learners' achievements across a wide range of mathematical topics at ages ten or eleven appeared to show little difference between the sexes.

According to Leder (1992: 608), males frequently, though certainly not invariably, by the beginning of the secondary school stage outperform females on standardised tests in mathematics. Information from all of the Assessment of Performance Unit (APU) surveys indicates that by the age of 15, males have a higher average level of achievement than females in all aspects of the mathematics curriculum (Costello, 1991: 145). In South Africa, the pattern across the different population groups is that

females fare worse in the matric mathematics exam than males (Arnott, Kubeka, Rice & Hall, 1997: 12).

With regard to topics in mathematics, gender differences exist in topics involving more complex mathematical tasks (Fennema & Hart, 1994: 651). A meta-analysis carried out by Hyde, Fennema and Lamon (1990: 139-155) indicated that males generally achieved better than females at high cognitive level mathematics tasks.

In a study conducted by Sibaya & Sibaya (1997: 9-16) Zulu-speaking males outperform females, regardless of the nature of mathematical task. Although the average scores for males are higher than those for females, females appear to improve in achievement with more years of educational experience (Sibaya & Sibaya, 1997: 14).

The majority of studies suggest that males achieve at a superior level to females. Macleod (1995: 191) however, found that males and females achieved at the same level. Cronjé (1995) cited in Cassy (1997: 15) argued that gender differences in mathematics achievement are seldom found and, when they are found, they are relatively small.

A survey conducted in 1995 by the Human Sciences Research Council (HSRC) as part of the Third International Mathematics and Science Study (TIMSS) indicated that the difference in achievement between males and females is minimal on an international scale. In South Africa, there was no statistical significant difference between the mean test scores of males and females in either Grade 7 or Grade 8 (Howie, 1997: 11). With regard to Grade 12 learners, South Africa was the only country with no significant difference in the achievement of males and females. In numerous other countries Grade 12 males performed better than females (Howie & Hughes, 1998: 5).

Citing the work of Chrisholm (1994), Gaganakis (1999: 148) states that gender inequalities in South Africa show marked dissimilarities from other Third World countries. In South Africa, the entry of females into and their participation in both schooling and higher education is comparable with that of advanced industrial countries. There are more females than males in the schooling system and more females pass Grade 12 (Gaganakis, 1999: 148).

According to Gaganakis (1999: 153), one of the problems with research in South Africa is that the South African work is empirical and lacks theoretical depth. International literature that provides theoretical rigour may however, be questionable in the local context.

In general, results on gender differences in achievement have been contradictory. Some studies have found no substantial gender differences, while others have. According to Macleod (1995: 191), these differences of opinion are due to poor methodology in some studies, varying sample sizes, and different conclusions drawn about similar statistical data.

In conclusion, the popular belief is that where differences exist, they occur from adolescence onwards. Males are favoured in achievement and participation in further study in mathematics (Barnard & Cronjé, 1996: 1).

3.2.1.3 Learners' perceptions of differences

An interesting characteristic of the differences in participation and achievement in mathematics between males and females, is that many learners do not see these differences. An Assessment of Performance Unit (APU) survey (1982) of 15 year olds included a section where learners were asked in detail about gender differences in mathematical achievement. A large proportion of both males and females claimed that there were no differences. Amongst those who believed that differences exist, opinion was almost equally divided as to which gender is superior. Some learners' comments on the matter are quoted by Burton (1986) cited in Costello (1991: 148):

Male: *The girls tend to get better results because they seem to be able to concentrate more.*

Female: *Girls do best. Most of the boys mess around.*

Male: *If some girls do not know something, they keep quiet about it.*

Male: *When a boy is asked what a question is, he answers it straightaway.*

Male: *When you ask a girl a maths question she takes about 5 minutes to answer it.... Boys do more complicated jobs than girls do – a boy learns easier as well.*

In many of these reported comments of learners, there is an identifiable, common feature which appears in various forms amongst both those who believe that females are better at learning mathematics, and those who think that males have the

advantage. The prevalent impression is that males have the confidence to answer immediately and often impulsively or spontaneously in class, whereas females are more careful, conscientious, meticulous and perhaps reflective. It seems that a lot of learners in secondary school would concur with an opinion of this kind. It is worth noting that the remarks tell us more about what learners think is necessary for being good at mathematics, than their perceptions of gender differences in learning mathematics (Costello, 1991: 148).

In South Africa, beliefs regarding achievement vary according to age level. Among the Grade 7 and Grade 9 learners the predominant belief is that females achieve as well as, if not better than males in mathematics. Grade 11 learners, on the other hand, believe that males fare better (Visser, 1989: 213).

3.2.1.4 Differences in attitude

Gender differences exist in attitudes towards mathematics at different age levels. This phenomenon is discussed in Chapter 2.

3.2.2 LANGUAGE

3.2.2.1 Learning through a language

According to Sibaya, Sibaya & Mugisha (1996: 32), "language is a vehicle of thought and the gasoline of our thought processes". Thought is shaped by life experiences (Sentson, 1994: 109), language develops in accordance with life experiences (Sibaya et al., 1996: 33) and language is the social means of communicating these thoughts (Sentson, 1994: 109). Life experiences all take place within a certain culture and therefore, it is believed that a communal culture has an effect on the way we think and learn.

In the classroom situation and in the learning process in particular, language is the medium through which learning takes place (Sibaya et al., 1996: 32). A child's intellectual growth is dependent upon his mastering language (Brodie, 1989: 42). Language understanding and development is basic to the formation of concepts and mental processes (Sibaya et al., 1996: 33) that are necessary for learning and therefore, the medium of instruction affects the level of understanding learners may attain (Sentson, 1994: 109).

3.2.2.2 Mathematics learning and language

"Mathematics education begins and proceeds in language, it advances and stumbles because of language, and its outcomes are often assessed in language. Consequently, the role of language in math's education is crucial" (Durkin, 1991: 3).

Secada (1992: 637) is of the opinion that there seems to be some relationship between the degree of proficiency in a given language, and mathematics achievement in that language.

3.2.2.3 Mathematics as a language

"In order to achieve in mathematics, students need to master the technical language of mathematics" (Maree, 1995: 320). According to Rothman & Cohen (1989) cited in Maree (1994: 116), few people seem to realise that proficiency in mathematics, both for computation and problem solving, means learning its language.

The language of mathematics is composed of normal English words but these words are often used in specific and unchanging contexts. According to Scott-Hodgetts (1988) and Christie (1989) cited in Maree (1994: 118), the mathematics vocabulary can be divided into three parts, namely:

- Words that have the same meaning in a mathematical context as they have in the colloquial language. For example, *six*, *ten*, *divide* and *add*.

- Words that were 'designed' specifically for mathematics and are not used in the colloquial language. For example, *quadrate*.

- Words that are used in both mathematics and the colloquial language, but which have different meanings in each. For example, the term *volume* has a different meaning in mathematics as it has in colloquial terms.

Learners need to understand the English language itself and the specific nuances that the same words might take on in a mathematics lesson. This makes the learning of mathematics in a second language very difficult.

3.2.2.4 Learning mathematics in a second language

South Africa is a multicultural and multilingual country, which creates a situation where many learners have to learn in a language which is not their first language. English is generally accepted as the language associated with technology, academics, politics, economics and education. This position is also enhanced by the fact that English has become the standard language of international communication (Sentson, 1994: 110). In South Africa, "English, spoken by 9.1% of the population, is the language of business and government; however, it is not the most widely spoken language at home" (Howie, Marsh, Allummoottil, Glencross, Deliwe & Hughes, 2000: 62).

Most black South African learners learn in English, which is a second language or possibly even a third language for these learners. According to Sentson (1994: 109), "second language learning is particularly relevant to the nature of education to which most, if not all, black South Africans are exposed."

Until recent changes in the law, South African black learners were taught in their first language for the first four years of schooling while English was presented as a subject. Thereafter, English was used as a medium of instruction for most subjects (Sentson, 1994: 111). Walker (1986: 101) points out that at the time that black South African learners are expected to convert to English as a medium of education, they have been exposed to 350 hours of English at school. For most learners this is their only encounter with English, as it is not usually spoken in the home.

Learning in a second language has been shown by several authors to create a situation in which the assimilation of knowledge is severely impaired (Sentson, 1994: 109). Factors affecting the difficulty of learning in a second language are the problems associated with linguistic distance and the lack of concepts in the African languages.

The structure of a language as well as the cultural setting of the languages affects the linguistic distance between two languages (Sentson, 1994: 110). The mathematics that is taught in South African schools is based on an Indo-European culture and linguistic structure (Sentson, 1994: 111). Indo-European languages are mutually 'close' while as a group they are all distinct from the sub-Saharan languages of Africa. In general, it is likely to be easier for a learner to function effectively in a

second language which is semantically and culturally close to his first language than in one which is remote (Berry, 1985: 20). It is this linguistic distance between English and the sub-Saharan African languages that increases the difficulty experienced by second language learners (Sentson, 1994: 110).

A child should attain a certain level of concept formation in English to be able to solve mathematical problems (Sibaya et al., 1996: 33). Concepts and meanings that are essential in mathematics like classification, pattern recognition, prefixes and suffixes, connectives, have been shown to have different meanings or not to exist at all in other languages which may be the first language of the learner (Sentson, 1994: 111).

As Strevens (1974) cited in Austin & Howson (1979: 169) points out, "there is a major difference in mental preparation for mathematics learning between a learner whose language makes use of the international Greek-Roman terminology, its prefixes (pre-, post-, anti-, etc.), suffixes (-action, -or, -ant, -ise, etc.) and roots (equ, arithm, etc.) and a learner whose language contains neither these items... nor any translation equivalents to them." For example, no terms exist in the Zulu language for concepts like *theorem*, *equation*, *trapezium* and *parallelogram* (Sentson, 1994: 111).

According to Austin & Howson (1979: 168), the traditional cultural demands among second language speakers have not led to the development of terminology adequate for the modern international view of mathematics. Michau (1978: 23) confirmed that studies conducted amongst black learners of South Africa, show that there are differences and inadequacies as far as mathematical conceptualisation is concerned. It can be assumed that the lack of some mathematical terms leads to gaps in the knowledge of the subject.

Furthermore, certain everyday concepts have different meanings based on the relevant culture in which it is used. In a study conducted by Maree (1992: 63), the concept volume was linked to a knob of a television set. This therefore, shows that one's everyday language interferes with the understanding of concepts in mathematics. This cross-cultural interference is a South African reality which indicates the difficulties experienced by second language learners.

The study conducted by Sibaya et al. (1996: 32-37) confirms that achievement in mathematics is influenced by the command of the language of instruction. Dawe (1983) cited in Sentson (1994: 111) explains that when mathematics is learned in a

second language it is not only the learner's proficiency in this second language (L2) that affects the nature and quality of learning, but also the learner's proficiency in his or her first language (L1). Thus, the learners' competence in the first language also affects their cognitive advancement even when they are being taught in a second language. The Dawe-Cummins threshold hypothesis asserts that:

- When the learner is highly proficient in both L1 and L2, this type of bilingualism (additive) will have a positive cognitive effect on the learning process.

- When the learner has native-like skills in at least one language, this type of bilingualism (dominant) has neither positive nor negative cognitive effects on the learning processs.

- When the learner has a low level of proficiency in both L1 and L2, this type of bilingualism (semilingualism) has negative cognitive effects on the learning process.

According to Graham (1988) cited in Sentson (1994: 111), one could then conclude that learners who know neither language well may experience negative effects, while those who know both languages extremely well, will experience positive cognitive effects. Thus, L1 maintenance needs to be taken seriously as a means of developing the cognitive flexibility of bilingual learners (Sentson, 1994: 111). If learners think of their first language as being inferior to English in the educational realm, they will be discouraged from becoming proficient in their first language (Sentson, 1994: 111). Encouragement to develop L1 skills is necessary if the learner is to develop competence in L2. If the learner receives instruction in a foreign language without simultaneous support in her first language, both languages as well as the learner's cognitive development and school achievement will suffer (Brodie, 1989: 45). It can therefore be concluded that it is the learners' mastery of English, as well as their first language that will lead them to positive cognitive outcomes.

According to the results of the Third international Mathematics and Science Study (TIMSS), learners whose first language differed from the language of the test, as in the case of South Africa, were seriously handicapped in comparison with their

international counterparts who were able to take the test in their first language (Papanastasiou, 2000: 5).

The TIMSS study highlights the importance, in national terms, of English language proficiency as a foundation for the development of mathematical fluency and skill (Howie et al., 2000: 64). Howie et al. (2000: 75) asserts: "Probably the most salient feature of the TIMSS study in South Africa is the revelation of the role of English language proficiency as a determinant of mathematical performance."

3.2.3 THE TEACHER

The three elements in the teaching-learning situation are namely: content, learner and teacher. The teacher is according to Fillis (1993: 38), the most important element in this teaching-learning situation that correspondingly exerts the most influence.

Thompson's study (1984: 105-127) which investigated the conceptions of mathematics and mathematics teaching held by three junior secondary school teachers, confirmed the assumption that teachers' beliefs, views and preferences about mathematics and its teaching, regardless of whether they are consciously or unconsciously held, play a significant, albeit subtle role in shaping their characteristic patterns of instructional behaviour. These characteristic instructional behaviours play an important role in affecting their effectiveness as the primary mediators between the subject mathematics and the learners (Thompson, 1984: 105). "Teachers play a major role in the development of their students, and research shows that both students and parents regard teachers as the most important factor in students' success" (Thompson, 1991 cited in Masutha & Ackermann, 1999: 243).

It appears, therefore, as though teachers have an effect on learners' academic achievement. Hafner (1993: 72) established a general relationship between teacher behaviour and learner achievement and Mullis (1991) cited in Moyana (1996: 33) is of the opinion that teachers are key figures in improving mathematics achievement.

Teachers also have an effect on learners' attitudes. The teacher's influence on learners developing positive or negative attitudes was discussed in Chapter 2.

3.2.3.1 Learners' perceptions of their teachers' behaviour and attitudes

People tend to define themselves on the basis of their perception of how others define and evaluate them. Learners evaluate their own value and potential in terms of their perception of their teachers' evaluations and expectations of them (Masutha & Ackermann, 1999: 243).

According to Ryan & Cooper (1988: 139), learners may be influenced substantially by teacher attitudes and behaviours of which the teacher may not even be aware. It is the learners' perceptions of the teachers' behaviour and attitudes that influence the learner (Putney & Cass, 1998: 628).

Sayers (1994: 397) is of the opinion that if a learner believes that a teacher has a low opinion of him or her, the likelihood is high that the learner may perform as expected. Masutha & Ackermann (1999: 247) state that teacher's expectations influence his or her behaviour in a significant way, which, in turn, influences a learner's self-expectation. The learner's name, gender, intelligence, ethnic background, previous achievement, physical characteristics, and socio-economic status contribute to the formation of certain expectations with the teacher (Masutha & Ackermann, 1999: 247).

Learners' perceptions of the teacher's involvement, support, encouragement, and interest in them have been found to play a major role in learners' behaviour and success (Mboya, 1995: 496). The teacher's behaviour also significantly influences the learner's perceptions of the teacher and of themselves, as well as perceptions and attitudes towards school. These factors influence the learner's academic achievement and general development significantly.

Masutha & Ackermann (1999: 243) state that gender and age seem to be variables that are relevant to learners' perceptions of teachers. Masutha & Ackermann (1999: 243) report the following: Various researchers have indicated that female learners, as opposed to males, perceive school more often as a supporting institution (Dartez, 1990), have more positive perceptions of teachers (Homburger, 1991) and view teachers as more important agents with regard to their self-perceived competence (Granleese, Turner & Trew, 1991). Carpenter (1985) cited in Masutha & Ackermann (1999: 243) adds that female learners also perceive the classroom environment more

positively than male learners. Older learners tend to have more positive perceptions of their teachers' behaviour than younger learners (Messinger, 1992 cited in Masutha & Ackermann, 1999: 243). According to the results of their study, Masutha & Ackermann (1999: 243) clearly point out that teachers' differential treatment of learners, based on their differential perceptions and expectations, might have detrimental effects on many of their learners.

3.2.4 ETHNICITY

Academic achievement and specifically achievement in mathematics in South Africa varies according to different population groups. Using figures for Sub A enrolment for 1980 and matriculation pass rates for 1991, the following figures provide a picture of the various achievements between different population groups. It is important to note however, that the figures presented are all average estimates of the real situation, which will tend to vary (depending on which years are chosen for analysis). These figures have aged, but still nevertheless provide a picture of disparities in achievements:

- For white learners, one learner obtains a matriculation exemption with mathematics and science for every 5.1 learners starting school.

- For Indian learners, one obtains matriculation exemption with mathematics and science for every 6.2 learners starting school.

- For coloured learners, for every 45.9 learners entering school one achieves matriculation exemption with mathematics and science.

- For African learners, one in 312 learners entering school obtains matriculation exemption with mathematics and science (Blankley, 1994: 54).

With the establishment of a new racially integrated provincial education system after the present government came to power, inequalities in the provision of education in South African schools did not disappear (Steyn, 1999: 66).

International literature also shows that ethnic differences exist in secondary school mathematics achievement (House, 1993: 155). The general picture of mathematics achievement in the United States of America is that the white population group

performs much better in mathematics than the Hispanics who, in turn, achieve slightly better than the African Americans (Secada, 1992: 628).

Findings by Azuma (1988) and Ogbu (1986) cited in Iben (1991: 135) suggest that there are some fundamental culturally based differences in attitudes that contribute to differences in achievement and persistence in academic studies. To explain racial differences in mathematics achievement, Reyes & Stanic (1988: 26) proposed a model that considers the effects of factors such as societal influences, school mathematics curricula, classroom processes, teacher and learner attitudes, and achievement related behaviours.

Few studies have examined mathematics attitudes in different cultures (Tocci & Engelhard, 1991: 280) and "further research is needed to investigate the relationship between student attitudes and the mathematics achievement of minority students" (House, 1993: 156).

"It seems reasonable to hypothesise that affective factors are particularly important to differences in performance between groups that come from different cultural backgrounds" (McLeod, 1992: 587).

3.2.5 ATTITUDES

3.2.5.1 A good attitude leads to success

A study, which linked common characteristics and actions to successful people, revealed that one of the most significant differences between high and low achievers was their attitude (Yanna, 1996: 9). Eagly & Chaiken (1993: 1) postulate that attitudes motivate behaviour and exert selective effects at various stages of information processing.

Holmes (1990) cited in Giordano (1993: 79) explains: "although educators debate whether positive attitudes are necessary for learning, all educators would agree that positive attitudes facilitate and enhance learning." Addleman (1972: 20) states: "Several investigators have concluded that student attitude is at least partial determinant of student achievement."

3.2.5.2 Attitudes and mathematics achievement

Aiken (1970: 558) is of the opinion that the assessment of attitudes towards mathematics would be of less concern if attitudes were not thought to affect achievement in some way. Brown & Abell (1965) cited in Osei (1995: 21) demonstrate that the correlation between learner attitude towards a subject and achievement in that subject is higher for arithmetic than for spelling, reading and language.

The following paragraphs show that in some studies attitude relates to achievement. However, other studies have also shown conflicting results. These are discussed further on.

Suydam & Weaver (1975) cited in Ma & Kishor (1997: 26) state that in both theory and practice, a strong relationship between attitude and achievement has long been assumed and "teachers and other mathematics educators generally believe that students learn more effectively when they are interested in what they learn and that they will achieve better in mathematics if they like mathematics. Therefore, continual attention should be directed towards creating, developing, maintaining and reinforcing positive attitudes." Costello (1991: 122) states that there is a common and reasonable belief that a positive attitude, a particular liking for, and interest in mathematics leads to greater effort and in turn to higher achievement.

Steinkamp (1982) cited in Ma & Kishor (1997: 28) concludes that attitude towards mathematics is primary among the variables that determine achievement in mathematics. Ma & Kishor (1997: 26) state that this conclusion is supported by a number of researchers. Giordano (1993: 105) states that the learning of mathematics is most effective when learners maintain positive attitudes.

Cheung (1988: 211) used data from the Second International Association for the Evaluation of Educational Achievement Mathematics Study (SIMS) (1980) to examine the relationship between mathematics achievement and attitudes towards mathematics in junior secondary schools in Hong Kong. The results indicated that the correlations between certain attitude dimensions and mathematics achievement were positive. Self-confidence correlated most highly with achievement, followed by the belief that mathematics was useful in careers, and lastly, the belief that

mathematics required creativity. Cheung (1988: 211) thus concluded that the more positive a learners attitude towards mathematics, the higher his or her achievement.

According to Dossey, Mullis, Lindquist & Chambers (1988) cited in McLeod (1992: 581), national assessment data illustrated a positive correlation between attitude and achievement at Grade levels 3, 7 and 11. The percentage of learners who say they enjoyed mathematics however, declined from 60% in Grade 3 to 50% in Grade 11.

Visser (1989: 213) states that the mathematics achievement of female Grade 9 learners in South Africa correlated strongly with self-confidence and motivation in the subject. The extent to which it is regarded as important and personally useful and the encouragement of others were also found to be accurate predictors of achievement. In the case of Grade 11 learners, the strongest predictors for both sexes were not intellectual factors, but self-confidence regarding mathematics and the expectations and encouragement of teachers (Visser, 1989: 213).

According to a study conducted by Masqud and Khalique (1991: 377-390), attitude towards mathematics significantly positively correlated with mathematics achievement for both males and females. Their results showed that the more positive the learners' attitude towards mathematics was, the higher their achievement.

The results of a study conducted by Tocci & Engelhard (1991: 280-285) confirmed research that a positive relationship between mathematics achievement and attitudes, exists. Tocci & Engelhard (1991: 285) reported that learners who have higher scores on mathematics achievement tests tend to have more positive perceptions of:

(a) Their encounters with and reactions to the subject of mathematics
(b) The usefulness of mathematics in society
(c) The stereotyping of mathematics as a male domain.

Wong (1992: 33) asserts that "attitudes play a crucial role in the learning of mathematics. When attitudes are used as predictors of achievement in mathematics, significant positive correlations are usually found...Positive attitudes also have a strong influence on student motivation...and the intention to learn."

Ma & Kishor (1997: 26) conducted a meta-analysis to integrate and summarise the findings from 113 primary studies. They found the relationship between attitudes and achievement in mathematics to be dependent on grade, ethnic background, sample selection and sample size. According to these authors, gender did not have a significant effect on the relationship; nor were there any significant interactions among gender, grade, and ethnic background.

According to Higbee & Thomas (1999: 12), learners' attitudes towards mathematics and towards themselves as learners are related to achievement. Higbee & Thomas (1999: 12) believe it is sometimes necessary to convince learners that they can be successful and are capable of learning mathematics. These researchers also state that it is furthermore important that learners understand that mathematics has a meaningful place in their lives.

According to the results of The Third International Mathematics and Science Study (TIMSS), by the International Association for the Evaluation of Educational Achievement (IEA) a positive correlation was often observed between mathematics achievement and the learners' attitude towards mathematics. Learners who do well in mathematics generally have positive attitudes towards the subject, and those who have positive attitudes tend to perform better. It was noted that while this may be true within some countries, there might however, be differences between different countries (Papanastasiou, 2000: 27).

As noted earlier, some studies do not show that a learner's attitude relates to mathematics achievement. Antonnen (1969) cited in Addleman (1972: 19) indicates that studies in which an attempt was made to relate mathematics attitude to mathematics achievement have led to no substantial relationships. When the factor of mathematical ability was held constant, Litwiller (1971) cited in Addleman (1972: 19) found that the relation of attitude towards mathematics and achievement was minimal. A study conducted by Norman (1988: 408-409) correspondingly reported no significant relationship between mathematics achievement and attitude.

Norman (1988: 54) is of the opinion that research findings on the relationship between learners' attitudes towards mathematics and mathematics achievement is inconclusive. Ma & Kishor (1997: 26) state that little consensus exists in the research literature concerning the relationship between attitude towards mathematics and achievement in mathematics.

As reported by Ma & Kishor (1997: 26), "a number of researchers have demonstrated that the attitude-achievement correlation is quite low and concluded that the relationship is weak and cannot be considered to be of practical significance." Some researchers have, however, demonstrated that the attitudinal variables are significant indicators of mathematics achievement. They confirmed that a few of the attitudinal variables showed strong relationships with mathematics achievement.

According to Abu-Hilal (2000: 75), reviews conducted on studies addressing attitudes to school subjects and achievement, indicate that the relationship between the two constructs is not conclusive and that the relationship between them is yet to be clearly defined. Papanastasiou (2000: 38) states that on the basis of the results of The Third International Mathematics and Science Study (TIMSS), further research is necessary to examine the influence of attitudes on mathematics achievement.

3.3 CONCLUSION

There are many factors related to achievement in mathematics. For the purpose of this research project, gender, language (ethnicity), perception of teachers' attitudes and learner attitudes were discussed as influencing achievement.

Based on the literature review, it seems that research in the area of attitudes influencing mathematics achievement is inconclusive.

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CHAPTER 4

RESEARCH DESIGN

The child's attitudes affect what he learns, what he remembers, and what he does. Hence evaluation of the child's attitudes – feelings for and against things – assumes a fundamental role in guiding his development.

(Ragan, 1953: 496)

CHAPTER 4

RESEARCH DESIGN

4.1 INTRODUCTION

Henerson, Morris & Fitz-Gibbon (1987: 11) states that the task of measuring attitudes is not simple. To begin with, the concept of attitude, like many abstract concepts, is a creation – a construct. As such, it is a tool that serves the human need to see order and consistency in what people say, think and do, so that given certain behaviours, predictions can be made about future behaviours. An attitude is not the something we can examine and measure in the same way we can examine the cells of a person's skin or measure the rate of a heartbeat. One can only infer that a person has attitudes by his or her words and actions. One may then question whether we can accept a person's statement about his or her own attitude as the best indicator of the attitude. In some instances the answer is yes, particularly when there is no reason for him/her to hide anything. However, an attempt to measure a complex attitude, for example, attitude toward school or work, involves many facets – feelings and beliefs about one's teachers or supervisors, classmates or co-workers, school subjects or jobs and activities.

Henerson et al. (1987: 13) states that the following precautions should be kept firmly in mind when proceeding with measuring attitudes:

- When measuring attitudes, reliance is made on inference, since it is impossible to measure attitudes directly.

- Behaviours, beliefs, and feelings will not always match, even when one correctly assumes that they reflect a single attitude.

- There is no guarantee that the attitude one wants to assess will 'stand still' long enough for a one-time measurement to be reliable. A volatile or fluctuating attitude cannot be revealed by information gathered on one occasion.

4.2 GENERAL AIM

The purpose of this research project is to determine whether there is a relationship between attitude towards mathematics and achievement in mathematics. Based on the literature review, certain deductions could be made regarding the relationship between attitude and achievement in mathematics. However, some results of previous research studies have been inconclusive. Ma & Kishor (1997: 26) state: "Little consensus exists in the research literature concerning the relationship between attitude toward mathematics and achievement in mathematics."

There are however, certain recommendations regarding future research on the matter of attitudes and achievement in mathematics. Aiken (1976: 302) concludes that in studies involving a measure of attitude towards mathematics, separate analyses by *gender* should always be conducted. He also reports that a low but significant positive correlation exists at the elementary and secondary school level and that the correlation between attitude and achievement varies with *grade level* (Aiken, 1976: 296). Ma & Kishor (1997: 26) state that "previous studies have identified a number of factors as having important effects on the relationship between attitude and achievement in mathematics. *Gender, grade*, and *ethnicity* are the *basic variables* in the examination of this relationship."

Based on the above recommendations, attitude towards mathematics is discussed separately for each of the basic variables. These basic variables are:

- Gender
- Grade level (in this instance, Grade 7, Grade 9 and Grade 11)
- Ethnicity (which is based on the learner's home language)

As seen in Chapter 2, the concept *attitude towards mathematics* has been defined in a variety of ways by various researchers. Aiken (1970: 28) is of the opinion that the problem of inconsistencies in the literature is due to a generalised attitude towards mathematics being measured. He continues by stating that it may be better to measure attitude toward specific mathematical activities. McLeod (1992: 582) recommends that attitudes towards different types of mathematics be measured, for example algebra, geometry and trigonometry. As however stated earlier, this research project does not lend itself to measuring attitudes towards different content

areas due to the fact that different grade levels are focused upon. Attitude towards mathematics is thus divided into the following four facets:

- The learners' confidence in doing mathematics
- The learners' motivation in mathematics
- The learners' perception of the usefulness of mathematics
- The learners' perception of teachers' behaviour and attitudes

A study conducted by Tocci & Engelhard (1991: 280-286) recommended that in future research on attitudes towards mathematics, "more emphasis should be placed on determining how attitudes are developed and the stability of attitudes over time; differences between subgroups, especially those related to gender, race, and social class".

4.3 HYPOTHESES

The main research question that is answered in this research project is as follows:

Is there a relationship between attitudes towards mathematics and achievement in mathematics of South African learners in Grades 7, 9 and 11?

Based on this main research question, the following sub-questions are asked:

- Do the attitudes of the learners differ with each grade level?
- Are there gender differences in attitudes at each grade level?
- Are there ethnic differences in attitudes at each grade level?
- Are there gender differences in achievement?
- Are there ethnic differences in achievement?

Based on all of the above questions, the following hypotheses can be formulated:

Hypothesis 1:

There is a significant positive correlation between attitudes towards mathematics and achievement in mathematics of Grade 7, 9 and 11 learners.

Hypothesis 2:

There is a significant difference in the attitudes of learners towards mathematics for each grade level.

Hypothesis 3:

There is a significant difference between male and female attitudes towards mathematics of learners in grade 7, 9 and 11.

Hypothesis 4:

There is a significant difference in attitudes towards mathematics for each ethnic group of learners in grade 7, 9 and 11.

Hypothesis 5:

There is a significant difference in mathematics achievement between male and female learners in grade 7, 9 and 11.

Hypothesis 6:

There is a significant difference in mathematics achievement between each ethnic group of learners in grade 7, 9 and 11.

4.4 RESEARCH METHODOLOGY

4.4.1 Research population

The population group in this research project consists of three sample groups. Sample Group A consists of all the learners in Grade 7 of a primary school. Sample Group B and C consists of all the learners in Grades 9 and 11 respectively of a secondary school. The schools were chosen randomly. They are English medium schools but the learners belong to various ethnic groups. The primary school is the feeder school for the secondary school. The schools are state co-educational. In terms of socio-economic background, the learners are middle to upper class. Table 4.1 indicates the numbers of male and female learners in each grade.

TABLE 4.1

TESTEE DISTRIBUTION ACCORDING TO GRADE AND GENDER

	Males	Females	Total
Grade 7	56	74	130
Grade 9	98	87	185
Grade 11	61	75	136
Total	215	236	451

Table 4.2 indicates the number of learners in each language group at each grade level.

TABLE 4.2

TESTEE DISTRIBUTION ACCORDING TO GRADE AND ETHNICITY

	English language	Afrikaans language	African language	Other language	Total
Grade 7	84	14	19	13	130
Grade 9	110	23	35	17	185
Grade 11	79	22	21	14	136
Total	273	59	75	44	451

4.4.2 Measuring instruments

A questionnaire and data is used in this research project. These are discussed separately under their respective sub-headings.

4.4.2.1 Questionnaire

The Human Sciences Research Council (HSRC) was contacted with regard to determining if a questionnaire measuring mathematical attitudes existed in South Africa. There is currently no questionnaire that specifically measures attitude towards mathematics in South Africa.

The researcher furthermore conducted a basic inquiry of international test users to determine whether a questionnaire measuring attitude towards mathematics exists. The Internet was also utilised. A selection of questionnaires and tests that are related to measuring mathematics attitude appear in Appendix B.

Due to the lack of a standardised South African questionnaire and the inapplicability of the other questionnaires, the researcher designed her own.

- **Structure of the questionnaire**

The questionnaire is designed to gather information regarding learners' attitudes towards mathematics. Based on the literature review, it was decided that the following four facets of attitude towards mathematics be included, and therefore, the concept *attitude towards mathematics* is divided into the following four facets:

- A learner's confidence in learning mathematics, personal enjoyment of mathematics and anxiety when confronted with mathematics.

- A learner's willingness to become involved in mathematics and motivation to do more mathematics than is actually required.

- A learner's perception and/or recognition of the usefulness of mathematics, i.e. it's value, importance and relevance for oneself and for society in general.

- A learner's perception of his or her teacher's attitudes and behaviour towards mathematics.

The questionnaire is a six point Likert scale ranging from 1 (strongly disagree) to 6 (strongly agree) with the statement. Some of the statements indicate favourable attitudes and some of the statements indicate unfavourable attitudes towards mathematics. The same questionnaire is used for all of the grades except for the Grade 7 learners, where some sentences were altered for ease of understanding. There are 60 questions in total, 15 questions for each of the different four facets of attitude. The item numbers that pertain to each of the four facets of attitude are given in Table 4.3.

TABLE 4.3

DISTRIBUTION OF ITEMS INTO SECTIONS

	FACET
Confidence in mathematics	1, 2, 3, 4, 5, 21, 22, 23, 24, 25, 41, 42, 43, 44, 45
Motivation in mathematics	6, 7, 8, 9, 10, 26, 27, 28, 29, 30, 46, 47, 48, 49, 50
Usefulness of mathematics	11, 12, 13, 14, 15, 31, 32, 33, 34, 35, 51, 52, 53, 54, 55
Perception of teachers' attitude	16, 17, 18, 19, 20, 36, 37, 38, 39, 40, 56, 57, 58, 59, 60

A high score on the questionnaire indicates a positive attitude towards mathematics with regard to each of the above four facets.

To ensure some measure of content validity at the outset, the Fennema-Sherman Scales and Aiken's scales were included. Some items were used unaltered, others were altered and several new items were written. The questionnaire appears in Appendix A. The origin of each item is shown.

4.4.2.2 Data

Each school provided the latest term exam results which were correlated with the score on the attitude questionnaire. According to Wylie (1979) cited in Abu-Hilal (2000: 82), school grades are a more important source of feedback than standardised tests. Abu-Hilal & Atkinson (1990) cited in Abu-Hilal (2000: 82) argue that the reason for this lies in the fact that learners are more personally related to school grades than to standardised tests, in as much as they are results of daily personal efforts.

4.5 SUMMARY

This chapter has outlined the method of the empirical investigation as well as the research instruments that were used to collect information about:

- Learners' attitudes towards mathematics in Grades 7, 9 and 11
- Learners' achievement in mathematics

The findings are discussed in the next chapter.

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CHAPTER 5

EMPIRICAL RESEARCH

Education must bring the practice as nearly as possible to the theory.

(Mann cited in Ryan & Cooper, 1988: 451)

CHAPTER 5

EMPIRICAL RESEARCH

5.1 INTRODUCTION

Following in this chapter is a discussion of the results of the empirical investigation. The following is included:

- An item analysis
- The testing of the reliability of the questionnaire
- The testing of the validity of the questionnaire
- Calculation of norms for the questionnaire
- The testing of the hypotheses

An item analysis is conducted to determine if all of the items in the questionnaire meet certain criteria. If the items do not meet the criteria they are regarded as unsuitable items and eliminated. The reliability of the questionnaire is tested to determine whether the questionnaire is consistent or not. Schweigert (1989: 36) states that a measure or procedure is reliable if "different researchers who use the same procedure to measure the same phenomenon acquire same results." Validity is the extent to which a measurement technique measures what it claims to measure and in this study it is evaluated using correlation coefficients. Norms are calculated for the questionnaire to determine if the testee has a positive, negative or neutral attitude towards mathematics. Lastly, the hypotheses noted in Chapter 4 are tested.

5.2 ITEM ANALYSIS OF THE QUESTIONNAIRE

The questionnaire consists of four sections, namely, the learners':

- Confidence in mathematics
- Motivation in mathematics
- Perception of the usefulness of mathematics
- Perception of teachers' attitudes

An item analysis was done for each section as well as for the whole questionnaire. On the basis of a calculated item-total correlation, it can be established whether each of the items make a contribution to the total of its particular section and to the whole

questionnaire. If the item-total correlation is very low or negative the item is left out. The Alpha reliability coefficient is calculated for each section of the questionnaire as well as for the total questionnaire. If the Alpha reliability coefficient increases substantially if the item were to be left out, a consideration is then made to omit the item.

Tables 5.1 to 5.4 indicate that all items showed a positive correlation with the total. The tables also indicate that the reliability coefficient of the particular section and of the total questionnaire is not significantly higher if any item is left out. Therefore, all of the items for each section were retained.

TABLE 5.1

ITEM ANALYSIS OF THE SECTION: CONFIDENCE IN MATHEMATICS

Number of subjects	: 451
Number of items	: 15
Alpha Reliability Coefficient	: 0.935

ITEM	ITEM CORRELATION WITH TOTAL	ALPHA IF ITEM IS LEFT OUT
1	0.627	0.932
2	0.687	0.931
3	0.645	0.932
4	0.723	0.930
5	0.725	0.930
21	0.748	0.929
22	0.639	0.932
23	0.767	0.929
24	0.557	0.934
25	0.529	0.935
41	0.788	0.928
42	0.633	0.932
43	0.740	0.929
44	0.688	0.931
45	0.642	0.932

TABLE 5.2

ITEM ANALYSIS OF THE SECTION: MOTIVATION IN MATHEMATICS

Number of subjects	: 451
Number of items	: 15
Alpha Reliability Coefficient	: 0.877

ITEM	ITEM CORRELATION WITH TOTAL	ALPHA IF ITEM IS LEFT OUT
6	0.559	0.868
7	0.457	0.872
8	0.653	0.863
9	0.354	0.877
10	0.457	0.872
26	0.670	0.863
27	0.674	0.862
28	0.602	0.866
29	0.515	0.870
30	0.339	0.877
46	0.587	0.866
47	0.653	0.863
48	0.644	0.864
49	0.220	0.882
50	0.562	0.868

TABLE 5.3

ITEM ANALYSIS OF THE SECTION: PERCEPTION OF THE USEFULNESS OF MATHEMATICS

Number of subjects	: 451
Number of items	: 15
Alpha Reliability Coefficient	: 0.870

ITEM	ITEM CORRELATION WITH TOTAL	ALPHA IF ITEM IS LEFT OUT
11	0.424	0.867
12	0.564	0.860
13	0.528	0.862
14	0.492	0.864
15	0.540	0.862
31	0.345	0.872
32	0.699	0.855
33	0.354	0.872
34	0.542	0.861
35	0.457	0.865
51	0.482	0.864
52	0.696	0.853
53	0.550	0.861
54	0.584	0.860
55	0.645	0.857

TABLE 5.4

ITEM ANALYSIS OF THE SECTION: PERCEPTION OF TEACHERS' ATTITUDES

Number of subjects	: 451
Number of items	: 15
Alpha Reliability Coefficient	: 0.847

ITEM	ITEM CORRELATION WITH TOTAL	ALPHA IF ITEM IS LEFT OUT
16	0.599	0.831
17	0.486	0.837
18	0.262	0.850
19	0.361	0.846
20	0.626	0.829
36	0.439	0.840
37	0.252	0.849
38	0.587	0.831
39	0.550	0.835
40	0.426	0.840
56	0.625	0.828
57	0.517	0.835
58	0.470	0.838
59	0.618	0.829
60	0.332	0.845

5.3 RELIABILITY OF THE QUESTIONNAIRE

The closer the reliability of a measuring instrument is to 1, the smaller the difference is between the variance of the actual score and the observed score. When an instrument is developed, an attempt is made to get the reliability of the instrument as close to 1 as possible. The reliability is determined by calculating the Alpha reliability coefficient for each of the sections as well as the total questionnaire.

It can be seen from Table 5.5 that the reliability coefficient for the questionnaire is 0.946. This value is very close to 1 and therefore, the questionnaire can be considered to be a reliable measuring instrument.

TABLE 5.5

RELIABILITY OF THE QUESTIONNAIRE

SECTION	ALPHA COEFFICIENT	NUMBER OF ITEMS
Confidence in mathematics	0.935	15
Motivation in mathematics	0.877	15
Perception of the usefulness of mathematics	0.870	15
Perception of teachers' attitudes	0.847	15
Questionnaire in totality	0.946	60

5.4 VALIDITY OF THE QUESTIONNAIRE

5.4.1 Content validity

To ensure some measure of content validity, the Fennema-Sherman Scales and Aiken's scales were included. Some items were used unaltered, others were altered and several new items were written. See Appendix A for the origin of each item and whether or not it was modified.

5.4.2 Construct validity

Although the questionnaire consists of different constructs, they are related to one another and to the total construct of the questionnaire because they all deal with attitude towards mathematics. One would expect to find significant positive correlations among the constructs (sections) and between each construct (section) and the construct measured by the questionnaire in total (attitude towards mathematics). If such correlations exist, one can regard the questionnaire to be construct valid. To determine construct validity, correlation coefficients were calculated between the four different constructs and between each construct and the total questionnaire. All of the correlations seem to be high positive correlations, significant on the 1% level. The different constructs therefore, strongly relate to one another and consequently the questionnaire may be considered construct valid. The correlation coefficients appear in Table 5.6.

TABLE 5.6

INTERCORRELATIONS BETWEEN ATTITUDE TOWARDS MATHEMATICS AND THE VARIABLES

	CONFIDENCE	MOTIVATION	USEFULNESS	TEACHER
CONFIDENCE		0.668	0.472	0.320
MOTIVATION			0.671	0.367
USEFULNESS				0.321
TEACHER				

5.5 CALCULATION OF NORMS FOR THE QUESTIONNAIRE

A norm is an objective standard whereby the scores which a testee receives on a measuring instrument, are interpreted. Stanines are standard scores divided into nine categories which were used to calculate the norms (see Table 5.7 for stanines).

TABLE 5.7

LIMITS AND AREAS OF STANINES

STANINES	LIMITS			% OF AREA
9	+∞	to	+1.75	4
8	+1.75	to	+1.25	7
7	+1.25	to	+0.75	12
6	+0.75	to	+0.25	17
5	+0.25	to	-0.25	20
4	-0.25	to	-0.75	17
3	-0.75	to	-1.25	12
2	-1.25	to	-1.75	7
1	-1.75	to	-∞	4

(Mulder, 1989: 205)

To calculate the stanines for each of the sections of the questionnaire, as well as for the total questionnaire, the cumulative percentages for each of the sections and for the total questionnaire were obtained. The stanines appear in Tables 5.8 to 5.12.

TABLE 5.8

TRANSFORMATION OF RAW SCORES INTO STANINES

SECTION: CONFIDENCE IN MATHEMATICS

RAW SCORE	STANINE
15 – 22	1
23 – 29	2
30 – 39	3
40 – 49	4
50 – 60	5
61 - 71	6
72 – 79	7
80 – 84	8
85 – 90	9

TABLE 5.9

TRANSFORMATION OF RAW SCORES INTO STANINES

SECTION: MOTIVATION IN MATHEMATICS

RAW SCORE	STANINE
15 – 34	1
35 – 43	2
44 – 49	3
50 – 57	4
58 – 65	5
66 – 73	6
74 – 79	7
80 – 84	8
85 – 90	9

TABLE 5.10

TRANSFORMATION OF RAW SCORES INTO STANINES

SECTION: PERCEPTION OF THE USEFULNESS OF MATHEMATICS

RAW SCORE	STANINE
15 – 42	1
43 – 53	2
54 – 64	3
65 – 71	4
72 – 78	5
79 – 82	6
83 – 85	7
86 – 89	8
90	9

TABLE 5.11

TRANSFORMATION OF RAW SCORES INTO STANINES

SECTION: PERCEPTION OF TEACHERS' ATTITUDES

RAW SCORE	STANINE
15 – 49	1
50 – 58	2
59 – 65	3
66 – 72	4
73 – 78	5
79 – 83	6
84 – 86	7
87 – 88	8
89 – 90	9

TABLE 5.12

TRANSFORMATION OF RAW SCORES INTO STANINES

TOTAL QUESTIONNAIRE

RAW SCORE	STANINE
60 – 174	1
175 – 203	2
204 – 227	3
228 – 251	4
252 – 275	5
276 – 300	6
301 – 319	7
320 – 335	8
336 – 360	9

By dividing the categories up as in Table 5.7 and then applying them to the four sections of the questionnaire as well as the total questionnaire, it is possible to establish whether an individual's attitude towards mathematics is below average, average or above average. According to Mulder (1989: 205), the following is understood as a general rule:

- The bottom three stanines (1, 2 and 3) are regarded as below average
- The next three stanines (4, 5 and 6) are regarded as average
- The top three stanines (7, 8 and 9) are regarded as above average

The classification of the scores is given in Table 5.13.

TABLE 5.13

CLASSIFICATION OF QUESTIONNAIRE RAW SCORES INTO CATEGORIES

SECTION	BELOW AVERAGE	AVERAGE	ABOVE AVERAGE
Confidence in mathematics	15 – 39	40 – 71	72 – 90
Motivation in mathematics	15 – 49	50 – 73	74 – 90
Perception of the usefulness of mathematics	15 – 64	65 – 82	83 – 90
Perception of teachers' attitudes	15 – 65	66 – 83	84 – 90
Total questionnaire	60 – 227	228 – 300	301 – 360

5.6 TESTING OF HYPOTHESES

5.6.1 Hypothesis 1

With regard to hypothesis 1, stated in paragraph 4.3, the following null hypothesis was tested:

> There is no significant positive correlation between attitude towards mathematics and achievement in mathematics of Grade 7, 9 and 11 learners.

All 451 learners were used in the testing of this hypothesis. Grades 7, 9 and 11 are presented separately in Tables 5.14, 5.15 and 5.16 respectively.

TABLE 5.14

CORRELATION OF ACHIEVEMENT AND ATTITUDE

GRADE 7

SECTION	ACHIEVEMENT
Confidence in mathematics	0.655 *
Motivation in mathematics	0.401 *
Perception of usefulness of mathematics	0.439 *
Perception of teachers' attitudes	0.272 *
Total	0.590 *

* $p < 0.01$

TABLE 5.15

CORRELATION OF ACHIEVEMENT AND ATTITUDE

GRADE 9

SECTION	ACHIEVEMENT
Confidence in mathematics	0.650 *
Motivation in mathematics	0.457 *
Perception of usefulness of mathematics	0.442 *
Perception of teachers' attitudes	0.299 *
Total	0.601 *

* $p < 0.01$

TABLE 5.16

CORRELATION OF ACHIEVEMENT AND ATTITUDE

GRADE 11

SECTION	ACHIEVEMENT
Confidence in mathematics	0.533 *
Motivation in mathematics	0.296 *
Perception of usefulness of mathematics	0.335 *
Perception of teachers' attitudes	0.311 *
Total	0.537 *

* $p < 0.01$

According to the correlation coefficients between attitude and achievement indicated in Tables 5.14; 5.15 and 5.16, the null hypothesis is rejected at the 1% level of significance. This implies that there is a significant positive correlation between learners' attitudes towards mathematics and achievement in mathematics for each grade level. There is also a significant positive correlation for each aspect of attitude and achievement in mathematics. Therefore, confidence and motivation in mathematics, perception of the usefulness of mathematics and perception of teachers' attitudes, all relate to achievement in some way.

A significant and strong positive correlation is evident between confidence in mathematics and achievement in mathematics for all of the grades. This correlation means that a learner's confidence in mathematics relates to his/her achievement. This relation is strongest for Grade 7 learners and weakest for the Grade 11 learners.

The lowest correlation was between perception of teachers' attitudes and achievement, however, only for the Grade 7 and Grade 9 learners. The lowest correlation for the Grade 11 learners was between motivation in mathematics and achievement. For Grade 11 learners, motivation therefore, relates to achievement to a lesser extent than the other aspects of attitude.

5.6.2 Hypothesis 2

With regard to hypothesis 2 stated in paragraph 4.3, the following null hypothesis was tested:

> There is no significant difference in the attitudes of learners towards mathematics for each grade level.

The testees were divided into the following three groups:

- Group 1: Grade 7
- Group 2: Grade 9
- Group 3: Grade 11

The F-test was used to determine whether there is a significant difference between attitude towards mathematics for the different grades. This was done for all four sections of the questionnaire as well as for the total questionnaire.

5.6.2.1 Comparison between the three grades with regard to Confidence in mathematics

The average scores for confidence in mathematics were calculated for each grade. In order to compare these averages, an analysis of variance was carried out. These results appear in Table 5.17.

TABLE 5.17
RESULTS OF THE ANALYSIS OF VARIANCE FOR CONFIDENCE IN MATHEMATICS FOR EACH GRADE

GROUP	N	MEAN	SD
Grade 7	130	61.462	16.309
Grade 9	185	54.400	20.704
Grade 11	136	49.000	15.219

$F(2,448) = 16.09 \quad p < 0.01$

The null hypothesis is rejected at the 1% level of significance and therefore, there is a significant difference in confidence in mathematics between the different grades.

In order to determine between which grades this difference exists, the t-values were calculated. These appear in Table 5.18.

TABLE 5.18
T-TEST ANALYSIS OF THE VARIABLE CONFIDENCE IN MATHEMATICS FOR EACH GRADE

GROUPS	DIFFERENCE BETWEEN THE MEANS	T VALUE	SIGNIFICANCE
Grade 7 & 9	7.062	$t > 2.4$	$p < 0.05$
Grade 7 & 11	12.462	$t > 2.4$	$p < 0.05$
Grade 9 & 11	5.400	$t > 2.4$	$p < 0.05$

Based on the results in Table 5.18, there is a significant difference in confidence in mathematics between all three grades. The highest average scores for confidence in mathematics were obtained from Grade 7 learners. The average scores subsequently decrease as learners move through to Grade 11. Thus, learners' confidence in mathematics lessens as they move to a higher grade.

5.6.2.2 Comparison between the three grades with regard to Motivation in mathematics

The average scores for motivation in mathematics were calculated for each grade. In order to compare these averages, an analysis of variance was carried out. These results appear in Table 5.19.

TABLE 5.19

RESULTS OF THE ANALYSIS OF VARIANCE FOR MOTIVATION IN MATHEMATICS FOR EACH GRADE

GROUP	N	MEAN	SD
Grade 7	130	67.392	11.473
Grade 9	185	60.124	16.166
Grade 11	136	56.279	13.300

$F(2,448) = 21.36 \quad p < 0.01$

The null hypothesis is rejected at the 1% level of significance and therefore, there is a significant difference in motivation in mathematics between the different grades.

In order to determine between which grades this difference exists, the t-values were calculated. These appear in Table 5.20.

TABLE 5.20

T-TEST ANALYSIS OF THE VARIABLE MOTIVATION IN MATHEMATICS FOR EACH GRADE

GROUPS	DIFFERENCE BETWEEN THE MEANS	T VALUE	SIGNIFICANCE
Grade 7 & 9	7.268	$t > 2.4$	$p < 0.05$
Grade 7 & 11	11.113	$t > 2.4$	$p < 0.05$
Grade 9 & 11	3.845	$t > 2.4$	$p < 0.05$

There is a significant difference in motivation in mathematics between all three grades. The average scores for motivation in mathematics, are again, highest for the Grade 7 learners and lowest for the Grade 11 learners. This means that the learners' motivation in mathematics declines as they move to a higher grade.

5.6.2.3 Comparison between the three grades with regard to Perception of the usefulness of mathematics

The average scores for perception of the usefulness of mathematics were calculated for each grade. In order to compare these averages, an analysis of variance was carried out. The results appear in Table 5.21.

TABLE 5.21

RESULTS OF THE ANALYSIS OF VARIANCE FOR PERCEPTION OF THE USEFULNESS OF MATHEMATICS FOR EACH GRADE

GROUP	N	MEAN	SD
Grade 7	130	78.738	8.159
Grade 9	185	70.805	14.148
Grade 11	136	68.493	13.415

$F(2,448) = 24.97 \quad p < 0.01$

The null hypothesis is rejected at the 1% level of significance and therefore, there is a significant difference in perception of the usefulness of mathematics between the different grades.

In order to determine between which grades this difference exists, the t-values were calculated. These appear in Table 5.22.

TABLE 5.22

T-TEST ANALYSIS OF THE VARIABLE PERCEPTION OF THE USEFULNESS OF MATHEMATICS FOR EACH GRADE

GROUPS	DIFFERENCE BETWEEN THE MEANS	T VALUE	SIGNIFICANCE
Grade 7 & 9	7.933	$t > 2.4$	$p < 0.05$
Grade 7 & 11	10.246	$t > 2.4$	$p < 0.05$
Grade 9 & 11	2.313	$t < 2.4$	$p > 0.05$

There is a significant difference in perception of the usefulness of mathematics between learners in Grade 7 and 9, and learners in Grade 7 and 11.

These results indicate that there is a significant difference in the perception of the usefulness of mathematics between Grades 7 and 9. Thus, Grade 7 pupils believe in the usefulness of mathematics but as they move to secondary school this belief changes significantly and becomes weaker. This belief does not change significantly between Grade 9 and Grade 11. When a learner however reaches Grade 11, his/her perception of the usefulness of mathematics has changed significantly and has become weaker from when he/she was in Grade 7.

5.6.2.4 Comparison between the three grades with regard to Perception of teachers' attitudes

The average scores for perception of teachers' attitudes were calculated for each grade. In order to compare these averages, an analysis of variance was carried out. The results appear in Table 5.23.

TABLE 5.23

RESULTS OF THE ANALYSIS OF VARIANCE FOR PERCEPTION OF TEACHERS' ATTITUDES FOR EACH GRADE

GROUP	N	MEAN	SD
Grade 7	130	76.331	10.002
Grade 9	185	70.346	13.605
Grade 11	136	74.110	11.522

$F(2,448) = 9.99 \quad p < 0.01$

The null hypothesis is rejected at the 1% level of significance and therefore, there is a significant difference in perception of teachers' attitudes between the different grades.

In order to determine between which grades this difference exists, the t-values were calculated. These appear in Table 5.24.

TABLE 5.24

T-TEST ANALYSIS OF THE VARIABLE PERCEPTION OF TEACHERS' ATTITUDES FOR EACH GRADE

GROUPS	DIFFERENCE BETWEEN THE MEANS	T VALUE	SIGNIFICANCE
Grade 7 & 9	5.985	$t > 2.4$	$p < 0.05$
Grade 7 & 11	2.220	$t < 2.4$	$p > 0.05$
Grade 9 & 11	3.764	$t > 2.4$	$p < 0.05$

There is a significant difference in perception of teachers' attitudes between Grade 7 and 9 learners, and, Grade 9 and 11 learners. These results indicate that Grade 9 learners' perceptions of their teachers' attitudes differ significantly from the Grade 7 learners' perceptions. The Grade 9 learners' average perceptions are lower. It can

therefore, be said that they do not perceive their teachers' attitudes as favourably as the Grade 7 learners do.

There is also a significant difference between Grade 9 and Grade 11 learners' perceptions. The Grade 11 learners' average perceptions of their teachers' attitudes increase from the Grade 9 level.

The learners' average perceptions of teachers' attitudes thus decrease in Grade 9 and increase again in Grade 11.

5.6.2.5 Comparison between the three grades with regard to the total questionnaire

The average scores for the three grades with regard to the total questionnaire were calculated. In order to compare these averages, an analysis of variance was carried out. These results appear in Table 5.25.

TABLE 5.25
RESULTS OF THE ANALYSIS OF VARIANCE FOR THE TOTAL QUESTIONNAIRE FOR EACH GRADE

GROUP	N	MEAN	SD
Grade 7	130	283.923	36.564
Grade 9	185	255.676	51.866
Grade 11	136	247.882	37.431

$F(2,448) = 25.33 \quad p < 0.01$

The null hypothesis is rejected at the 1% level of significance and therefore, there is a significant difference in the average attitudes between the different grades.

In order to determine between which grades this difference exists, the t-values were calculated. These appear in Table 5.26.

TABLE 5.26

T-TEST ANALYSIS OF THE TOTAL QUESTIONNAIRE FOR EACH GRADE

GROUPS	DIFFERENCE BETWEEN THE MEANS	T VALUE	SIGNIFICANCE
Grade 7 & 9	28.247	$t > 2.4$	$p < 0.05$
Grade 7 & 11	36.041	$t > 2.4$	$p < 0.05$
Grade 9 & 11	7.793	$t < 2.4$	$p > 0.05$

There is a significant difference in attitude towards mathematics between learners in Grade 7 and 9, and learners in Grade 7 and 11.

The learner's mean attitude towards mathematics scores are significantly higher in Grade 7 than in Grade 9 and therefore, the learners attitude towards mathematics declines significantly as he/she moves from Grade 7 to Grade 9. Moving from Grade 9 to Grade 11 the average attitude does not change significantly but continues to decline as compared to the Grade 7 learners' average scores. There is also a significant difference in the mean attitude towards mathematics scores between Grade 7 and Grade 11 learners with the mean attitude towards mathematics scores for the Grade 7 learners being higher than the scores for the Grade 11 learners.

5.6.3 Hypothesis 3

With regard to hypothesis 3 stated in paragraph 4.3, the following null hypothesis was tested:

> There is no significant difference between male and female attitudes towards mathematics of learners in grade 7, 9 and 11.

All 451 learners were used in the testing of this hypothesis. The average attitude scores towards mathematics were calculated for males and females in each grade. T-tests were used. These values appear in Tables 5.27, 5.28 and 5.29.

TABLE 5.27

DIFFERENCE BETWEEN ATTITUDE TOWARDS MATHEMATICS OF MALES AND FEMALES

GRADE 7

VARIABLE	GENDER	NO.	MEAN	STD DEV	T	DF	P
Confidence	M	56	63.089	16.144			
	F	74	60.230	16.435	0.990	128.0	p>0.05
Motivation	M	56	67.286	11.633			
	F	74	67.473	11.430	0.092	128.0	p>0.05
Usefulness	M	56	79.929	7.417			
	F	74	77.838	8.618	1.453	128.0	p>0.05
Teachers	M	56	73.357	11.364			*
	F	74	78.581	8.220	3.042	128.0	p<0.01
Total	M	56	283.661	37.329			
	F	74	284.122	36.229	0.071	128.0	p>0.05

* Significant at the 1% level

The null hypothesis is rejected with regard to perception of teachers' attitudes for males and females in Grade 7 indicating a significant difference. The mean perceptions of teachers' attitudes are higher for females than males; therefore, females in Grade 7 generally view teachers more favourably than males. With regard to the other facets of attitude there is no significant difference between males and females in Grade 7.

TABLE 5.28

DIFFERENCE BETWEEN ATTITUDE TOWARDS MATHEMATICS OF MALES AND FEMALES

GRADE 9

VARIABLE	GENDER	NO.	MEAN	STD DEV	T	DF	P
Confidence	M	98	55.888	20.697			
	F	87	52.724	20.704	1.038	183.0	p>0.05
Motivation	M	98	59.796	16.902			
	F	87	60.494	15.383	0.293	183.0	p>0.05
Usefulness	M	98	70.959	14.774			
	F	87	70.632	13.491	0.157	183.0	p>0.05
Teachers	M	98	67.745	14.582			*
	F	87	73.276	11.824	2.811	183.0	p<0.01
Total	M	98	254.388	54.880			
	F	87	257.126	48.523	0.358	183.0	p>0.05

* Significant at the 1% level

With regard to perception of teachers' attitudes for Grade 9 male and female learners, the null hypothesis is rejected. This indicates a significant difference in perception of teachers' attitudes between males and females in Grade 9. The average perceptions of teachers' attitudes are higher for females than males. For this reason, females in Grade 9 generally view teachers more favourably than males. No significant difference between males and females in Grade 9 was found with regard to the other facets of attitude.

TABLE 5.29

DIFFERENCE BETWEEN ATTITUDE TOWARDS MATHEMATICS OF MALES AND FEMALES

GRADE 11

VARIABLE	GENDER	NO.	MEAN	STD DEV	T	DF	P
Confidence	M	61	49.770	16.053			
	F	75	48.373	14.585	0.531	134.0	p>0.05
Motivation	M	61	56.639	13.059			
	F	75	55.987	13.574	0.284	134.0	p>0.05
Usefulness	M	61	69.787	13.036			
	F	75	67.440	13.713	1.015	134.0	p>0.05
Teachers	M	61	71.557	12.548			*
	F	75	76.187	10.237	2.370	134.0	p<0.05
Total	M	61	247.754	37.628			
	F	75	247.987	37.523	0.036	134.0	p>0.05

* Significant at the 1% level

For Grade 11 male and female learners, the null hypothesis is rejected with regard to perception of teachers' attitudes. A significant difference in perception of teachers' attitudes between males and females in Grade 11 is thus indicated. The mean perceptions of teachers' attitudes are higher for females than males and this shows that females in Grade 11 generally view teachers more favourably than males. With regard to the other facets of attitude, no significant difference was found between males and females in Grade 11.

A comparison of the attitudes of males and females in Grade 7, 9 and 11 indicates that there is a significant difference between males and females regarding perception

of teachers' attitudes. For the other three facets of attitude in these particular three grades, no significant difference between males and females is found.

5.6.4 Hypothesis 4

With regard to hypothesis 4 stated in paragraph 4.3, the following null hypothesis was tested:

> There is no significant difference in attitude towards mathematics for each ethnic group of learners in grade 7, 9 and 11.

The testees were divided into the following three groups of ethnicity on the basis of the language they speak at home:

- Group 1: English
- Group 2: Afrikaans
- Group 3: African language

The F-test was used to determine whether there is a significant difference between attitude towards mathematics in the different language groups. This was done for all four sections of the questionnaire as well as for the total questionnaire.

5.6.4.1 Comparison between the three language groups with regard to Confidence in mathematics

The average scores for confidence in mathematics were calculated for each language group. In order to compare these averages, an analysis of variance was carried out. These results appear in Table 5.30.

TABLE 5.30

RESULTS OF THE ANALYSIS OF VARIANCE FOR CONFIDENCE IN MATHEMATICS FOR ETHNIC GROUP

GROUP	N	MEAN	SD
English	273	52.711	19.011
Afrikaans	59	53.407	18.684
African	75	56.120	15.953

$F(2,404) = 1.01 \quad p > 0.05$

The null hypothesis cannot be rejected and therefore, there is no significant difference in confidence in mathematics between the three different language groups.

5.6.4.2 Comparison between the three language groups with regard to Motivation in mathematics

The average motivation for mathematics scores for each of the three language groups was calculated and an analysis of variance was carried out in order to compare them. These results appear in Table 5.31.

TABLE 5.31

RESULTS OF AN ANALYISIS OF VARIANCE FOR MOTIVATION IN MATHEMATICS FOR ETHNIC GROUPS

GROUP	N	MEAN	SD
English	273	58.879	15.520
Afrikaans	59	61.119	14.713
African	75	65.400	10.961

$F(2,404) = 5.89 \quad p < 0.01$

The null hypothesis can be rejected at the 1% level of significance. Therefore, there is a significant difference in the average motivation in mathematics between the three language groups.

In order to determine between which language groups this difference exists, the t-values were calculated. These appear in Table 5.32.

TABLE 5.32

T-TEST ANALYSIS OF THE VARIABLE MOTIVATION IN MATHEMATICS

GROUPS	DIFFERENCE BETWEEN THE MEANS	T VALUE	SIGNIFICANCE
English & Afrikaans	2.240	$t < 2.4$	$p > 0.05$
English & African	6.521	$t > 2.4$	$p < 0.05$
Afrikaans & African	4.281	$t < 2.4$	$p > 0.05$

There is a significant difference in motivation in mathematics between learners who speak English and learners who speak an African language at home. Since the average scores for motivation in mathematics are higher for African speaking learners than for English speaking learners, learners who speak an African language at home are significantly more motivated in mathematics than learners who speak English at home.

5.6.4.3 Comparison between the three language groups with regard to Perception of the usefulness of mathematics

The average scores for perception of the usefulness of mathematics were calculated for each language group. In order to compare these averages, an analysis of variance was carried out. These results appear in Table 5.33.

TABLE 5.33

RESULTS OF AN ANALYISIS OF VARIANCE FOR PERCEPTION OF THE USEFULNESS OF MATHEMATICS FOR ETHNIC GROUPS

GROUP	N	MEAN	SD
English	273	71.117	14.142
Afrikaans	59	72.576	13.698
African	75	74.160	8.926

$F(2,404) = 1.64 \quad p > 0.05$

The null hypothesis cannot be rejected and therefore, there is not a significant difference in the average perception of the usefulness of mathematics between the three language groups.

5.6.4.4 Comparison between the three language groups with regard to Perception of teachers' attitudes

The average perception of teachers' attitudes for each of the three language groups was calculated and an analysis of variance was carried out in order to compare them. These results appear in Table 5.34.

TABLE 5.34

RESULTS OF AN ANALYISIS OF VARIANCE FOR PERCEPTION OF TEACHERS' ATTITUDES FOR ETHNIC GROUPS

GROUP	N	MEAN	SD
English	273	72.982	12.692
Afrikaans	59	74.593	12.575
African	75	72.853	12.385

$F(2,404) = 0.43 \quad p > 0.05$

The null hypothesis cannot be rejected and therefore, there is not a significant difference in the average perception of teachers' attitudes between the three language groups.

5.6.4.5 Comparison between the three language groups with regard to the total questionnaire

The averages for the three language groups with regard to the total questionnaire were calculated. In order to compare these averages, an analysis of variance was carried out. These results appear in Table 5.35.

TABLE 5.35
RESULTS OF THE ANALYSIS OF VARIANCE FOR THE TOTAL QUESTIONNAIRE FOR ETHNIC GROUPS

GROUP	N	MEAN	SD
English	273	255.689	48.506
Afrikaans	59	261.695	50.232
African	75	268.533	33.031

$F(2,404) = 2.38 \qquad p > 0.05$

The null hypothesis cannot be rejected and therefore, there is not a significant difference in the average total score of the questionnaire between the three language groups. Therefore, there is not a significant difference in attitude towards mathematics between the three language groups.

5.6.5 Hypothesis 5

With regard to hypothesis 5 stated in paragraph 4.3, the following null hypothesis was tested:

> There is no significant difference in mathematics achievement between male and female learners in grade 7, 9 and 11.

All 451 learners were used in the testing of this hypothesis. The differences in achievement between Grades 7, 9 and 11 is presented in Table 5.36.

TABLE 5.36
DIFFERENCE BETWEEN ACHIEVEMENT OF MALES AND FEMALES

GRADE	GENDER	NO.	MEAN	STD DEV	T	DF	P
Grade 7	M	56	65.410	13.409			
	F	74	68.649	12.199	1.436	128.0	p>0.05
Grade 9	M	98	52.224	25.288			
	F	87	57.954	23.671	1.585	183.0	p>0.05
Grade 11	M	61	43.853	18.639			
	F	75	51.493	19.184	2.340	134.0	p<0.05

The null hypothesis cannot be rejected for Grades 7 and 9, and therefore, there is not a significant difference in achievement between males and females for Grades 7 and 9.

The null hypothesis is however, rejected for Grade 11. A significant difference in achievement between males and females in Grade 11 exists. The average score for achievement in mathematics is higher for females indicating that females achieve significantly better than males in Grade 11.

5.6.6 Hypothesis 6

With regard to hypothesis 5 stated in paragraph 4.3, the following null hypothesis was tested:

> There is no significant difference in mathematics achievement between each ethnic group of learners in grade 7, 9 and 11.

The average scores for achievement in mathematics were calculated for each language group. In order to compare these averages, an analysis of variance was carried out. These results appear in Table 5.37.

TABLE 5.37
RESULTS OF THE ANALYSIS OF VARIANCE FOR ACHIEVMENT IN MATHEMATICS

GROUP	N	MEAN	SD
English	273	55.454	21.815
Afrikaans	59	58.797	21.320
African	75	51.187	16.858

$F(2,404) = 2.27 \qquad p > 0.05$

The null hypothesis cannot be rejected and therefore, there is not a significant difference in the average achievement in mathematics between the three language groups.

5.7 CONCLUSION

An item analysis was carried out for each section as well as for the whole questionnaire. No items were excluded from the questionnaire.

The reliability of the questionnaire was measured by calculating the Alpha reliability coefficient. This was found to be 0.946 for the total questionnaire and therefore, it can be considered to be a reliable measuring instrument.

The construct validity of the questionnaire was measured by calculating correlation coefficients between the four different constructs and between each construct and the total questionnaire. All of the correlations were high positive correlations significant on the 1% level. The different constructs strongly relate to one another and thus the questionnaire is construct valid.

Norms for the questionnaire were calculated by converting the raw scores to stanines.

The following conclusions were arrived at after the testing of the hypotheses:

- There is a significant positive correlation between learners' attitude towards mathematics and achievement in mathematics for each grade level.
- There is a significant difference in confidence in mathematics between all three grades.
- There is a significant difference in motivation in mathematics between all three grades.
- There is a significant difference in perception of the usefulness of mathematics between learners in Grade 7 and 9, and Grade 9 and 11.
- There is a significant difference in perception of teachers' attitudes between learners in Grade 7 and 9, and Grade 9 and 11.
- There is a significant difference in attitude towards mathematics between Grades 7 and 9, and Grades 7 and 11.
- There is a significant difference in perception of teachers' attitudes between males and females for all three grades.
- With regard to confidence, motivation and perception of the usefulness of mathematics there is no significant difference between males and females for all of the grades.
- There is no significant difference in confidence in mathematics between the three different language groups.
- There is a significant difference in motivation in mathematics between learners who speak English at home and learners who speak an African language at home.
- There is no significant difference in the average perception of the usefulness of mathematics between the three language groups.
- There is no significant difference in the average perception of teachers' attitudes between the three language groups.
- There is no significant difference in average attitude towards mathematics between the three language groups.
- There is no significant difference in achievement between males and females for Grades 7 and 9.
- There is a significant difference in achievement between males and females in Grade 11.
- There is no significant difference in average achievement in mathematics between the three language groups.

CHAPTER 6

FINDINGS, RECOMMENDATIONS AND CONCLUSION

To receive a proper education is the source and root of all goodness.

(Plutarch cited in Ryan & Cooper, 1988: 529)

CHAPTER 6

FINDINGS, CONCLUSION AND RECOMMENDATIONS

6.1 INTRODUCTION

The purpose of this research project is an attempt to answer the following main question:

> **Is there a relationship between attitude towards mathematics and achievement in mathematics?**

This main question was divided into sub-questions which, together with the main question stated as a hypothesis, all served as hypotheses. The sub-questions related to gender, grade and ethnicity.

In this chapter the findings are discussed and comparisons are made with previous research. Recommendations and suggestions for further research are given.

6.2 SUMMARY OF THE FINDINGS

6.2.1 Findings from the literature reviews

Literature reviews were conducted on the two subjects of *attitudes* and *achievement*. Chapter 2 focused upon the theory of attitudes as well as on attitudes relating to mathematics. Chapter 3 focused upon achievement and some factors that influence achievement. Only the factors relating to this research project were discussed. Attitudes relating to mathematics achievement were discussed at the end of Chapter 3.

Based on the literature review it is evident that attitudes have been, and still are, defined in various ways. The researcher chose Eagly & Chaiken's (1993: 1) definition of attitude, as it is comprehensive. Attitudes consist of three components, namely: an affective, cognitive and behavioural component. Evaluation has to take place for an attitude to develop and evaluations can fall into one of the three components. Attitudes are not necessarily expressed but it is through expression

that attitudes are observed. Attitudes are learned in various ways and serve various functions to humans.

For the purpose of this research project *attitude towards mathematics* was defined as *a psychological tendency that is expressed by evaluating the subject of mathematics with some degree of favour or disfavour.* The concept *attitude towards mathematics* was divided into four facets, namely:

- The learners' confidence in mathematics
- The learners' motivation in mathematics
- The learners' perception of the usefulness of mathematics, and,
- The learners' perception of teachers' behaviour and attitudes.

Attitudes towards mathematics develop in various ways, but parents, teachers and peers seem to influence the development of these attitudes the most. The following summarises some of the findings on attitudes towards mathematics:

- Learners' confidence, enjoyment and interest in mathematics declines as learners move through elementary school to secondary school.

- At elementary school level, little identifiable difference is observed between males and females with regard to attitude towards mathematics and confidence in mathematics.

- Mathematics is generally accepted as being useful across all ages, however, small differences have been reported between males and females.

- Gender differences exist in secondary school with regard to confidence in mathematics and participation in further study, with males being more confident and continuing in further study of mathematics.

- People hold different ideas as to the nature of mathematics.

Achievement in mathematics is influenced by various factors, some of which relate to gender, language, the teacher and attitudes. Gender differences exist in mathematics learning and achievement.

The following summarises some findings relating to gender and mathematics:

- At elementary school level, differences in achievement between males and females are minimal.

- At secondary school level, the popular belief is that males generally achieve better in mathematics than females. Results however, have been contradictory. In some studies, gender differences in mathematics achievement have not been found while some studies found minimal differences.

- Males generally continue with mathematics to a higher level than females.

Language affects a persons thinking and learning. Mathematics has a language of its own and the learning of mathematics is dependent on the mastery of the mathematical language and the language of instruction. Learning mathematics in a second language influences achievement in the subject.

The teacher influences learners in many ways among others, a learner's attitude towards mathematics. It is not only the teacher's true behaviour and his or her own attitudes that can influence a learner's attitude but also the learner's perception of the teacher's attitudes influences the development of the learners' attitudes.

Literature reviews of South Africa and countries abroad show ethnic differences in mathematics achievement. Differences in mathematical attitudes among different ethnic groups, seemingly also contributes to differences in achievement.

In the final section of Chapter 3 a literature review is provided on attitudes and the manner in which they influence achievement. Some studies have proved that attitudes relate to achievement while other studies have shown this not to be true. Researchers (Papanastasiou, 2000; Abu-Hilal, 2000) recommend that further research is necessary on the relationship between attitude towards mathematics and achievement in mathematics.

6.2.2 Findings from the empirical research

From the empirical investigation the following was found with regard to the hypotheses.

6.2.2.1 Hypothesis 1

There is a significant positive correlation between attitudes towards mathematics and achievement in mathematics of Grade 7, 9 and 11 learners.

All 451 learners were used in the testing of the null hypothesis as stated in paragraph 5.6.1. The results indicated a significant positive correlation between learners' attitudes towards mathematics and achievement in mathematics for each grade level. Each facet of attitude was also tested and a significant positive correlation was also found.

A significant and strong positive correlation was found between confidence in mathematics and achievement in mathematics for all of the grades. The relation was strongest for Grade 7 learners and weakest for Grade 11 learners. It can therefore, be said that confidence relates to achievement to a greater extent for Grade 7 learners than for Grade 9 and 11 learners.

The lowest correlation was found between perception of teachers' attitudes and achievement, however, only for Grade 7 and Grade 9 learners. For Grade 11 learners, the lowest correlation was found between motivation in mathematics and achievement. Motivation thus seemed to relate to achievement to a lesser extent than the other aspects of attitude for Grade 11 learners.

6.2.2.2 Hypothesis 2

There is a significant difference in the attitudes of learners towards mathematics for each grade level.

The null hypothesis was tested on all four sections of the questionnaire as well as for the total questionnaire. The findings indicated that there is a significant difference in confidence in mathematics for each grade. There was also a significant difference in motivation in mathematics for each grade. With regard to perception of the

usefulness of mathematics, there was a significant difference between learners in Grade 7 and 9, and Grade 7 and 11. Grade 7 learners seem to believe in the usefulness of mathematics but as they move to secondary school this belief changes significantly and becomes weaker. This belief does not change significantly between Grade 9 and Grade 11. When a learner however reaches Grade 11, his or her perception of the usefulness of mathematics has changed significantly (become weaker) from the way it used to be when he/she was in Grade 7. Another finding is that there is a significant difference in perception of teachers' attitudes between learners in Grade 7 and 9, and Grade 9 and 11. This indicates that Grade 9 learners' perceptions of their teachers' attitudes differ significantly from Grade 7 learners' perceptions. The Grade 9 learners' average perceptions are lower, thus they consequently do not perceive their teachers' attitudes as favourably as Grade 7 learners do. The results also indicate a significant difference between the Grade 9 and Grade 11 learners' perceptions. The Grade 11 learners' average perception of their teachers' attitudes increase from Grade 9. Therefore, the learners' average perception of teachers' attitudes decrease in Grade 9 and increase again in Grade 11, but not to the same level as in Grade 7. Lastly, it was found that there is a significant difference in attitudes towards mathematics between learners in Grade 7 and 9, and Grade 7 and 11. This indicates that the learner's average attitude towards mathematics declines significantly as he/she moves from Grade 7 to Grade 9. Moving then from Grade 9 to Grade 11 this average attitude does not change significantly but continues to decline. The average attitude towards mathematics between Grade 7 and Grade 11 learners differs significantly.

6.2.2.3 Hypothesis 3

There is a significant difference between male and female attitudes towards mathematics of learners in Grade 7, 9 and 11.

Based on the results of the empirical investigation it was found that there is a significant difference in perception of teachers' attitudes between males and females for all three grades. With regard to the other facets of attitude there was no significant difference between males and females for all of the grades.

6.2.2.4 Hypothesis 4

There is a significant difference in attitudes towards mathematics for each ethnic group of learners in grade 7, 9 and 11.

Based on the results of the empirical investigation it was found that there is no significant difference in the average score for confidence in mathematics, perception of the usefulness of mathematics and perception of teachers' attitudes between the three different language groups. There was however, a significant difference in motivation in mathematics between learners who speak English at home and learners who speak an African language at home. In total, there was no significant difference in the average attitude towards mathematics between the three language groups.

6.2.2.5 Hypothesis 5

There is a significant difference in mathematics achievement between male and female learners in Grade 7, 9 and 11.

Based on the results of the empirical investigation, there was no significant difference in achievement between males and females for Grades 7 and 9. There was however, a significant difference in achievement between males and females in Grade 11. Females achieve significantly better than males in Grade 11.

6.2.2.6 Hypothesis 6

There is a significant difference in mathematics achievement between each ethnic group of learners in Grade7, 9 and 11.

The null hypothesis was tested and it was found that there is no significant difference in the average score for mathematics achievement between the three language groups.

6.3 COMPARISON OF THE FINDINGS FROM THE LITERATURE REVIEW AND THE FINDINGS FROM THE EMPIRICAL INVESTIGATION

The following is a comparison of the findings from the literature review and the empirical investigation. Each facet of attitude and achievement is discussed separately and attitude as a whole is discussed lastly.

Based on the results of the empirical investigation, there is a significant difference in confidence in mathematics between Grades 7, 9 and 11. This finding corresponds with the literature findings that confidence in mathematics declines as learners move through the grades. Concurring with the findings of the literature, confidence in mathematics significantly positively correlates with achievement for all three grades (Reyes & Stanic, 1988: 34; Cheung, 1988 cited in Kloosterman, 1994: 3641). There is no significant difference in confidence in mathematics between males and females for all three grades. This concurs, in part, with the research conducted by Eccles (1984) cited in Iben (1991: 141) that males and females have equal confidence scores during the elementary grades. This research however, does not correspond with the findings of the literature that females have less confidence in their ability to do mathematics (Dossey, Mullis, Lindquist & Chambers, 1988 cited in Iben, 1991: 141; Shashaani, 1995: 32; Steinback & Gwizdala, 1995: 38). There is no significant difference in confidence in mathematics between the three different language groups.

Motivation in mathematics is significantly related to mathematics achievement for all three grades. There is a significant difference in motivation between the three grades. Motivation declines significantly as learners move through the grades. There is no significant difference in motivation between males and females across the three grades. With regard to motivation among different ethnic groups, there is a significant difference in motivation between learners who speak an African language and learners who speak English at home. Learners who speak an African language are more motivated.

With regard to the perception of the usefulness of mathematics, there is a significant positive correlation with achievement. This finding confirms other findings (Meece, Parsons, Kaczala, Goff & Futterman, 1982 and Sherman & Fennema, 1977 cited in Reyes & Stanic, 1988: 35). Learners' ideas of the value of mathematics decline as they move to a higher grade. There is a significant difference between the elementary school learner and the secondary school learner. This seems to contradict literature. There is no significant difference between males and females with regard to the perception of the usefulness of mathematics over all three grades, which contradicts research of Tocci & Engelhard (1991: 284). There is no significant

difference in the perception of the usefulness of mathematics between the different ethnic groups.

Perception of teachers' attitudes is significantly positively correlated with mathematics achievement for all three grades. There is a significant difference between Grade 7 learners and Grade 9 learners. Grade 7 learners have more favourable perceptions of their teachers than Grade 9 learners. There is also a significant difference in perceptions of teachers' attitudes between Grade 9 and Grade 11 learners. Grade 9 learners have the least favourable perceptions. The average score for perception of teachers' attitudes decreases from Grade 7 to Grade 9 and increases again in Grade 11. This finding concurs with the work of Messinger (1992) cited in Masutha & Ackermann (1999: 243) that older students have more positive perceptions of their teachers' behaviour. In this research project the Grade 11 learners' scores were not as high as those of the Grade 7 learners'. There is a significant difference in the perceptions of teachers' attitudes between males and females for all three grades. Females generally perceive their teachers' attitudes more favourably. This supports the findings of the literature (Homburger, 1991 cited in Masutha & Ackermann, 1999: 243). There is no significant difference between the ethnic groups with regard to perception of teachers' attitudes.

With regard to achievement, there is no significant difference in achievement between males and females for Grades 7 and 9. There is however, a significant difference in achievement between males and females for the Grade 11 learners. The average score for achievement in mathematics is higher for females than males in Grade 11. The results of the empirical research are similar to the literature where no significant differences in achievement are evident until adolescence (Visser, 1989: 213; Shashaani, 1995: 33; Barnard & Cronjè, 1996: 3). Howie et al. (2000: 67) reports that males and females of Grades 7 and 8 had similar achievement scores, which is similar to the findings of this research project. Findings from this research project however, contradict literature findings where the popular belief is that males achieve significantly better than females (Fennema & Carpenter, 1981 cited in Reyes & Stanic, 1988: 31; Visser, 1987: 137; Visser, 1989: 213; Kaiser-Messmer, 1993: 220; Barnard & Cronjè, 1996: 1). There is no significant difference in achievement between the different language groups, which contradicts certain literature (House, 1993: 62). This finding contradicts with literature that black learners achieve lower mathematics scores than white learners (Reyes & Stanic, 1988: 31).

It can be noted in summation that there is a significant positive correlation between attitude towards mathematics and achievement in mathematics over all three grades. This finding concurs with certain literature that there is a positive relationship between attitudes and achievement in mathematics (Aiken, 1976: 296; Cheung, 1988: 211; Higbee & Thomas, 1999: 12; Papanastasiou, 2000: 4). This finding however, also contradicts certain literature (Wilson, 1981, cited in Papanastasiou, 2000: 28). Attitudes towards mathematics decrease significantly between elementary school and secondary school. This finding concurs with the following findings from literature, namely: attitudes are more positive in the elementary grades (Aiken, 1970: 555); the correlation of attitude and achievement in mathematics varies with grade level (Aiken, 1976: 296); and junior secondary school years seem to be particularly important for attitudes towards mathematics as this is the time when negative attitudes develop (Aiken, 1970: 556; Aiken, 1976: 296; Ma & Kishor, 1997: 35). The finding from the research project also concurs with literature pointing out that attitudes found in the elementary grades begin to decline as learners move through to the secondary school (McLeod, 1992: 576). There is no significant difference in attitude between males and females over all three grades. This concurs with some literature findings (Visser, 1989: 213; Shashaani, 1995: 35; Ma & Kishor, 1997: 43) but contradicts other literature findings (Pederson, Bleyer & Elmore, 1985 cited in Tocci & Engelhard, 1991: 280; Tocci & Engelhard, 1991: 280). With regard to the different ethnic groups there is no significant difference in attitude towards mathematics. This finding concurs with some literature findings, on the one hand, that the attitude and achievement relationship is similar among ethnic groups (Aiken, 1976: 295). However, on the other hand, it contradicts some literature findings (Ma & Kishor, 1997: 36).

6.4 LIMITATIONS OF THE RESEARCH PROJECT

The following can be regarded as limitations of the research project:

- The possibility that a reciprocal relationship exists between attitudes towards mathematics and achievement in mathematics is excluded.

- Attitudes towards specific content areas in mathematics (e.g. algebra and geometry) were not measured.

- More than one type of measure of achievement could have been included (for example, school grades and standardised tests).

6.5 RECOMMENDATIONS

6.5.1 Recommendations for educators

- There should be emphasis on improving learners' attitudes towards mathematics. Abu-Hilal (2000: 82) suggests that although attitudes to school subjects are unique and distinct, they are interrelated. Therefore, any intervention to foster positive attitudes towards mathematics among learners may influence their attitudes towards other subjects as well.

- Attitudes are learned and can therefore, become important educational objectives.

- Based on the finding that learners' perception of their teachers' behaviour and attitudes correlates significantly and positively with achievement, it is recommended that the teacher (within the framework of outcomes based education) act as and be perceived by learners as a major source of support and as a facilitator of learning.

6.5.2 Recommendations for parents

- Raising parents' awareness of the influence of attitudes on achievement in mathematics is recommended.

- Attitudes are learned. Therefore, positive attitudes can be taught in the home.

- Learners' poor achievements in mathematics may not necessarily be ascribed to ability. The existence of poor attitudes must be considered.

6.5.3 Recommendations for learners

- One's attitude towards mathematics influences achievement.

6.6 SUGGESTIONS FOR FURTHER RESEARCH

- Research into the reciprocal relationship of attitudes and achievement in mathematics is suggested.

- Attitudes towards specific aspects of mathematics (for example, algebra and geometry) can be researched.

- More information on the attitudes of teachers and the consequences on learners should be researched. The expectations of teachers and the effects on learners' attitudes and achievement would be useful.

- Guidelines can be developed on techniques for developing positive attitudes and modifying negative attitudes towards mathematics.

- Standardised test scores as well as school grades can be correlated with attitudes towards mathematics.

- The inclusion of mathematical ability in the correlations between attitude and achievement in mathematics can be researched.

- Comparisons can be made between different schools with regard to the relationship between attitude and achievement, as school sizes, schools general socio-economic status and practices could influence the relationship.

6.7 CONCLUSION

The main research question in this research project was to determine if a relationship exists between attitude towards mathematics and achievement in mathematics of learners in Grades 7, 9 and 11. Based on the empirical investigation, a significant positive correlation exists between attitude towards mathematics and achievement in mathematics for all three grades.

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APPENDIX A

QUESTIONNAIRE

Your Full Name: .....

Please provide the following information by filling in the number next to the statement which you have selected, in the block provided.

1 Grade

Grade 7	1
Grade 9	2
Grade 11	3

2 Gender

Male	1
Female	2

3 Language you speak at home

English	1
Afrikaans	2
African language	3
Other	4
(please specify)	
.....	

INSTRUCTIONS

On the following pages is a series of statements. Consider each statement carefully and answer how you feel about the statement.

Indicate your feelings regarding the statement, by making a choice on a scale from **6 (Strongly Agree** with the statement) to **1 (Strongly Disagree** with the statement). Write the number (1 – 6) in the block alongside the statement.

Remember:

- This is not a test. There are no "right" or "wrong" answers.
- Consider each statement on its own.
- Make sure you have answered every statement.
- Please be completely honest.
- Your answers will be treated with the strict confidentiality.
- Work as quickly as possible.

Thank You

Strongly Agree 6 5 4 3 2 1 Strongly Disagree

The statements altered specifically for the Grade 7 learners appear under the respective statement in italics.

Key: A : Item adapted from Aiken
F : Item adapted from Fennema
O : Own item written

A	1.	Mathematics is my most dreaded subject *I do not look forward to maths*
F	2.	A maths test scares me
F	3.	Generally, I feel confident about doing maths
F	4.	Most subjects I can cope with, but I have a way of messing up in maths
A/F	5.	Mathematics makes me feel nervous
F	6.	Mathematics is boring
F	7.	I do as little work in maths as possible
A	8.	Maths is very interesting
F	9.	When a problem in maths is left unanswered, I continue to think about it afterwards
A	10.	Maths is boring, because it leaves no room for personal opinion *Maths is boring, because you cannot have your own personal opinion*
A	11.	Maths has contributed greatly to science and other fields of knowledge *Maths has contributed a lot to science and other fields of knowledge*

A	12.	Maths is needed in order to keep the world running *Maths is needed to keep the world running*
A	13.	Maths is needed to design practically everything *Maths is needed to design nearly everything*
A	14.	Maths is not important in everyday life
A	15.	Maths helps to develop a person's mind and teaches him/her to think
O	16.	My teacher is interested in my progress in maths
O	17.	My teacher has encouraged me to study more for maths
O	18.	My teacher thinks I should *not* continue with maths *My teacher thinks I should not do maths in high school*
O	19.	My teacher would not believe me if I told him/her I was interested in a career in maths *My teacher would not believe me if I told him/her I was interested in a job in maths*
O	20.	My maths teacher has made me feel I can do well in maths
A/F	21.	Mathematics makes me feel tense
F	22.	I get a sinking feeling when I think of trying difficult maths problems
F	23.	For some reason, even though I have studied, maths seems unusually difficult for me
F	24.	I am usually relaxed in maths class
A	25.	I always enjoy studying maths
F	26.	I like doing maths problems and questions
A	27.	I want to gain further knowledge of mathematics *I want to get more knowledge of mathematics*
F	28.	Figuring out mathematical problems does not appeal to me *Solving maths questions does not interest me*
A	29.	I am prepared to use mathematics in a future job
F	30.	When I cannot solve a a maths question immediately, I stick with it until I have the solution
A	31.	An understanding of mathematics is needed by artists and writers, as well as scientists
A/F	32.	Maths is a worthwhile and necessary subject
O	33.	Too much emphasis is currently being placed on the importance of mathematics *Too much emphasis is being placed on the importance of maths at the moment*

A	34.	Mathematics is not important for the development of civilization and society
A	35.	Mathematics is less important than art or literature *Maths is less important than art of English*
O	36.	My teacher enjoys teaching maths
O	37.	My maths teacher expects boys to perform better than girls *My maths teacher expects boys to do better than girls*
O	38.	My maths teacher is unfair towards pupils
O	39.	My maths teacher gets impatient when pupils ask for help
O	40.	My maths teacher always encourages us to work hard in maths
F	41.	Mathematics doesn't scare me at all
F	42.	Mathematics makes me feel restless *Maths makes me feel fidgety*
F	43.	I have a lot of self-confidence in doing mathematics
A/F	44.	Mathematics confuses me
F	45.	I am usually at ease during maths tests and exams *I am usually calm during maths tests*
F	46.	Once I start to work on a maths question, I find it hard to stop
A	47.	I would like to develop my mathematical skills and study the subject more *I would like to improve my maths skills and study the subject more*
F	48.	The challenge of solving mathematical problems does not appeal to me *Solving maths problems does not interest me*
F	49.	I am challenged by mathematical problems that I do not understand immediately
F	50.	I don't understand how some people can spend so much time on maths and seem to enjoy it
O	51.	Doing well in maths is important because society places emphasis on maths achievement
O	52.	I will need maths in my future
O	53.	I will rarely use mathematics in my future life *I will not use maths often in my future life*
O	54.	Taking mathematics is a waste of time
O	55.	Having knowledge of maths will one day help me earn a living
O	56.	It is difficult to get my maths teacher to like me

O 57. I have a hard time getting my teacher to talk seriously with me about my maths progress

I struggle to get my teacher to talk seriously with me about my maths progress

O 58. My maths teacher enjoys talking to us

O 59. I can easily go to my maths teacher for help with a maths problem

O 60. My maths teacher expects boys and girls to perform equally well

My maths teacher expects boys and girls to perform the same

APPENDIX B

LIST OF OTHER QUESTIONNAIRES AND TESTS AVAILABLE TESTING MATHEMATICAL ATTITUDE

Title: Mathematics Attitude Inventory
Author: Richard Sandman
Abstract: Measures attitudes toward mathematics of secondary school students in grades 7 through 12. Determines group attitudes toward mathematics and the changes in these attitudes.
Number of test items: 48
Grade level(s): 7–12
Publication date: 1972
ETS tracking number: TC015295

Title: Inventory of Affective Aspects of School
Author: Thomas Haladyna and Joan Shaughnessy
Abstract: three versions of this instrument measure attitudes of students in grades 4, 7, and 9 and teachers. They are said to be useful across grades 4-12. The grade 4-6 version measures 34 variables, and for grades 7-12, 45 variables. Scales are said to be useful in measuring changes in the classroom over time but not for measuring individual student change. A small computer and program can be used for scoring. Some of the variables include: satisfaction with the class, fatalism, teacher enthusiasm and support, cohesiveness, friction. These tools were designed for use in research on correlates of attitudes toward subjects.
Grade level(s): 4-12
Publication date: 1982
ETS tracking number: TC014938

Title: Fennema-Sherman Mathematics Attitudes Scales
Author: Elizabeth Fennema and Julia Sherman
Abstract: Measures some important, domain specific, attitudes which the authors feel are related to the learning of mathematics by all high school students and/or the cognitive performance of females. The Father, Mother, and Teacher Scales measure the perceptions by students of the attitudes of

father, mother or teacher toward the students as a learner of mathematics.
Grade level(s): 9-12
Publication date: 1976
ETS tracking number: TC008612

Title: Revised Math Attitude Scale
Author: Lewis Aiken
Abstract: Designed to assess attitudes toward mathematics, particularly those of women. Research has shown this instrument to be a reliable and valid predictor for college women of success in mathematics when used in conjunction with a test of mathematical ability.
Grade level(s): Higher Education
Publication date: 1963
ETS tracking number: TC008698

Title: AVJ Scale of Attitude Toward Mathematics
Author: Sam Adams and others
Abstract: Designed to assess attitudes toward mathematics of undergraduate students of education.
Grade level(s): Higher Education
Publication date: 1977
ETS tracking number: TC008832

Title: Survey of Student Interests in and Opinions of Mathematics
Author: Linda Michaels
Abstract: Designed for use with junior high school students. It is intended to measure the following four facets of the student's attitude toward mathematics: enjoyment of word problems, enjoyment of pictorial problems, appreciation of the utility of mathematics, and security with mathematics.
Grade level(s): 7
Publication date: 1976
ETS tracking number: TC009073

Title: Semantic Differential Instrument for Measuring Attitude Toward Mathematics
Author: Earl McCallon and John Brown
Abstract: Designed to assess attitudes towards mathematics of graduate

students who are not mathematics majors.
Grade level(s): Higher Education
Publication date: 1971
ETS tracking number: TC009074

Title: Attitude Scale
Author: Wilbur Dutton
Abstract: Designed to measure students' attitudes toward modern, or "new" mathematics.
Grade level(s): 6-8
Publication date: 1968
ETS tracking number: TC009387

Title: Attitude Toward Mathematics Scale
Author: Penelope Peterson
Abstract: A five-point agree-disagree scale to measure students' interest in mathematics. A higher score indicates a more positive attitude.
Grade level(s): 4-6
Publication date: 1978
ETS tracking number: TC012001

Title: Aiken's Enjoyment of Mathematics and Value of Mathematics Scales
Author: L Aiken
Abstract: This instrument was used in connection with a wider study on instructional methods at the University of Tasmania. The two scales are scored on a 5-point Likert-style format ranging from zero to four on each response along a continuum from "strongly disagree" to "strongly agree." There are 11 items on the Enjoyment of Mathematics Scale and 10 items on the Value of Mathematics, and is used to measure different aspects of attitude toward mathematics. Although used for college students, it could be used fro secondary school students.
Grade level(s): Higher Education
Publication date: 1974
ETS tracking number: TC013641

Title: General Attitudes Toward Mathematics
Author: Claudia Merkel-Keller

Abstract: Developed as part of a study to determine outcomes in mathematics in the affective and cognitive areas of students in grade 9. To determine outcomes in the affective domain, an attitude measure was constructed.
Grade level(s): 9
Publication date: 1974
ETS tracking number: TC013890

Title: Mathematics Attitude Scale
Author: L.R. Aiken
Abstract: A 24-item scale which measures attitudes toward mathematics in Iranian middle schools. The total score is based on four subscores in the following areas: enjoyment, motivation, importance and fear.
Grade level(s): 4-6
Publication date: 1979
ETS tracking number: TC015184

Title: Students' Beliefs About Mathematics
Author: Denise Spangler
Abstract: Students' Beliefs About Mathematics was designed as an informal assessment of both students' beliefs about mathematics and awareness of their own beliefs toward mathematics. It may be used with students in elementary and high school and with graduate students in mathematics education. The instrument consists of 11 open-ended questions which can be presented to students as a homework assignment, as a tool for gathering responses from others, or as journal writing entries. Students' responses should be shared as part of a class discussion. It may also be presented as a class discussion with no prior preparation on the part of the students. The information obtained may be used by teachers to help plan instruction and structure the classroom environment to help students develop more enlightened beliefs about mathematics and mathematics learning.
Publication date: 1992
ETS tracking number: TC018850

Title: Diagnostic and Prescriptive Mathematics: Attitude Scale
Author: Pennsylvania Department of Education
Abstract: This attitude scale is part of five basic instruments that comprise the diagnostic assessment program. The five instruments are: Level 1 Survey

Test; Level 2 Concept Tests; Level 3 Interviews; Attitude Scale and Learning Style Inventory. These tests are based on the Mathematics Content List (MCL). The Mathematics Attitude Scale is a collection of 20 statements about mathematics and mathematics classes. Each statement is answered with yes or no depending on whether students agree or disagree with the statement. This instrument is intended for use with students in grades 4 through 8. Knowing how the students feels about mathematics can influence teacher behaviours during prescriptive teaching.
Grade level(s): 4-8
Publication date: 1991
ETS tracking number: TC019714