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Mathematical Attitudes and Achievement Strategies of Successful Mathematics Learners

by

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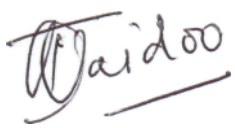

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and

Selvan

ABSTRACT

Too often, discussions about Mathematics express feelings of anguish and despair; and, indeed Mathematics results in general in South Africa can be described as dismal. The Department of Education (DoE) reported that in the 2010 National Senior Certificate examinations, 52.6% of learners obtained less than 30% in Mathematics and 69.1% of learners obtained less than 40% (DoE, 2010). This implies that a very small percentage of grade 12 learners would be eligible to further their studies in the fields of Mathematics and science at tertiary level, resulting in a depletion of science and Mathematics-oriented professionals. This study explored the mathematical attitudes and achievement strategies of successful Mathematics learners to overcome the factors that might impede achievement. This study has the potential to improve practice because the findings of the study and recommendations are made implicit in the discussion. In particular this study sought to investigate the following issues: (a) What are secondary school learners' attitudes towards Mathematics? (b) In what ways are these attitudes linked to factors to which the learners attribute their achievement in Mathematics? (c) What strategies do successful Mathematics learners use to overcome the factors that they identify as impeding their performance in Mathematics? This research involved a case study approach. The study solicited both quantitative and qualitative data from the participants. The participants comprised 95 Grade 10, 11 and 12 Mathematics learners. The Fennema-Sherman Mathematics Attitude Scales (FSMAS) questionnaire was used to collect data from participants. The data was analysed using Attribution Theory and Achievement Theory. Two learners, who obtained more than 60% in the 2011 half-year Mathematics examination, from grades 10, 11 and 12 respectively, constituted the focus group. The focus group interview enhanced the study by clarifying the responses to the questionnaire and providing answers to the second and third research questions. The findings of the research include the following: teachers play an important role in shaping learners' attitudes toward Mathematics; learners are anxious when asked to solve mathematical problems; parents are very encouraging of their children learning Mathematics; the importance of Mathematics for future careers exerted a significant effect on mathematical achievement; and finally the various strategies that learners employ that positively impact on their achievement in mathematics include mastery experience, motivation, private tuition and peer group teaching-learning. The final section of this dissertation discusses the implications of this study for practising Mathematics teachers and suggestions for further research in the area of affect.

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CHAPTER 1
INTRODUCTION

In this chapter, I will outline the research process. First, I will discuss the background to the study, the role of mathematics, what motivated this research study leading to the discussion of the purpose of this study. I will then state the research questions which I will attempt to answer through the research process. Further, I will clarify the critical concepts of the question being researched and briefly describe the methodology used in this study. Finally, I will present a synopsis of the chapters that follow in this dissertation.

1.1 Background and context of the study

Often when one in the academic field talks about Mathematics it seems to conjure feelings of anguish and despair; and Mathematics results in general can often be described as dismal. International and national studies have revealed the poor mathematics skills of South African learners. The performance of Grade 8 learners in the Trends in International Mathematics and Science Study (TIMMS) of 1995, 1999 and 2003 (Howie, 2003; Reddy, 2006) revealed that South African learners had the lowest scores amongst 40 countries. Although there may have been criticism against some of the procedures followed in these studies (Reddy, 2006; Vithal, 2008), the results remain a serious concern. The Department of Education (DoE) reported that in the 2010 National Senior Certificate examinations, 52.6% of learners obtained less than 30% in Mathematics and 69.1% of learners obtained less than 40% (DoE, 2010). This implies that a very small percentage of grade 12 learners would be eligible to further their studies in the fields of Mathematics and science at tertiary level, resulting in a depletion of science and Mathematics-oriented professionals. The concern regarding this state of affairs seems to be around one primary factor: education quality (Howie, 2003).

There is a proliferation of research in many educational fields that focuses on the policy and practice of teachers and education, but few of these focuses on the learners. Much research focusing on learners' voices has been conducted in the field of Mathematics but one could not ascertain whether these are taken into consideration by policy makers. Tobias (2005) considered what learners had to say about mathematical word problems; Vithal and Gopal (2005) researched what mathematics learners say about the new South African reform curriculum; while Moodley and Hobden (2010) investigated self-efficacy beliefs of Mathematics learners and the impact on Mathematics learning.

1.2 The role of Mathematics

Mathematics is a way of seeing and having a sense of the things around us. It is used to communicate information and to analyse situations. It is also used to tackle all sorts of real life problems. Mathematics is a subject that lends itself well to the illustration of learning hierarchies of intellectual skills. According to Ames (1992) Mathematics brings stability and structure to a situation or problem and its solution, as Mathematics uses logical patterns and predictions. It is therefore important that we teach learners the skills of logic and prediction. Mathematics equips learners with skills to work with numbers, money, time, shape and measurement. Mathematics is the language used to describe the problems arising in most branches of science and technology. The functional role of Mathematics in science and technology is multifaceted and multifarious in that no area of science, technology and business enterprise escapes its application (Okereke, 2006, Okigbo & Osuafor, 2008).

Okigbo and Osuafor (2008) observe that learners generally do not take interest in Mathematics and tend to perform very poorly in it. Okigbo and Osuafor (2008) add that Mathematics is one of the most poorly taught, widely hated and most abysmally understood subjects in secondary schools. Learners' poor performance in Mathematics over the years has been attributed to the fact that the subject is difficult.

These facts are of great concern to society. Obioha (1987) and Olatoye (2002)'s studies both note that we live in a world where science and technology have become an integral part of world culture; therefore for any nation to be relevant, it must not overlook the importance of Mathematics in its educational system. As a consequence, poor performance in Mathematics should be a matter of serious concern for all teachers.

1.3 Attitude

In the field of Mathematics education, research on attitude has been motivated by the belief that the attribute known as "attitude" plays a crucial role in learning Mathematics (Neale, 1969). For Alrwais (2000), attitude is the general way people evaluate themselves, other people, objects and issues. According to this definition, a 'positive' attitude is a positive emotional disposition toward the subject, while a 'negative' attitude is a negative emotional disposition toward the subject. Attitude towards Mathematics plays a crucial role in the

teaching and learning processes of Mathematics. The teaching method, the support structure of the school, and families' and learners' attitude towards the school affect attitudes towards Mathematics. Unfortunately, the way that Mathematics is represented in the classroom and perceived by learners, even when teachers believe they are presenting it in an authentic and context-dependent way alienates many learners from Mathematics (Furinghetti and Pekhonen, 2002). Research has shown that a positive attitude towards Mathematics leads learners to succeed in Mathematics. The poor attitude to and lack of belief in one's ability to do Mathematics is fast creating mathematically illiterate people, who lack the necessary academic and technological expertise to maintain and advance technology (Middleton & Spanias, 1999). McLeod (1994) notes that while attitude towards Mathematics is related to Mathematics success in the classroom, conversely, a learner's achievement can influence a learner's attitude as well. Thus, it is important for teachers to help learners achieve, as this will lead to a positive change in their attitude toward Mathematics (Ma & Xu, 2004).

Learners' confidence is another ingredient for success in Mathematics. "Having a positive attitude towards Mathematics means generally enjoying working with Mathematics and having confidence in one's own ability to do it but it does not mean that a learner will display this positive attitude towards the whole area of Mathematics all the time" (Aiken, 2000, p.570). Much of the research in this field in recent years has focused on identifying the key factors that promote academic success among learners whose demographic characteristics and school circumstances place them at high risk of failure. The literature largely supports the positive role that learners' attitudes and behaviour play in improved academic achievement. Several studies (McLeod, 1994; Aiken, 2000 and Ma & Xu, 2004) have found that engagement in school and perceived academic competence (that is, positive feelings about one's ability to be successful academically) strongly predict improved reading and Mathematics achievement. Similarly, the literature supports the positive influence of factors in the school context - for example, the presence of high quality, engaging instructional activities and supportive adult relationships - in improving learners' academic outcomes. It is therefore imperative for teachers to use improved and appropriate instructional strategy to inculcate a positive attitude towards Mathematics in learners.

According to Bandura (1997) self-efficacy (SE) refers to the personal evaluation of one's capabilities to organise and execute courses of action to attain specific goals. Children's self-efficacy beliefs become more accurate and stable over time, and are very difficult to change

(Bandura, 1997). Mathematics self-efficacy refers to the belief that learners have in their capability to do Mathematics. The relationship between efficacy, academic motivation and achievement in Mathematics has been widely studied. It has been found that self-efficacy beliefs appear to be a more important factor influencing attitudes, achievement, and educational and career choices, than other variables such as anxiety, Mathematics experiences, and perceptions of Mathematics (Zimmermann, 2000). Bandura (1986) notes that, while young learners are generally overconfident about their abilities, some overestimation of capability is useful since it increases effort and persistence. However, in the case of continual failure, learners need to be protected from the danger of disappointment. This has important implications for education, and indicates that a careful instructional design could play a significant role in promoting both learners' attitude to Mathematics and their self-efficacy beliefs. Hence, teachers need to pay as much attention to their learners' affect world as to actual performance. The level of teachers' own sense of efficacy is of course, also very important. It has been argued that teachers' beliefs about Mathematics play a major role in shaping their instructional practice, and consequently influence their learners' attitudes, self-efficacy and achievement (Gibbons, Kimmel, & O'Shea, 1997; Muijs & Reynolds, 2001).

1.4 Motivation for the study

From my experience Mathematics is a troublesome area of study for many learners. Many learners either experience difficulty with Mathematics or have simply not successfully mastered a significant amount of Mathematics. Because Mathematics is an exact science, learners and teachers alike need not expect that the learning of Mathematics will, or should, be without obstacles or a need for re-teaching. Many factors affect the way that learners relate to Mathematics. These factors include, but are not limited to, Mathematical domain knowledge, attitudes toward Mathematics, self-efficacy beliefs, and attributes necessary for achievement in Mathematics. Knowledge affects attitude and efficacy beliefs; and attitude and efficacy beliefs affect attribution, and *vice-versa*. Through a description of learners' previous experiences, this study explores situations in which attitude toward Mathematics, mathematical efficacy beliefs, and attributes that lead to achievement in Mathematics influenced the acquisition of mathematical domain knowledge.

In recent years, I have met many Mathematics teachers, Mathematics examiners and Mathematics subject advisors from different parts of Durban at workshops and seminars; who echoed sentiments about the poor performance of learners, especially in senior Mathematics. My concern was that if learners perform very poorly at the end of grade nine, then they cannot drop Mathematics, but are forced to continue with it either as Mathematics or Mathematical Literacy in their grade 10 year. There is a need to examine what lies behind the difficulty experienced by learners in coping with Mathematics. Anxious individuals may avoid Mathematics classes, and may be more likely to have a negative attitude toward Mathematics-related activities, (Ho *et al*., 2000). Learners' beliefs about their competence and their expectations for success in school have been directly linked to their levels of engagement, as well as to emotional states that promote or interfere with their ability to be academically successful. According to Abu-Hilal (2000), learners who believe they are academically incompetent tend to be more anxious in the classroom and more fearful of revealing their ignorance. They fear that educational interactions will result in embarrassment and humiliation, and this, in turn, inhibits them from behaving in ways that might help them, such as asking questions when they are confused or engaging in trial-and-error problem solving (Abu-Hilal, 2000). Such learners are more likely to avoid putting much effort into a task so that they can offer a plausible alternative to low ability or lack of knowledge as an explanation for failure.

1.5 Focus of the study

Several studies, (Howie, 2003) and (Bolaji, 2005), have reported a number of shortcomings in the teaching and learning of Mathematics. Ashcraft and Kirk (2001) describe the common belief that because of "long-term avoidance of Mathematics, and their lesser mastery of the Mathematics that couldn't be avoided, high-Mathematics-anxiety individuals are simply less competent at doing Mathematics" (p. 224). Bandura (1997) believes that when an individual works in a field, he/she develops a high self-efficacy towards it, becomes interested in it, and is willing to pursue his/her work in that particular field. Hence, he/she creates an internal motivation towards the task. It has also been reported that a positive attitude towards Mathematics is mostly determined and predicted by self-efficacy beliefs. The literature in this field has highlighted the factors that result in learners' poor performance in Mathematics. However, it is imperative not only to highlight the challenges faced by poor achievers in Mathematics but also to focus on the experiences of successful Mathematics learners. While

copious literature on performance in Mathematics exists, there are gaps in the literature on the experiences of the learners who achieve in Mathematics. Hence the focus of this study is to explore the mathematical attitudes and achievement strategies of successful Mathematics learners.

In particular this study seeks to investigate the above issue through the following research questions (RQs):

- RQ1. What are secondary school learners' attitudes towards Mathematics?
- RQ2. In what ways are these attitudes linked to factors to which the learners attribute their achievement in Mathematics?
- RQ3. What strategies do successful Mathematics learners use to overcome the factors that they identify as impeding their performance in Mathematics?

This study has the potential to improve practice because its findings and recommendations are made implicit in the discussion. The study has the potential to make a contribution to the scholarly literature in the field of Mathematics achievement as it provides insight into the experiences of learners who excel in Mathematics and how they overcome certain constraints that could hinder their progress.

1.6 Outline of the research process

This research was conducted at a school which will be called Fairfield Secondary School to preserve the anonymity of the participants. I have been teaching at this school for 21 years and have over the years observed a decline in the number of learners that elect to do Mathematics in the Further Education and Training phase (grade ten-twelve). Hence this research grew out of the concern for the poor performance of learners in the General Education and Training phase (grade seven-nine) of Mathematics education. It involved both quantitative and qualitative methods of data analysis. According to Denzin and Lincoln (2003), quantitative studies emphasise the measurement and analysis of causal relationships between variables, where the researcher is objective and the participants' responses are value-free. Qualitative studies involve the researcher locating her/himself, as a part of the participants' world (Sherman and Webb, 1988). Sherman and Webb (1988) add that qualitative researchers study things in their natural settings, and attempt to interpret the results in terms of the meanings people (learners) bring to them. For the purpose of this study,

qualitative data was collected in a focus group interview, whereas quantitative data was collected by means of questionnaires to assess attitudes to Mathematics.

1.7 Overview of the study

Chapter 1 introduces the research study, highlights the rationale for the study, and provides a brief background. Concepts are clarified in order to facilitate an understanding of the content of this research.

Chapter 2 provides a literature review on the research topic focusing on attitude and mathematical achievement, which provides the theoretical framework for this study.

Chapter 3 highlights the research design and methodology followed during the fieldwork. This includes the study design, the research instruments, questionnaires and semi-structured interviews. Ethical issues, the administration of instruments, the limitations of the design and methodology, and data analysis are also discussed.

The results of the study are presented and discussed in Chapter 4. The main trends and patterns in the data are discussed with reference to the three research questions. The results are also interpreted in terms of the literature/theory reviewed in Chapter 2.

Chapter 5 contains the conclusions and recommendations arising from this study. This chapter presents a summary of this study, the conclusions for each proficiency strand, and the larger significance and value of the study. This chapter concludes with recommendations for further research, the implementation of the findings and possible policy implications.

CHAPTER 2

LITERATURE REVIEW

INTRODUCTION

This chapter highlights the theoretical framework surrounding research on affect and its relation to Mathematics education. The study aims to determine (a) what secondary school learners' attitudes towards Mathematics are, (b) in what ways are these attitudes linked to factors to which the learners attribute their achievement in Mathematics and (c) what strategies successful Mathematics learners use to overcome the factors they perceive as impeding their performance in Mathematics. McLeod (1994) notes that attitude toward Mathematics is related to Mathematics success in the classroom. Conversely, a learner's achievement can also influence a learner's attitude. Thus, it is important for teachers to help learners' improve their results in order to bring about a positive change in their attitude towards Mathematics (Ma & Xu, 2004). This research seeks to highlight affective issues that influence learning in the Mathematics classroom.

2.1 FOCUS OF THE LITERATURE REVIEW

The purpose of this review is to detail the theoretical viewpoints guiding research in the area of learner attitude and its effect on achievement in Mathematics. The review will be discussed under the following key topics: (a) defining and discussing learners' attitude to Mathematics and its relation to learning, (b) the self-efficacy beliefs of learners and their effect on learners' attitude to Mathematics, (c) Mathematics anxiety and performance in Mathematics, (d) attribution theories and (e) strategies that will improve the learning of Mathematics. Highlighting the definitions of the terms used in this study ensures that the participants and readers are clear about the meanings that have been attached to the concepts in this dissertation. Hence a detailed discussion of the key concepts: attitude, self-efficacy, confidence, and motivation will be provided by reviewing the theoretical definitions presented by various researchers. This will be followed by a discussion of some of the different theoretical perspectives on the role that these factors play in influencing learner achievement in Mathematics drawing on the findings of national as well as international studies. A discussion on strategies for the improvement of Mathematics learning follows, with a focus on the roles of teachers, parents and peers, and learner self-efficacy beliefs. This discussion also serves to inform the data analysis.

2.2.1 Attitude

The exact definition of attitudes toward Mathematics (ATM) varies. Attitudes serve as functions, including social expressions, value expressive, utilitarian, and defensive functions, for the people who hold them (Hammouri, 2004). Instructional design can create instructional environments to effect attitude change. In the realm of social psychology, attitudes are typically classified within the affective domain, and are part of the larger concept of motivation (Greenwald, 1989). Attitudes are connected to Bandura's (1997) social cognitive learning theory as one of the personal factors that affect learning. The definition of attitude depends on the purpose of the definition. Most attitude researchers include the concept of evaluation as the basis for the definition (e.g. Hart, 1989; Kamradt & Kamradt, 1999). For, Greenwald (1989) attitude is the general evaluation people have of themselves, other people, objects, and issues. Greenwald (1989) sees attitudes as pervasive. They predict behaviours, are a force in perception and memory, and they serve various psychological functions. Among the definitions of ATM put forward, two main categories can be identified (McLeod, 1994). Using a simple definition, ATM is a positive or negative emotional disposition towards Mathematics (McLeod, 1994). Using a multidimensional definition, ATM comprises three components (Hart, 1989). Although there is on-going debate about the structure of attitudes instructional designers have long assumed that attitude is made up of three components: a cognitive component, an emotional component, and a behavioural component (eg Hart, 1989; Kamradt & Kamradt, 1999). Ma and Kishor (1997) propose a wider definition; they conceive ATM 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" (p. 27). Hence the positive influence of the school context on improved achievement is mediated by learners' attitudes about themselves as learners and by behaviour that is correlated with academic success.

2.2.2 Self- Efficacy beliefs

Various studies have put forward different definitions of Mathematics self-efficacy (SE). SE refers to learners' judgement of their capabilities to solve Mathematics problems and perform in Mathematics-related courses. Self-efficacy refers to beliefs about one's capability to learn

or perform at designated levels (Bandura, 1997). Self-efficacy involves one's judgement of one's capabilities based on mastery criteria. It involves an individual getting a sense of his or her own competence within a specific framework. Self-efficacy involves an introspection of one's own abilities in relation to goals and standards, rather than making comparisons with others' capabilities. According to Bandura (1997) self-efficacy forms the basis for human motivation, perseverance and behaviour. Self-efficacy beliefs are context specific which means that a learner may have high self-efficacy beliefs in some aspects of Mathematics, but not in others.

2.2.3 Mathematics anxiety

Education scholars have found that academic activities are often infused with perturbing elements. When these perturbing elements are at high levels, they influence the academic performance of individuals. These arousals, which are known as anxiety, are recognisable in different fields. Ashcraft and Kirk (2001) define Mathematics anxiety as a feeling of tension, apprehension, or fear that interferes with Mathematics performance. For Meece, Wigfield and Eccles (1997), Mathematics anxiety involves "feelings of tension and anxiety that interfere with the manipulation of numbers and the solving of mathematical problems in a wide variety of ordinary life and academic situations" (p. 65). Implicit in this description is the assumption that mathematical anxiety is a causative agent of some impairment of mathematical functioning.

2.2.4 Motivation

According to Ames (1992) motivation exists as part of one's goal structures, and one's beliefs about what is important, and it determines whether or not one will engage in a given pursuit. He adds that two distinct types of academic motivation interrelate in most academic settings - intrinsic and extrinsic motivation. Academic intrinsic motivation is the drive or desire of the student to engage in learning "for its own sake". Learners who are intrinsically motivated engage in academic tasks because they enjoy them. They feel that learning is important with respect to their self-image, and they seek out learning activities for the sheer joy of learning (Middleton, 1995). Their motivation tends to focus on learning goals such as understanding and mastery of mathematical concepts (Duda & Nicholls, 1992). Learners who are extrinsically motivated engage in academic tasks to obtain rewards (e.g., good grades,

approval) or to avoid punishment (e.g., bad grades, disapproval) (Ames, 1992; Duda & Nicholls, 1992). This in turn would result in learners developing mathematical competency and hence would cause them to achieve in Mathematics.

Motivation is a key domain of attitudes toward Mathematics. According to self-determination theory (Deci & Ryan, 1985), motivation can be categorised into three broad categories, namely amotivation, extrinsic motivation and intrinsic motivation. These three categories of motivation exist on a continuum according to the level of self-determination underlying the motives behind behaviours. Figure 2.1 which is adapted from Deci and Ryan (1985) illustrates this continuum.

Low Self-determination Level **High Self-determination Level**

Low Autonomy High Autonomy

Low Sense of Control High Sense of Control

Amotivation	**Extrinsic motivation**			**Intrinsic motivation**
	External	Introjection Regulation	Identification	To know To accomplish To stimulate
Characteristics Non-valuing Incompetence	External rewards or punishments	Internal rewards or punishments	Personal importance Valuing	Interest Enjoyment Inherent satisfaction

Figure 2.1 Self-Determination Continuum (Adapted from Deci & Ryan, 1985)

Amotivation lies on the extreme left of the self-determination continuum and occurs when individuals feel that an activity has no value, that they do not feel competent to complete a task, or do not expect any desirable outcome from the activity (Deci & Ryan, 1985).

Extrinsic motivation refers to the desire to engage in an activity because it leads to an unrelated outcome (Deci, 1972). On the self-determination continuum, extrinsic motivation is further categorised, from a lower to a higher level of self-determination, into external regulation, introjection and identification (Deci & Ryan, 1985). External regulation is caused by externally imposed rewards or punishment (Deci & Ryan, 1985). Introjection takes place when individuals internalise the reasons for their behaviours and impose their own rewards or constraints (Deci, 1972). Finally, identification occurs when an individual identifies with the reason for behaving in a particular manner. The behaviour is valued by the individual and occurs because the individual chooses to do so. Identification differs from intrinsic motivation because pleasure or satisfaction may not be derived in the process of completing the task (Deci & Ryan, 1985). Intrinsic motivation lies on the extreme right of the continuum, which is characterised by high autonomy and sense of control (Deci & Ryan, 1985). It refers to an inner desire to accomplish a task, and pleasure is derived in the process (Deci, 1972). Deci & Ryan, (1985) further categorise intrinsic motivation into intrinsic motivation to know, to accomplish things, and to experience stimulation.

Achievement Motivation Theory developed by McClelland (1958) is defined as the required tendency of the individuals involved in a task (for achievement) to achieve success and avoid non-achievement. McClelland (1965) underlines three needs - achievement, power, and close relationship - that are significantly important variables in determining the behaviour of individuals. McClelland (1965) explains the need for achievement as overcoming a difficult task, becoming skilled, overcoming drawbacks, being perfect, and promoting, orienting, and regulating oneself. McClelland (1965) maintains that individuals, who have a low need for achievement, attribute negative outcomes to factors more internal, stable, and global than those cited by individuals with a high need to achieve. Weiner (1974) maintains that the need to achieve is closely related to an individual's perception of the importance of achievement and non-achievement. A low need for achievement is thought to be associated with a sense of low competence, low expectations, and an orientation towards failure (McClelland, 1965).

2.2.5 Confidence

Confidence in learning Mathematics, or the degree to which a person feels certain of his/her ability to do well in Mathematics, has emerged as an important component of achievement differences (Vermeer *et al*, 2000). Confidence in Mathematics has been associated with

Mathematics achievement. For example, Ryan and Pintrich (1997) showed that learners who perceived themselves as cognitively competent were less likely to avoid seeking help, whereas learners who were unsure of themselves were more likely to feel threatened when asking their peers for help and more likely to avoid seeking help. Ryan and Pintrich explain that learners with high confidence in Mathematics do not attribute their need for help to lack of ability and are thus more likely to seek help when they need it (Ryan & Pintrich, 1997). They also found that highly confident learners were engaged in Mathematics a greater percentage of the time than learners who had low levels of confidence.

2.2.6 Affective domain

In the context of Mathematics education, the affective domain is a broad term encompassing feelings, emotions, attitudes and values that are attached to an idea, subject or object (Leder & Forgasz, 2006). The *affect* refers to *the range of emotions (*feelings, beliefs and moods) that learners develop toward a subject as a result of their experiences with it in the classroom (McLeod, 1994). The affective domain is critically important in all teaching and learning, but especially in Mathematics (Leder & Forgasz, 2006; McLeod, 1994). This study refers to affect as the range of emotions that learners develop toward Mathematics as a result of their experiences with it.

2.3 ATTITUDE

The present study adopts a simple definition of attitudes that includes different kinds of feelings towards Mathematics, such as love, hate, or interest, and a perception of the usefulness of Mathematics in life. Thus, statements such as “I like Mathematics” or “Mathematics is boring” are defined as attitudes. Attitudes are commonly distinguished from beliefs in that attitudes are moderate in duration, intensity and stability and have an emotional content, while beliefs become stable and are not easily changed (McLeod, 1994; Pajares, 2002; Hannula, 2002). The inference that can be made from the literature is that attitudes can be changed. Hannula (2002) maintains that attitudes can change in a short period of time, sometimes dramatically. Hannula (2002) found that, although once established, an attitude is fairly stable, but changes based on successes and failures could occur.

2.3.1 Correlation between Mathematical achievement and attitude towards Mathematics

Numerous studies (Fennema & Sherman, 1976; Ma & Kishor, 1997; Papanastasiou, 2002; Tapia & Marsh, 2004) have established a correlation between mathematical achievement and ATM. Accordingly these studies have indicated that many children begin schooling with positive ATM; these attitudes, however, tend to become less positive as children grow up, and frequently become negative at high school level. It would appear that the pressure on learners to cope with highly demanding tasks, often at a pace beyond their ability, together with unimaginative instruction and non-positive teacher attitudes have a destructive impact on their ATM (Ma &Xu, 2004). Hammouri's (2004) study of attitudinal and motivational variables and their relation to Mathematics reached similar conclusions. He states: "Attitude itself can affect level of energy input, perseverance, time on tasks, standard of achievement and engagement in an activity" (p. 248). It can therefore be deduced that the more positive a learner's attitude towards Mathematics is, the more successful and the higher the performance level will be for that learner - that is there is a positive interaction between ATM and Mathematics achievement. Several other studies have shown that positive attitudes are conducive to good performance and that extremely positive or negative attitudes tend to predict Mathematics achievement better than more neutral attitudes (Schreiber, 2000; Hannula, 2002). Having inferred that there is a direct link between learners' ATM and learner outcomes, one could deduce that a learner's ATM is a significant factor in whether or not that learner pursued a career in Mathematics. According to Ma (1999), "researchers have concluded that negative beliefs about learning and doing Mathematics seem to be a key to many learners' inability to focus enough to 'survive' Mathematics courses…" (p. 28). Bolaji (2005) also found that when learners believe that they are incapable of achieving in Mathematics, their ATM becomes a self-fulfilling prophecy, resulting in high levels of failure and lack of interest in any courses involving Mathematics.

2.3.2 Factors that influence attitude

Newman (1990) developed and evaluated strategies directed at improving learners' ATM, which included a strong relationship between Mathematics content and learners' everyday experiences; learning opportunities to integrate different pre-existing knowledge, a variation in teaching methods, enhancing co-operation and communication in the classroom and training of teachers. Not only is this necessary to improve attitude, but learners also needed to

develop the attitudes and habits of mind that are considered necessary for meaningful work in Mathematics and technology. These include commitment to accuracy, precision and integrity. Teachers also play a critical role in influencing learners' attitudes to Mathematics. This could be manifested through the teachers' personality, teaching methods and his or her clarity in presenting the material (Muijs & Reynolds, 2001 and Reynolds &Walberg, 1992). In addition, information technology in the form of real world interfaces such as digital cameras, video cameras and data loggers can bring to life in the classroom those outside situations to which Mathematics is applied (Oldknow, 2003). This inculcates in learners that the value of Mathematics does not only confine itself to the classroom but also extends itself to the real world. Hence the latter could be instrumental in developing learners' positive attitude towards Mathematics.

Parents are often instrumental in reinforcing the beliefs that their children hold about Mathematics. "Many, even parents believe that math ability is genetic… Parents tell their kids that they don't expect them to succeed in math because they, themselves, were unsuccessful." (McLeod & Ortega, 1993, p. 26). Parents who themselves were not good at Mathematics or are afraid of Mathematics, pass this on to their children. Learners watch their parents' reaction to Mathematics and use this to justify their own performance. McLeod (1994) alludes to the notion that parents find poor grades in Mathematics more acceptable than poor grades in other subjects. However, it should be pointed out that several studies have reported no relationship between attitude and achievement. Wong (2003), for instance, reported that learners' attitude did not show a relationship to their achievement in Algebra.

2.4 SELF-EFFICACY

In Bandura's social cognitive theory, self-efficacy beliefs are a major constituent. The construct puts forward the argument that a person's beliefs concerning his/her ability to successfully perform a given task or behaviour determines the outcome. This claim could be summarised as individuals engage in personal ability judgements based on their own unique system of appraisal, the task at hand and the situation at that point in time. To reiterate this argument, it was further found that SE is a major determinant of the choices that individuals make, the effort they expend, the perseverance they exert in the face of difficulties, and the thought patterns and emotional reactions they experience (Bandura, 1997). This in turn informs their behaviour. Schunk (2001) also contributed to the knowledge base of SE by re-

affirming that SE beliefs play an essential role in achievement motivation, interact with self-regulated learning processes, and mediate academic achievement.

Bandura (1997) postulates four sources of SE information: mastery experiences, vicarious experiences, verbal-social persuasion and physiological and emotional arousal, which have to do with the level of emotional and physiological readiness of the individual to undertake a specific task. While these sources of SE information are significant in the creation of efficacy beliefs, the interpretation thereof is of paramount importance since cognitive processing predetermines the weighting of information sources and how they influence the analysis of the task.

2.4.1 Correlation between mathematical achievement and self-efficacy beliefs

The relationship between efficacy, academic motivation and achievement in Mathematics has been widely studied. SE beliefs appear to be more important in influencing attitudes, achievement, and educational and career choices, than other variables such as anxiety, Mathematics experiences, perceptions of Mathematics and self-regulation beliefs (Zimmermann, 2000). A South African study by Moodley and Hobden (2010) had pointed out that most high-performing learners hold high self-efficacy beliefs in Maths. It was also found that the influence of SE on Mathematics performance is as strong as the influence of general mental ability (Zimmermann, 2000). Pajares and Miller (1994) revealed that Mathematics self-efficacy was more predictive of problem solving than was Mathematics self-concept, the perceived usefulness of Mathematics, prior experience with Mathematics, or gender. Abu-Hilal (2000) found that learners' perceptions regarding the importance of Mathematics exerted a significant effect on achievement and that Mathematics achievement then increased self-concept. Bandura (1997, p. 75) concluded, "Students may perform poorly either because they lack the skills or because they have the skills but lack the perceived personal efficacy to make optimal use of them." Pajares and Kranzler (1995) found that Mathematics self-efficacy was significantly associated with achievement. A number of studies (Abu-Hilal, 2000; Zimmermann, 2000; Pajares and Schunk, 2001) indicate that the strong relationship between self-efficacy and achievement could be accounted for by Bandura's Social Cognitive Theory (1997), which postulates that human achievement depends on interactions between one's behaviours, personal factors (thoughts, beliefs) and environmental conditions.

According to Bandura (1986), highly efficacious Mathematics learners display the qualities of (a) eagerness and commitment in tackling a Mathematics task and (b) perseverance and resilience in completing the task. They also regard failure as a minor setback and attribute failure to factors that they believe are within their control. Highly efficacious learners generally attribute failure to lack of effort. Learners with low self-efficacy see things as being more difficult or insurmountable than they actually are (Bandura, 1986). It is further argued that self-efficacy judgments are dependent on a particular domain. In other words, they are domain specific. This means that high self-efficacy judgments in a particular area are not necessarily indicative of high self-efficacy in other domains (Bandura, 1997).

Pajares and Schunk (2001) postulate that high self-efficacy beliefs in learners tend to conjure up feelings of calmness and confidence in the way they approach a task. They add that highly efficacious Mathematics learners view tasks as challenges to be overcome and as such these learners display perseverance and resilience during the task. Hence success or attainment of the desired level of performance encourages better performance, which in turn fuels greater confidence and higher self-efficacy. Research by Pajares and Schunk (2001) also emphasises that learners with low self-efficacy beliefs tend to be less confident and therefore more anxious and stressed when attempting a task. They see the task as a threat, and would rather avoid it than confront it. Consequently, they do not put as much effort into an activity and this more often than not, leads to failure. Failure in learners with low SE lowers the learner's confidence and morale (Pajares & Schunk, 2001). Low self-efficacy tends to perpetuate itself. Additionally (Schunk & Pajares, 2001) assert that learners who do not doubt their learning capabilities, and feel efficacious for learning or performing a task participate more readily, work harder, persist longer when they encounter difficulties, and achieve at a higher level.

It is further argued that the relation of SE to motivation and self-regulated learning can indirectly influence performance in Mathematics (Ryan and Pintrich, 1997), since learners with high level of SE are motivated and confident in their skills, use self-regulatory strategies and achieve better than others. Self-efficacious learners very often judge themselves, are able to solve problems *a priori,* and thus make choices about strategy and effort that often lead to successful problem solving. According to Pajares and Miller (1994) learners may have a positive self-concept in general, but lack self-efficacy in a particular area. They add that a relationship exists between one's perceived ability to solve a specific Mathematics problem and one's actual efficacy in solving that problem. As the former increases, so does the latter.

That is not to say that self-efficacy alone can ensure success in Mathematics problem solving, but rather that when enhanced self-efficacy is combined with domain knowledge and proper use of strategies, a greater degree of success may be attained.

2.4.2 Factors that influence self-efficacy

It has been argued that teachers' beliefs about Mathematics play a major role in shaping their instructional practice, and consequently influence their learners' attitudes, SE, interests and achievement (Zimmermann, 2000). Hence, teachers need to pay as much attention to their learners' affect world as to actual performance. The level of teachers' own sense of efficacy is, of course, very important. Believing in their capabilities is what motivates learners to persist in the learning of Mathematics. As Bandura (1997, p.80) note, "Unless people believe that they can produce desired effects by their actions, they have little incentive to act." Without some degree of self-efficacy, learners are likely to pursue mathematical learning only because it is required, and not for the purpose of mastering the material.

Mathematical self-efficacy beliefs are related to mathematical achievement and are influenced in a number of ways. First, efficacy beliefs are formed and influenced by past attempts to achieve mathematical success. "The results… (indicate) that perceived self-efficacy is a significant contributor…including past performance" (Bandura & Locke, 2003, p.90). Depending upon the level of success attained, learners form beliefs about their future abilities to perform the same mathematical task or function. A series of unsuccessful attempts to perform mathematically could contribute to a negative set of mathematical self-efficacy beliefs. Once these negative beliefs exist, they are difficult to overcome. According to Bandura & Locke (2003) learners often recall a teacher in their educational experience who was instrumental in their understanding of a certain subject. In the area of Mathematics, it is probable that such teachers overcame negative self-efficacy beliefs that the learners already possessed, and fostered positive self-efficacy beliefs that the learners did not possess, or both.

According to Bandura (1997), efficacy beliefs are related to the social beliefs of individuals. For example, a learner may perceive that he or she is efficacious in Mathematics based upon success with Mathematics in their immediate family, or in their peer group. "Parental aspirations and perceived efficacy build children's sense of efficacy and academic aspirations…" (Bandura, 1997, p.76). When parents facilitate and encourage academic

pursuits in their children, efficacy beliefs in these children are likely to be high. That is not to say that those same children are always the high achievers; but rather that they are not hindered in their learning by the effects of low self-efficacy beliefs. Perceived academic efficacy affects learners' academic achievement both independently and through the mediated effects of peer relations (Bandura, 1997). Therefore peer groups can also have an influence- positive or negative, on efficacy beliefs.

Efficacy beliefs also have a reciprocal relationship with motivation. People generally avoid activities with which they do not feel comfortable. It is important that teachers recognise the relationship between efficacy beliefs and motivation. According to Bandura and Locke (2003), efficacy beliefs contribute significantly to the level of motivation and performance. They add that learners, whose sense of efficacy was raised, set higher aspirations, showed greater strategic flexibility in the search for solutions, achieved higher intellectual achievement, and were more accurate in evaluating the quality of their achievement than learners of equal cognitive ability who were led to believe they lacked such capabilities. It should also be noted that learners obtain information to appraise their self-efficacy from their actual achievements, and their physiological reactions (Schunk & Pajares, 2001).

2.5 MATHEMATICS ANXIETY

According to Ashcraft and Kirk (2001) Mathematics anxiety is seen to manifest itself as a fearful reaction to the subject. Meece, *et al*, (1997) iterate that this phenomenon could occur at any stage during a learner's career and it usually does not disappear spontaneously. There are many variables that affect Mathematics anxiety. Learners' achievement motivation plays a significant role in the levels of Mathematics anxiety that they experience.

2.5.1 Correlation between mathematical achievement and Mathematics anxiety

It has been noted in Tapia (2004)'s study that Mathematics anxiety has been found to be consistently related to lower achievement in Mathematics at all ages. It was reported in that study that learners having little or no Mathematics anxiety scored significantly higher in motivation than learners with some or high Mathematics anxiety, and learners with some Mathematics anxiety scored significantly higher than learners with high Mathematics anxiety.

From this one could establish that there exists a significant relationship between low achievement in Mathematics and high levels of Mathematics anxiety.

Zimmermann (2000) highlights that self-efficacy beliefs appear to be more important in influencing attitudes, achievement, and educational and career choices, as opposed to other variables such as anxiety, Mathematics experiences, and perceptions of Mathematics. Ashcraft and Kirk (2001) suggest that highly anxious Mathematics learners will avoid situations in which they have to perform mathematical equations. Mathematics avoidance tends to create learners who are lacking in competency, exposure and Mathematics practice, leaving learners more anxious and mathematically unprepared to achieve. According to Ashcraft and Kirk (2001) because Mathematics anxiety can cause Mathematics avoidance, an empirical dilemma arises. For instance, when a highly Mathematics-anxious learner performs disappointingly on a Mathematics question, it could be due to Mathematics anxiety, or a lack of competency in Mathematics because of Mathematics avoidance.

It is vital for Mathematics teachers to identify the levels of anxiety that prevail amongst their learners. Bandura (1997) has examined Mathematics anxiety more extensively. In many situations parents impose demands on their children, which often result in learners making fervent attempts to obtain very high marks in Mathematics. These demands are often quite difficult for the learners to fulfil and accomplishment that falls short of these imposed standards are generally devalued. A learner experiencing such a failure also tends to experience tremendous degrees of anxiety. The effect of this anxiety is further compounded when such failures weaken learners' sense of efficacy. Past performance experience in Mathematics has no direct effect on learner anxiety. Rather, the impact of past successes and failures on anxiety is mediated entirely through their effects on beliefs of personal efficacy (Meece, *et al*, 1997). This implies that a learner's efficacy beliefs could result in his/her past academic experiences influencing his/her levels of anxiety. Bandura (1997) notes that, learners who have a low sense of efficacy to manage academic demands, are especially vulnerable to achievement anxiety. Although a relationship has been observed between anxiety and academic achievement, research findings show that self-efficacy beliefs play an important role in the manifestation of these differences (Pajares & Miller, 1994; Pajares & Kranzler, 1995; Bandura, 1997; Meece *et al*. 1997).

Causal models have revealed that while there is a relationship between anxiety and achievement, this is as a result of the deep-seated impact of self-efficacy on anxiety. In other words the consequence of the omission of self-efficacy from the model or a negligible level of self-efficacy in the model is a diminished relation between anxiety and achievement. Pajares and Kranzler (1995) indicate that the influence of anxiety on performance is primarily a result of noncausal covariation, largely due to the effect of self-efficacy. This finding can be interpreted in two different ways. First, the intrinsic relation between anxiety and performance can be assumed to be low since a high percentage of this relation is a result of the effect of self-efficacy on anxiety. Second, the effect of self-efficacy on anxiety is assumed to be so high that it has also influenced the subsequent effects of anxiety.

2.6 ATTRIBUTIONS FOR ACHIEVEMENT

For the purposes of this study, the term attribution for achievement refers to what or to whom a person gives credit for mathematical achievement. Learners might attribute success in the area of Mathematics to various influences. A popular attribution for achievement is studying. Learners associate studying well with academic success, not only in their own experience but in general. This is a desirable attribution, but studying may be interpreted too broadly. Because of differences of opinion, it is difficult to measure some attributions made by learners. For example, what one learner considers as studying in depth, another might consider nothing more than reading over material. Nevertheless, attributions are routinely made, and can serve in a general way to inform Mathematics instructors as to the mind set of their learners.

The types of attributions learners make fall into one of two categories. The first is an external attribution, for example, “The test was too hard, so I failed it”. The other is an internal attribution, for example, “I did not prepare properly for the exam, so I failed it”. The second type of attribution, internal attribution, “claims that the person was directly responsible for the event” (Butterfield, 1996, p. 4). Some examples of positive external attributions are: “I was just born with Mathematics intelligence”; “my brother is really good at Mathematics”, “I really like this teacher”, “my grade depended on it”, “the test was easy”, etc. Examples of negative external attributions include: “I was just not born with any Mathematics intelligence”, “the test was too hard”, “the teacher is terrible”, etc. These external attributions do not leave the learner any recourse to perform better next time. With this kind of mind set,

if the external factors remain the same, the learner's achievement level will also remain the same. In the case of external attributions, the learner places the responsibility for his/her performance on someone or something other than his/her own efforts. Some examples of positive internal attributions are: "I studied hard for that test", "I utilized the proper strategies", and "I recalled the algorithm for solving that problem", etc. Examples of negative internal attributions include: "I forgot to use the proper problem-solving strategy", "I am not the kind of person who spends any time studying", "I did not internalise the material in this unit", etc. These attributions leave room for improvement, and may lead to increased self-efficacy, and as such are more desirable than external attributions for achievement. According to Butterfield (1996), attributions with an internal locus lead to feelings of confidence. Internal attributions tend to be habit forming. For example, performing well in a Mathematics examination after studying in a certain part of the library with another learner might encourage the learners to study together at the same place for the next examination. Over the course of the year, it may become a habit for the learners to meet at that same place to study for Mathematics examinations. The learner may then come to believe that their mathematical achievement is linked to studying with that other learner (external), or at the location in the library (external), or to the methods and strategies (internal) he or she used to study. Clearly, attributing mathematical success to the methods and strategies used for studying is the desirable attribution, because the other two rely on factors outside the learner's control. In fact, attributing successes to external factors can "…undermine an existing habit" (Butterfield 1996, p. 6), such as might occur in the scenario above if all the attribution is given to the location and the study partner. The learner may cease to employ the methods and strategies that caused success in the first place. Attributing successes to proper (mostly internal) factors reinforces good habits, thereby possibly increasing success in Mathematics and mathematical self-efficacy beliefs.

2.6.1 Attribution theory

Attribution theory is concerned with how individuals interpret events and how this relates to their thinking and behaviour. Heider (1958) was the first to propose a psychological theory of attribution, but Weiner (1974) developed a theoretical framework that has become a major research paradigm of social psychology. Attribution theory assumes that people try to determine why they do what they do, i.e., attribute causes to behaviour. It incorporates behaviour modification in the sense that it emphasises the idea that learners are strongly

motivated by the pleasant outcome of being able to feel good about themselves. A person seeking to understand why another person did something may attribute one or more causes to that behaviour. A three-stage process underlies an attribution: (1) the person must perceive or observe the behaviour, (2) then the person must believe that the behaviour was intentionally performed, and (3) then the person must determine if they believe the other person was forced to perform the behaviour (in which case the cause is attributed to the situation) or not (in which case the cause is attributed to the other person). An important assumption of attribution theory is that people will interpret their environment in such a way as to maintain a positive self-image. That is, they will attribute their successes or failures to factors that will enable them to feel as good as possible about themselves.

Attribution theory has been used to explain the difference in motivation between high and low achievers. According to attribution theory, high achievers will approach rather than avoid tasks related to succeeding because they believe success is due to high ability and effort, which they are confident of. This theory goes on further to explain that failure is thought to be caused by bad luck or a difficult/badly set examination, i.e. not their fault. Thus, failure doesn't affect their self-esteem but success builds pride and confidence. According to attribution theory low achievers avoid success-related chores because they tend to (a) doubt their ability and/or (b) to assume that success is related to luck or to "who you know" or to other factors beyond their control. Thus, even success is not rewarding for the low achiever because he/she doesn't feel responsible, i.e., it doesn't increase his/her pride and confidence. In general, this means that when learners succeed at an academic task, they are likely to want to attribute this success to their own efforts or abilities; but when they fail, they will want to attribute their failure to factors over which they have no control, such as bad teaching or bad luck.

2.7 STRATEGIES FOR THE IMPROVEMENT OF MATHEMATICS ACHIEVEMENT

This section has focussed on affective issues and strategies that would improve learner achievement in Mathematics. Emphasis was placed on the role of teacher, peers, the classroom environment and learner self-efficacy beliefs and their role in enhancing learner attitudes and meaningful learning experiences, which in turn impact on learner achievement.

Drawing the inference of causality between SE, ATM and performance is difficult, but the evidence indicates that the relationship is reciprocal. This is why many SE researchers have suggested that teachers should pay as much attention to learners' perceptions of capability as their actual capability, because these perceptions may more accurately predict learners' behaviour (Pajares, 2002). On the other hand, if teachers strive to create an environment where learners are successful, this will improve learners' sense of efficacy and their attitudes towards learning, with all the benefits that could arise from such a scenario.

2.7.1 Developing positive learner attitude

Studies investigating the relationship between instructional practices and learners' attitudes toward Mathematics reported that classroom organisation and instructional variables correlate strongly with learner achievement, while measures of teachers' personal qualities correlate highly with learners' attitudes towards Mathematics (Alrwais, 2000). According to Mullis *et al* (2001) learner achievement in Mathematics is a function of learners' attitudes towards Mathematics and other variables such as teacher efficacy, anxiety, etc. that impact on variations in learner achievements in Mathematics. Ghanbarzadeh, (2001) notes that, the question of how to motivate learners in the classroom has become a leading concern of education authorities. According to Ghanbarzadeh (2001) school teachers need to be well grounded in motivating and managing learners because this is relevant to Mathematics achievement.

2.7.2 Inculcating self-efficacy

The inculcation of self-efficacy and enhancing achievement in learners depends to a large extent on the efficacy of teachers. According to Gibbons *et al.* (1997) teacher efficacy may be defined as "the teacher's belief in his or her capability to organise and execute [the] course of actions required to successfully accomplishing a specific teaching task in a particular context" (p. 305). Teacher efficacy encompasses maintaining an orderly classroom conducive to learning, self-belief in instructional practices in different knowledge domains, enlisting resources, and counteracting social influences that affect learners' academic pursuits (Bandura, 1997). Teacher efficacy as noted by Pajares (2002), also determines teaching methods and the prediction of learner performance and self-efficacy. This is supported by Bolaji (2005) who re-affirms that teacher efficacy plays a significant, positive role in

teachers' adoption of innovations in educational processes. Pajares (2002) notes that teachers with high self-efficacy help create mastery experiences for their learners; teachers with low instructional efficacy can undermine learners' cognitive development and self-efficacy. Schunk and Pajares (2001) emphasise that teachers' statements pertaining to the value of a task in the classroom influence self-efficacy and motivation.

Research on the use of learning strategies and self-efficacy, examined by Schunk (2001) reports that cognitive modelling enhanced achievement for learners who scored below grade-level in Mathematics. Schunk (2001) notes that when learners experiencing difficulties with subtraction were exposed to mastery or coping models, they performed well. In order for modelling to result in increased levels of achievement Schunk (2001) emphasises that modelling followed by monitoring and training in self-monitoring produced better performance, as opposed to modelling without monitoring. According to Schunk and Pajares (2001) strategies defining teacher-led, motivated learning that help develop self-efficacy and increase motivation should encompass the following: ensuring that learners develop an affinity for learning what is being taught, encouraging learners to identify the relevance of learning in their lives, engaging learners on the use of strategy and feedback on how the use thereof has helped improve performance, adapting content so that learners understand it, providing instructional presentations that cater for individual differences, setting learning goals and guiding learners to monitor daily progress, feedback on progress in learning, and rewards linked to progress.

2.7.3 Developing highly motivated learners

Motivational principles that teachers could adopt in the classroom could include well defined, realistic expectations, a comparison of learners' present achievements with their past achievements, greater emphasis on cooperation rather than competition and providing immediate feedback on task-specific activities (Margolis & McCabe, 2004). Teachers could also play a role in assisting learners to develop internal standards to perform self-evaluation (Pajares, 2002). As Pajares (2002, p.121) notes, **"**the teacher's challenge is to ensure that their students' internal standards are rigorous without being debilitating, realistic without being self-limiting, fluid without being wishy-washy, consistent without being static". Highlighting the need for teachers to focus on learners' self-efficacy beliefs and self-regulatory strategies in professional practice, Pajares notes, "Teachers have the responsibility

to ensure that educational programmes that seek to empower students must not only cultivate the knowledge to succeed but must endeavour to maximise the potential for success by nurturing the belief that one can indeed succeed and the self-regulatory strategies required to help bring about that success" (2002, p.121). Pajares, (2002) suggests that teachers should aim for tasks that are only slightly higher than the learner's actual capability, so that they are encouraged to aspire to something that is achievable. The nature of the task influences the learner's sense of self-efficacy of the task and how they approach the task. An ambiguity in the task affects the amount of effort that learners are prepared to exert on a task. It also impacts on whether learners will persevere in attempting the task and the extent of their resilience in carrying it to completion (Pajares, 2002). Successful experiences must be made personal to the learner and should not be seen in competition with others. Learners must therefore be encouraged to compare their current performance with their previous performance and not that of their peers (Larcombe, 1985).

2.7.4 Parental involvement

Singh *et al.* (2004) have reported a positive relation between perceived parental involvement and learners' achievement. They stated that when parents are actively involved in their children's learning there are many benefits relating to the teaching, learning and understanding of their children. Children whose parents show an interest in and enthusiasm for Mathematics around the home will be more likely to develop that enthusiasm themselves. South African learners participating in the TIMMS study in 1995 were asked in a survey by the HSRC to indicate the highest level of education completed by their parents. The study revealed a clear positive correlation cross-nationally between parents' education and learners' Mathematics and science literacy. Learners whose parents had had more education had higher Mathematics and science literacy scores. The bulk of South African parents had either completed primary school or partly completed secondary school and it was possible that the level of parental education was one of the factors limiting academic performance (Howie and Hughes 1998).

Parents have an advantage in that they can provide a more stable and continuously positive influence that could enhance and complement what the school fosters on their children. Parents and other adults often benefit from knowing what kind of monitoring is appropriate

for learners with different individual needs (Hong & Lee, 2003). For example, on the one hand learners who are easily distracted or who struggle with learning may need and benefit from relatively close monitoring, as is true of learners who like to work near a parent or receive frequent feedback. On the other hand learners that find learning relatively straightforward are likely to benefit from less monitoring and increased autonomy (Hong & Lee, 2003). The role that parents may play in the Mathematics learning of their children is also highlighted in a comparative study by Wang and Lin (2005). This study suggests that Chinese learners' success in Mathematics, when compared to US learners, is likely to stem from family values and processes. The research also suggests that Chinese parents set higher expectations for their children's Mathematics achievement, engaged their children in working more on Mathematics at home, and used formal and systematic instructional approaches at home. Parents choose to become involved in homework because they believe their involvement will make a positive difference in their children's learning, and perceive that their involvement is invited, expected, and valued by school personnel (Hoover-Dempsey & Sandler 1995).

Most parents would like to help their children succeed but usually possess little knowledge of how their children develop educationally. One factor that may hinder parental involvement is the educational level of the parent. In this case the parents arrange for private tutoring for one of two main purposes: first, for enrichment purposes for academically able learners who are seeking to capitalise on their abilities; and second, for remedial assistance to learners who are struggling to "keep up" with mainstream academic expectations. Private tutoring is more likely to be used as an enrichment strategy in education systems where there are "clear high-stakes decision points" like public examinations for selective secondary schools and/or intense competition for limited university places (Bray & Silova, 2006, p. 32). However Baker and LeTendre (2005) argue that most private tutoring is for remedial education purposes, particularly in countries where there is a high level of parental awareness of the economic importance of successfully completing secondary school. Private tuition appears to be used as an avenue to enhance the mathematical competency of learners so as to improve their achievement in Mathematics.

2.8 SUMMARY

The aim of this chapter was to explore the relationship between learners' attitudes towards Mathematics, and mathematical achievement. Attitudes towards Mathematics play a crucial

role in the teaching and learning processes of Mathematics. It affects learner competency in Mathematics, which is directly linked to learner achievement. Gaining an insight into the affective factors that influence learning in the Mathematics class and strategies that foster learner achievement in Mathematics will enable the researcher to recommend strategies for developing a successful learning environment in the Mathematics class.

CHAPTER 3
METHODOLOGY

This chapter explains the research process that led to the collection of data that was used to provide answers to the main research questions. It discusses the research context, the research design, the rationale behind the research methodology and data collection instruments. This chapter also seeks to highlight the data collection process, ethical considerations, sampling strategies and the techniques that were used in the data analysis of this study.

3.1 RESEARCH CONTEXT

The research was conducted at a school which will be referred to as Fairfield Secondary School to preserve the anonymity of the participants. It is an established secondary school situated in a small semi-rural suburb on the KwaZulu-Natal north coast. Fairfield Secondary School caters for learners from a mainly lower socio-economic area classified as previously disadvantaged. A small proportion of learners come from a slightly more affluent area. Many learners come from single parent homes and homes where one or both parents are unemployed. There are also a substantial number of learners who come from child headed households and households that have been affected by HIV/AIDS. One thousand two hundred learners are enrolled at the school. Class sizes are generally large, ranging from 40 to 50 learners in a class. While many neighbouring schools' School Governing Bodies employ additional staff to reduce the number of learners per class, this is not an option at Fairfield Secondary, due to severe financial constraints caused by the large number of non or partial school fee paying parents. Fairfield Secondary has received accolades from the Department of Education (DoE) for obtaining a more than 90% overall pass rate in the Senior Certificate examination for the past 15 years. I teach Life Sciences from grades 10 to 12 at the school.

3.2 RESEARCH METHODOLOGY

This is a case study of the attitudes and achievement strategies of successful Mathematics learners in a secondary school. The study seeks to solicit both quantitative data and qualitative data from the participants. The sample comprised 95 grades 10, 11 and 12 Mathematics learners. Once the broad research topic was established, it was necessary to translate this into a set of inquiry based research questions that was able to provide the answers required to address the scope of the study. The research questions served a twofold purpose. Firstly, they would be used to provide answers to the main question under study.

Secondly, they had to be developed in order to determine the research methods and data collection instruments that would be most appropriate in gathering the data that was needed. These questions provided a focussed means of investigating the research area (Cohen, Manion & Morrison, 2007; Gaskell, 2000). Identifying the broad questions stemming from the main research topic clarified the type of data that was required to answer these questions. The following questions were formulated to obtain preliminary data: (a) What are secondary school learners' attitudes towards Mathematics? (b) In what ways are these attitudes linked to factors to which the learners attribute their achievement in Mathematics? (c) What strategies do successful Mathematics learners use to overcome the factors they identify that impede their performance in Mathematics?

Qualitative and quantitative methods are systematic processes that through which data could be obtained in research. My study adopted a quantitative and qualitative approach. According to Creswell (2009) this type of research relies primarily on the collection of quantitative data. The basic building blocks of quantitative research are variables with an emphasis on the relationships, either correlational or causal, that exist between these variables. In a quantitative research design the researcher will count and classify, and build statistical models to then explain what is observed. Quantitative data collection methods use a limited range of predetermined responses in which the experiences and perceptions of the participants can be measured (Creswell 2009). The quantitative approach used in this study involved the use of questionnaires to establish the attitudes exhibited by learners who study Mathematics. According to Creswell (2009), if the problem calls for the identification of factors that influence an outcome, then a quantitative approach is best. As this study seeks to look for such relationships between attitudes and achievement, the use of the quantitative method of data collection was indeed appropriate.

Sherman and Webb (1988) note that a qualitative approach implies a direct concern with experience as it is lived, felt or undergone. However, it can be argued that experiences of individuals are quite different from one another and as such the qualitative researcher will argue that experiences cannot be boxed into categories. Sherman's and Webb's (1988) study stated that qualitative descriptions allow the reader to be "transported" to the scene, "experience" the phenomenon being researched and evoke the feeling and nature of the experience. This signifies that qualitative research occurs in a natural setting. Being a school-based research, this would require that this study pay close attention to what ordinarily and

routinely happens in schools and classrooms. Creswell (2009) concurs that a qualitative approach is used in more natural and less controlled research settings, while Denzin and Lincoln (2003) note that qualitative research focuses on the socially constructed nature of reality, and the relationships between the researcher and what is studied, as well as the contextual constraints of the inquiry. Conducting an interview enabled me to understand learners' feelings and the meanings of situations through the lens of the learners. Open-ended questions allowed me to delve into the personal experiences of the respondents that will reveal and verify emerging themes concerning the strategies that successful Mathematics learners use. The advantage of using qualitative methods is that they generate rich, detailed data that leave the participants' perspectives intact and provide a context for specific types of behaviour.

3.3 PARTICIPANTS

The participants were Mathematics learners from grades 10, 11 and 12. This study considers these learners to be successful as they were selected to do Mathematics. At Fairfield Secondary School learners who were not successful in Mathematics in the GET are encouraged to do Mathematical Literacy in grade 10 and up. Of a total of 100 Mathematics learners, 5 did not complete the questionnaires as they were in the process of changing their subject choice from Mathematics to Mathematical Literacy. Altogether 95 participants returned their questionnaires for the analysis. This number of participants was used in order to obtain a wide range of responses that make the research trustworthy. Table 3.1 provides the biographic data from the participants of the quantitative part of the study.

Table 3.1 Biographic data from participants of the questionnaire

Grade	No. of Mathematics learners in grade	Sample	Gender		Race		Home language	
			Girls	Boys	Blacks	Indians	isiZulu	English
10	45	42	26	16	13	29	13	29
11	35	33	17	16	17	16	17	16
12	20	20	07	13	10	10	10	10
Total	**100**	**95**	**50**	**45**	**40**	**55**	**40**	**55**

To obtain rich qualitative data, I requested learners who obtained more than 60% in their 2011 half-year examination from each of the grades 10, 11 and 12 to voluntarily participate in the focus group interview. Ideally I would have preferred to use 80% as the benchmark for the focus group interview but I was unable to do so because there was just one learner from grade 10 who obtained over 80%. Therefore this would not have been a well-represented sample. Many of the learners were also reluctant to participate, hence the reason for a small focus group. Two participants, one girl and one boy from each grade constituted the focus group. The half-year examination mark of the sample in the focus group ranged from 66% to 92%. Creswell (2009) argues that the purposeful selection of participants represents a key decision point in qualitative research and that the researcher needs clear criteria and rationales for these decisions. See table 3.2.

Table 3.2 Biographic data from interview participants

Grade	Interviewee	Gender	Home language	June mark	Average attitude score
10	Zammy	Girl	isiZulu	66	3.77
10	Kimo	Boy	English	92	3.91
11	Nelly	Girl	isiZulu	66	4.31
11	Sivi	Boy	English	90	4.33
12	Lily	Girl	isiZulu	70	4.74
12	Kris	Boy	isiZulu	84	4.36

This study seeks to solicit both quantitative and qualitative data from the participants. While the power differential between learners and I might make the learners feel obligated to participate in the research even though they might not want to (Cohen *et al*, 2007), learners were informed that their participation in the study was completely voluntary and would not influence their marks in Mathematics.

3.4 RESEARCH INSTRUMENTS

After much deliberation on the merits of the various data collection instruments, I decided to use more than one source in order to facilitate the collection of data that would further the aims of the study. See the table 3.3.

Table 3.3 Match of data collection instruments to research questions

Data collection instrument	RQ1	RQ2	RQ3
Attitudes questionnaire	**X**	**X**	
Interviews	**X**	**X**	**X**

3.4.1 Questionnaire

The rationale for using the questionnaire was to collect data from a larger group of participants, which deepened my understanding. Attitudes have been studied in various ways, with data collected from individual interviews, focus groups, diaries, observation and questionnaires. Since Fennema and Sherman conducted their research in the 1970s, questionnaires have become standard tools for assessing student attitudes. The Fennema-Sherman Mathematics Attitude Scales (FSMAS) consist of a group of nine instruments. For the current study, I selected the (1) attitude toward success in Mathematics scale, (2) teacher scale, (3) mother/father scale, (4) attributing factors, (5) Mathematics anxiety scale, (6) effect and motivation scale in Mathematics, and (7) Mathematics usefulness scale. The number of statements per scale varied. Positive and negative statements were included in the scale, although these were not equivalent in number. The instrument uses Likert scales. The Likert Scale caters for a range of responses that exhibit varying degrees or intensities of feelings, thereby making it a more flexible tool that generates statistics that can be easily analysed. A five–point scale was used and the responses ranged from disagree strongly, to disagree, neither agree nor disagree, agree and agree strongly. Learners were asked to place a 'cross' in the appropriate column. An example was provided for the learners to use as a guide in responding to the statements in the questionnaire. In the event of positively phrased items the values ranged from 5 for 'strongly agree' to 1 for 'strongly disagree' while a value of 5 for 'strongly disagree' to 1 for 'strongly agree' was assigned to each negatively phrased item. It is important to note that a high score on the FSMAS indicates a low level of Mathematics anxiety; therefore adding the values to calculate the total score could be used to reveal the levels of anxiety of the learners. The adapted FSMAS questionnaire is presented in Appendix A. The questionnaire solicited data to answer the first two research questions of the study. The questionnaire elicited responses that were analysed quantitatively.

The focus group interview was conducted over a single one-hour session. The interview was conducted with provision being made for any participant to withdraw from the study at any point. The interview served to generate rich data, which the questionnaire had failed to do, thus enhancing the quantitative data (Murray and Beglar, 2009). Interviews provide the researcher with the opportunity to obtain in-depth answers and to clarify responses (Bell, 1993). They provide respondents with the opportunity to express their interpretations of the world of Mathematics. Group interviews bring together learners with differing perceptions and minimise the intimidation factor that is present in individual interviews. The success of a group interview is dependent on many factors. They require the interviewer and the respondents to work together. The context should be relaxed and the interviewer trustworthy so that the respondents will be encouraged to respond truthfully. The power differential between the participants of the focus group and I were diminished as I was not their Mathematics teacher and furthermore I do not occupy a management position at the school. The learners that participated in the interview felt comfortable to express their views as they realised that there would be no implications since I am not their Mathematics teacher. Further to this the participants were requested to select a venue of their choice for the interview. The decision of the learners to have the interview conducted in the Biology laboratory which I used to conduct my Life Sciences lessons provided me with sufficient assurance that they were as comfortable as possible and would therefore respond freely. The main purpose of the focus group research was to draw upon respondents' experiences on the strategies that they, as successful Mathematics achievers, use to overcome the factors that could impede their performance in Mathematics. According to Cohen *et al*. (2007), interviews will differ from one to the other, depending on factors such as mutual trust, social distance and how the interviewer controls the interview. To avoid any misconceptions, I had to ensure that communication was sincere and that the purposes were apparent to the respondents. The questions for the interview were standardised and open-ended and it was hoped that they would elicit the responses that would provide any missing links in the investigation.

Copies of the interview questions were given to the learners half an hour prior to the commencement of the interview so that they would have the time to go through the questions. The learners were told that they could jot down their thoughts and ideas if they wished to. Although they were not compelled to write responses on the interview sheet, they were

requested to fill in their personal details and to hand them in at the end of the interview, irrespective of whether they had written down something or not. The participants' personal details were necessary in order to correlate the interview sheets with the transcripts of the interview during analysis. The learners' notes on the interview sheets helped to verify what they had said. It was also hoped that the notes would dissuade learners from simply going along with what others in the group were saying. The interview sheet also gave learners an opportunity to write down what they possibly did not want to say in the presence of the group. Knowing their names provided me with the opportunity to ask further questions subsequent to the interview. The interview sheets were collected from the learners at the end of the interview. The group interview was recorded on audiotape. This allowed me to focus on the interview, rather than on manually recording what was said. It also prevented gaps in the data collected. Recording the data enabled me to ask probing, follow-up questions not accounted for in the pre-set interview questions and to accurately transcribe the interview at a later stage.

Sensitive questions concerning learners' perceptions about Mathematics were being investigated and it was imperative that learners respond truthfully. This required me to be honest and approachable, and to create a climate of trust and respect for and between them. At the end of the session, the tape was played back to the group so that they could clarify their statements further. Learners were then thanked for participating in the interview and for their honest responses. Copies of the interview questions and the interview transcripts are provided in Appendix B. The data solicited from the interviews enabled me to clarify the responses to the questionnaire and to provide answers to the second and third research questions.

3.5 DATA ANALYSIS

The data from the questionnaire was captured on a spread sheet using computer software called Excel. This facilitated the statistical representation of data in terms of percentages and graphs. Learners were assigned numbers that protected their identity. In addition to recording each learner's score on the FSMAS the 2011 second-term mark for the Mathematics examination and assessment was entered on the spread sheet. Reliability and validity are two important aspects of accuracy which must be ensured in any study.

Cronbach's Alpha coefficient was calculated to test the internal consistency of data. It measures how well a set of items measures a single one-dimensional latent construct. When the structure of the data is multidimensional, Cronbach's alpha will usually be low. Cronbach's alpha is a coefficient of reliability and when the average inter-item correlation increases, the Cronbach's alpha also increases. This means that there is evidence that the items are measuring the same underlying construct (Labate, 2006). The data for each instrument was tabularised so that percentages and proportions could be clearly defined.

Analysing what respondents have said in an interview extends far beyond the literal meaning of what has been said. It requires the researcher to relive the interview and to find threads of commonality, which are able to link up to the underlying theory, whilst looking for evidence that supports or/and contradicts theories (Gaskell, 2000). The analysis began with the transcription of the group interviews. I preferred to do the transcription myself because I could recognise the respondents' voices; and the interviews were still fresh in my mind, so if the tape was unclear I was able to recall what was said. Doing the transcribing enabled me to revisit the interviews, going through the respondents' every word and expression in an effort to make sense of the data. It also allowed me to identify the various nuances in the data that gave me greater insight in analysing the data. Once the audiotape was transcribed, I met again with the group, played the recording of the interview and read out the transcript. The respondents were asked to verify that the transcription was in keeping with what had been said and that what they had meant to convey was communicated. Once the transcription was complete, key factors that emerged from the interviews were linked directly to how learners strategise to increase their mathematical achievement despite there being factors that could impede their performance.

3.6 ETHICAL CLEARANCE

Seeking consent is a necessary process as it protects respondents and the researcher. It also provides proof of the authenticity of the data collected and the processes that were used (Cohen *et al*., 2007). During the planning and implementation of the research, due consideration was given to the ethical issues that could arise when using learners as part of the data collection process. The challenges that these ethical issues present are diverse and although it may be possible to confront many of them, it is not always possible to eradicate them without compromising the study.

The University of KwaZulu-Natal requires the research proposal for any research done with human subjects to be reviewed by a research committee. The research proposal for this study was reviewed and approved by the Research Ethics Committee of the Faculty of Education (Reference number HSS/0710/011M). A copy of the Certificate of Ethical Clearance is presented in Appendix F.

The proposal for the study was submitted to the Department of Education. Consent was also obtained from the principal of Fairfield Secondary School. A copy of the correspondence is presented in Appendix C.

According to Cohen *et al* (2007) the researcher should first get consent from the adult whose charge the learner falls under and then from the learners themselves. Letters of consent were given to the parents or guardians of the learners who were participating in the study. The consent letter explained the area of research and its broad aims and objectives. The consent form also assured respondents of absolute confidentiality. The assurance of confidentiality and anonymity dictates that the write-up of the research should at no point suggest or reveal information that can identify the respondent (Cohen *et al*., 2007). Hence in the transcription of the interviews pseudonyms and not the actual names of the participants were used. The parents and learners signed and returned the consent forms to the researcher. A copy of the explanatory letter and the consent form is presented in Appendix D and Appendix E.

3.7 LIMITATIONS OF THE STUDY

A questionnaire has limitations in terms of the scope of the questions that can be asked and the range of the responses that can be anticipated (Bell, 1993).The items in the questionnaire could become very monotonous; therefore, learners could get tired of answering them and pen responses without thinking. Learners had varying definitions of what they perceived to be success and failure in Mathematics. At times learners would try to impress me and provide an answer that they thought I wanted. Certain learners were shy or afraid to say what they really wanted to say.

Data collection was limited to just one interview with one focus group in order to gain a picture of Mathematics from the learners' perspective. Despite informing the principal of the school that there were going to be three interview sessions, however this had not materialised

because some of the learners were reluctant to participate in this part of the study. Such a small-scale study is restricted in terms of reliability, and the limitations inherent in a single interview are recognised. This study therefore lacked the ability to generate rich data that could have provided a deeper insight into the successful learners' achievement strategies.

3.8 SUMMARY

This chapter identified the research design as a case study, using both quantitative and qualitative methods for the collection of data. It also focused on ethical issues that pertained to the study. The following chapter presents and discusses the findings of the study.

CHAPTER 4
FINDINGS

In this chapter, I will analyse the data that was solicited during the research process, present and discuss the findings of the research according to my three research questions. I include the research questions in this chapter as confirmation to the reader. They are as follows:

- RQ1. What are secondary school learners' attitudes towards Mathematics?
- RQ2. In what ways are these attitudes linked to factors to which the learners attribute their achievement in Mathematics?
- RQ3. What strategies do successful Mathematics learners use to overcome the factors that they identify as impeding their performance in Mathematics?

The chapter highlights learners' perceptions of and experiences in Mathematics; the factors that they perceive to influence their achievement in Mathematics; and the strategies successful Mathematics learners use to overcome the factors they identify that might impede their performance in Mathematics. The data solicited through the questionnaire is presented first, followed by the data from the group interviews. Any correlation or uniqueness that emerged from both the findings is also reported. The findings of the study will be reported under the following key headings: (a) learner perceptions and experiences relating to Mathematics and the Mathematics class, (b) factors to which learners attribute their achievement in Mathematics and (c) learner perceptions of strategies that will overcome the factors that could impede the learning of Mathematics.

4.1 ANALYSIS OF DATA

The responses to the Fennema-Sherman Mathematics Attitude Scales (FSMAS) instrument were assigned scores ranging from 1 to 5. For the positively phrased items the values ranged from 5 for 'strongly agree' to 1 for 'strongly disagree', while a value of 5 for 'strongly disagree' to 1 for 'strongly agree' was assigned to each negatively phrased item. The responses were tabularised using Microsoft Excel software. I then verified the reliability and validity of the results. The Cronbach's alpha coefficient was computed to check the internal consistency of the items in questionnaire. Cronbach's alpha ranges in value from 0 to 1 - the higher the score the more reliable the scale. The Cronbach alpha coefficient for the questionnaire was calculated and an overall reliability score of 0.997 was obtained, which is

indicative of a high degree of acceptable and consistent scoring for the various categories in the questionnaire. Table 4.1 details the analysis of the data.

Table 4.1 Summary of data corpus and analysis methods

	Description	Data obtained	RQ	Method of analysis
1	Questionnaire	Learner self-efficacy beliefs in Mathematics	1	Frequency counts of each response and means Cronbach Alpha Testing for correlation analysis
		Perceived usefulness of Mathematics		
		Perceptions of teacher and peer attitude		Exploratory factor analysis and testing to validate instrument
		Perceptions of parent attitude to Mathematics		
		Attributions to success in Mathematics	2	
2	Interviews	Learners' current perceptions and experiences of Mathematics	1	Interpretation using theoretical explanation highlighted in the literature review
		Attributions to success in Mathematics	2	Analysis of data using themes from other instruments and including this one
		Strategies to overcome factors that impede Mathematics learning	3	

The data analysis of the findings in the FSMAS questionnaire was originally collated under the following key headings: (a) personal confidence about Mathematics: self-confidence/self-efficacy, (b) perceptions of parent attitude, (c) perceptions of teacher attitude, (d) perceived usefulness of Mathematics, (e) attributing factors and (f) general attitude to Mathematics (see Appendix A). Since the data was extensive the use of exploratory factor analysis to reduce the data was instituted as follows. The exploratory factor analysis was performed on the items from each of the subscales of the FSMAS to see if components could be identified and regrouped into new scales thereby reducing the data. Once the factor analysis was done, four subscales emerged from the generalised theme which is "I have a positive attitude towards Mathematics". The four subscales are as follows with an (*) denoting negative items that were reverse coded:

Subscale one: Personal competence and confidence summarised by the composite statement *I feel competent and confident when I do Mathematics,* comprises the following items:

A1. I am good at maths.
* A2. I do not enjoy maths.
* A3. I find maths too difficult for me.
* A4. Most subjects I can handle but I just cannot do well in maths.
A5. I am confident of myself when I do maths
* A6. Doing maths makes me nervous and upset.
* A7. I'm not the type to do well in maths.
* A8. I'm just not good in maths
A9. I am sure that I learn maths.
* A10. I am always anxious when asked to solve maths problems.
* A11. Maths is my worst subject.
A12. When I am in a maths class I feel relaxed.
* A13. I don't think I can learn maths.
* A14. I am always under a terrible strain in the maths class.
* A15. I often get scared when I open my maths book and see a page full of problems
* A16. Studying mathematics makes me feel nervous.
* A17. I am able to solve mathematics problems without too much difficulty
* E3. I never do well in maths no matter how hard I try.
E5. Learning maths is too pressurising and stressful.

Subscale two: Learner perceptions of the usefulness of Mathematics summarised by the statement *I will use Mathematics as an adult,* consists of the following items:

D1. Knowing maths will help me get a good job.
* D2. Maths will not be important to me in my life's work.
D3. I will use maths in many ways as an adult.
* D4. I don't know why I have to learn maths.
* D5. Doing well in maths is not important for my future.
D6. Mathematics is important in everyday life.
D7. Mathematics is one of the most important subjects for people to study.
D8. High school math courses would be very helpful no matter what I decide to study,
* D9. I would like to avoid studying mathematics after matric.
F1. I would like to further my studies in maths.
F2. I would study maths at tertiary level only if I absolutely had to.
F3. I do not mind studying maths after matric, if it is necessary for my studies.
* F4. I would prefer never to study maths ever again.

Subscale three: Learner perceptions of teacher attitude and peer attitude which was summarised as *I feel comfortable with my teacher and peers in the Mathematics class,* comprises the following items:

C1. My maths teacher makes me feel I have the ability to go on in maths.
* C2. I wish my math teacher would pay more attention to my maths learning in class
C3. My teacher thinks that I could do well in maths.
* C4. I feel that my maths teacher ignores me when I try to ask questions in class.
* C5. My teacher makes me feel silly when I ask questions in maths class.
* C6. My teacher only worries about teaching the clever learners in class.
* E1. I am afraid to ask questions in class because my peers will think I am stupid.
* E2. The 'clever' learners in my class make me feel stupid.
E4. My peers are understanding and help me to learn maths.

Subscale four: Learner perceptions of parent attitude to Mathematics summarised as *my parents encourage me in Mathematics,* having the following items:

B1. They encourage me to do well in maths.
B2. They think that I could be good in maths.
B3. They would be disappointed if I do not do well in maths.
B4. They think it is important for me to study maths.
B5. They think that private tuition would improve my mark.

Since the sample size differed greatly from grade ten which comprised 42 learners to grade eleven with 33 learners and 20 grade twelve learners, it was considered more meaningful to use percentages when making comparisons. The data from the questionnaire have been summarised with learner responses of 'Agree' and 'Strongly Agree' being reflected under the common heading "Agree" and responses of 'Disagree' and 'Strongly Disagree' under the heading "Disagree" while the Neutral responses have been acknowledged accordingly.

4.2 LEARNERS ATTITUDES TO MATHEMATICS

The data from the attitudes questionnaire was analysed through SPSS and the findings were recorded accordingly.

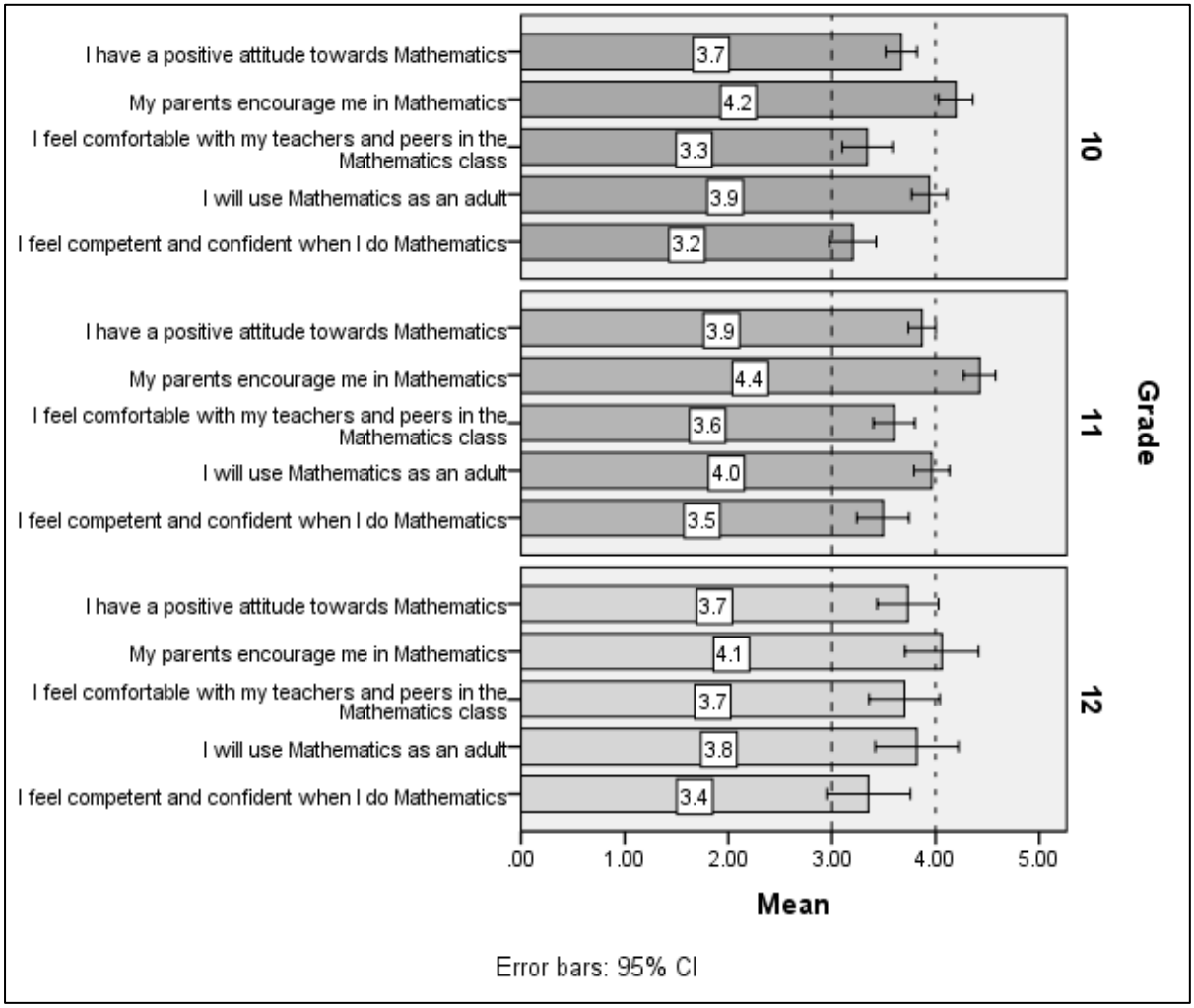

Figure 4.1 Means for subscales for grades 10, 11 and 12

From Figure 4.1 it can be noted that the learners in all three grades have a positive attitude towards Mathematics as the means for grades 10, 11 and 12 is 3.7, 3.9 and 3.7 respectively.

The grade 11 Mathematics learners show the greatest inclination towards agreeing with having a positive attitude towards Mathematics. It is also noted that the grade 10 learners felt the least competent and confident when doing Mathematics. These findings would be explored later in the discussion.

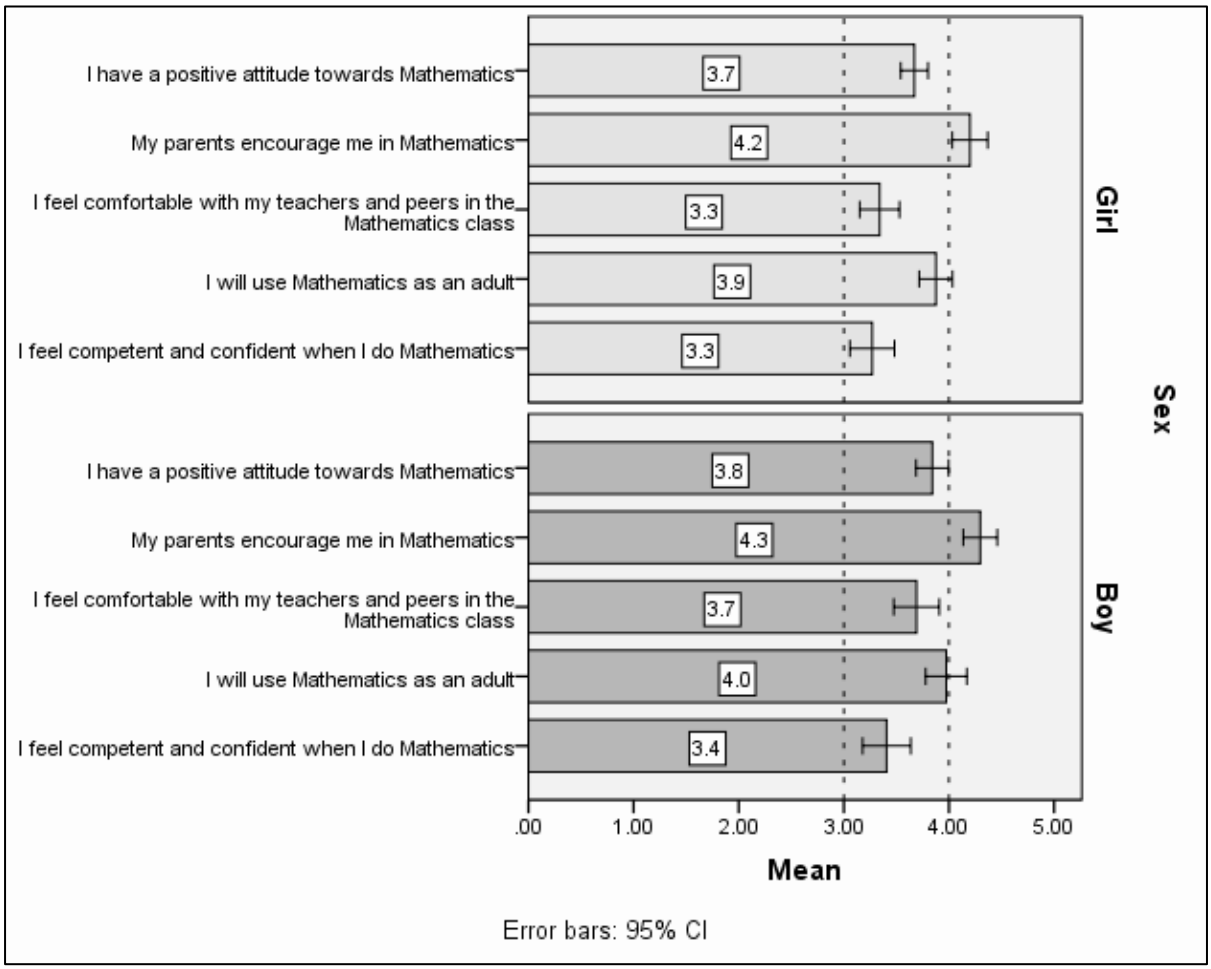

Figure 4.2 Means for subscales for girls and boys

The results of this study, (see Figure 4.2) revealed that the boys had a more positive towards Mathematics than the girls. Despite that the mean is not significantly higher; it is worth noting that the means for each of the four subscales increases from the girls to the boys. Of further interest is that while the increase for three subscales is small (0, 1); the largest increase (0, 4) is in the subscale which reads "I feel comfortable with my teacher and peers in the Mathematics class". Hence one could deduce that the boys felt more comfortable in the Mathematics class as opposed to the girls. However I would like to note that although I did not explore this question deeply in the interview, the learners of the focus group did touch on this aspect which is interrogated later in the discussion. In Figure 4.2 it was noted

that more boys than girls believed that they will use Mathematics as an adult. This figure is not significantly high but none the less the issue of gender seems to be quite prevalent in this study. It could also be noted that more of the boys received encouragement from their parents than the girls. This study did not probe this issue further.

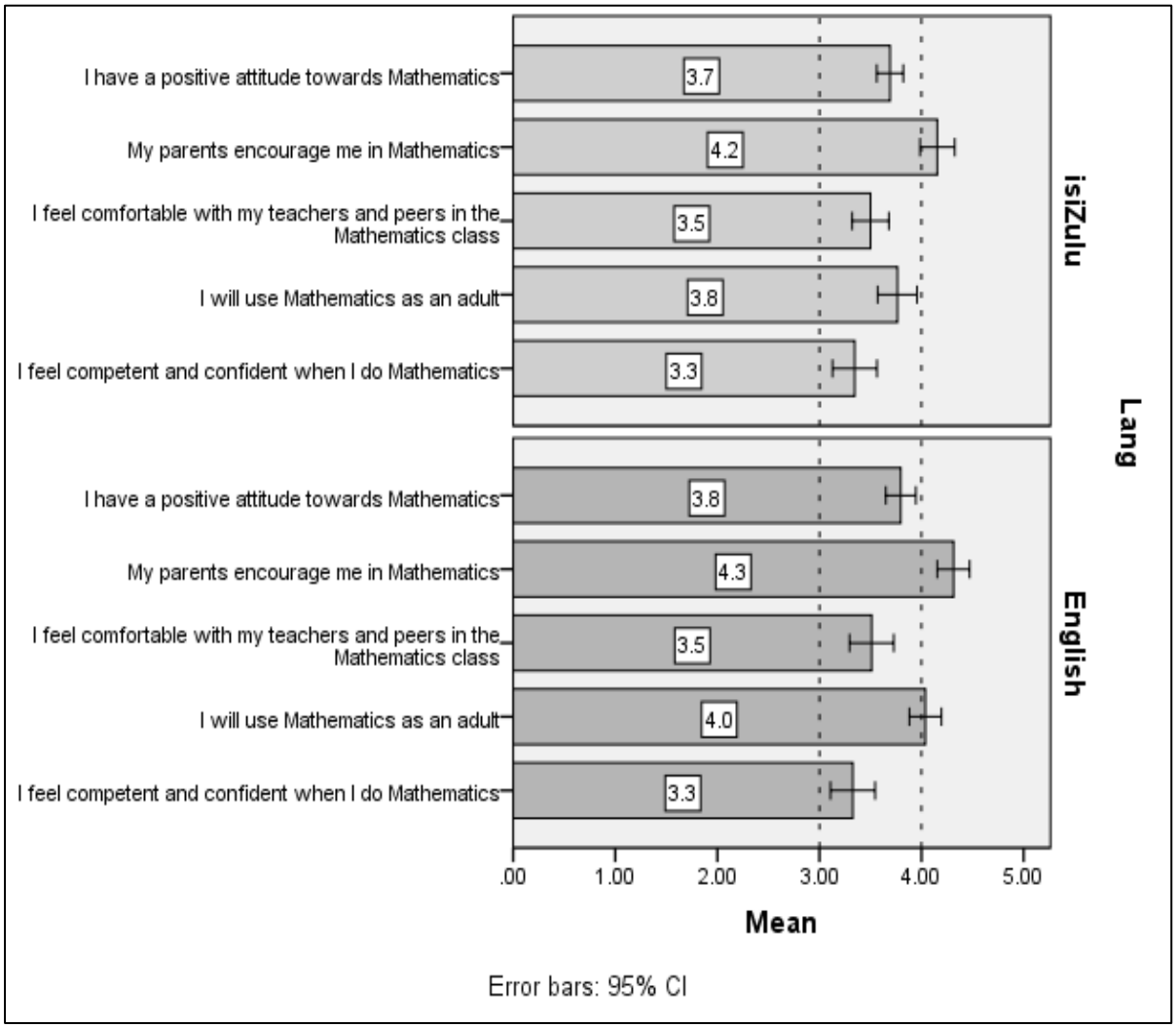

Figure 4.3 Means for subscales according to participants' home language

In Figure 4.3 it could be noted that English home language participants are more positive towards Mathematics than the isiZulu home language participants. With regards to the subscales which read "I feel competent and confident when I do Mathematics" and "I feel comfortable with my teacher and peers in the Mathematics class" the mean for both isiZulu and English home language participants were exactly the same. It is important for this study to acknowledge this point because Fairfield Secondary School is an ex Indian school whose

staff compliment is Indian. Although this study did not seek to explore race issues relating to Mathematics, however the results reveal that one home language speakers were not more comfortable with the Mathematics teacher than the other or *vice versa*. Hence I could deduce that this factor could not have influenced one group's attitude towards Mathematics over another's - either positively or negatively. Another observation that could be made *(see* Figure 4.3) was that a significantly higher number of English home language learners have the perception that they would use Mathematics as an adult as opposed to the lower number of isiZulu home language speakers. This could possibly be attributed to the greater parental encouragement in English home language participants as opposed to isiZulu home language speakers. However, this study did not probe these particular issues any further.

4.3 LEARNER PERCEPTIONS AND EXPERIENCES RELATING TO MATHEMATICS

Learner perceptions and experiences in Mathematics are reported with respect to the following aspects: learner personal confidence /self-efficacy about Mathematics; learner perceptions of the usefulness of Mathematics; learner perceptions of teacher attitude and peer attitude; and learner perceptions of parent attitude to Mathematics. The interview data is also included in the report. Full transcripts of the interview can be found in Appendix B from pages 85 to 98. Learner verbatim responses are presented in Italics in the discussion.

4.3.1 Learner personal confidence /self-efficacy about Mathematics: I feel competent and confident when I do Mathematics

In subscale one the average scores for grades 10, 11 and 12 were 3.2, 3.5 and 3.4 respectively (see Figure 4.1). This implies that many learners across the three grades were not significantly competent and confident when they did Mathematics. It must further be noted that the grade 10 learners had somewhat lower levels of confidence than the grades 11 and 12 learners when doing Mathematics A closer analysis of the data gathered allowed for the identification of the following key issues to be highlighted: learner confidence, learner anxiety and learner difficulty.

Learner confidence

With regards to learner levels of confidence and SE regarding their engagement with Mathematics, it is evident from the responses to the questionnaire that a large percentage of

learners in grades 10, 11 and 12 did not have very high levels of confidence and SE in Mathematics (see A5 in Table 4.2). Sixty percent of the grade 12 learners disagreed with A7 and A8 in Table 4.2. Although it might not appear to be a very convincing percentage to draw on, during the interview the two grade 12 participants revealed that they were not highly efficacious when they engaged with Mathematics during their grade ten year. Lily said that she *was convinced that Mathematics required you to be very intelligent and since I was not the top learner, receiving all the awards in primary school, I felt that no matter how much of effort I put in I am not going to be "good" in Mathematics*.

Table 4.2 Learner responses to perceptions of personal confidence about Mathematics

Item	Statements	% Agree			% Disagree		
	Grades	**10**	**11**	**12**	**10**	**11**	**12**
A1	I am good in maths	45	33	55			
A5	I am confident of myself when I do maths	42	58	45			
A7	I am not the type to do well in maths				57	55	60
A8	I'm just not good in maths				52	55	60

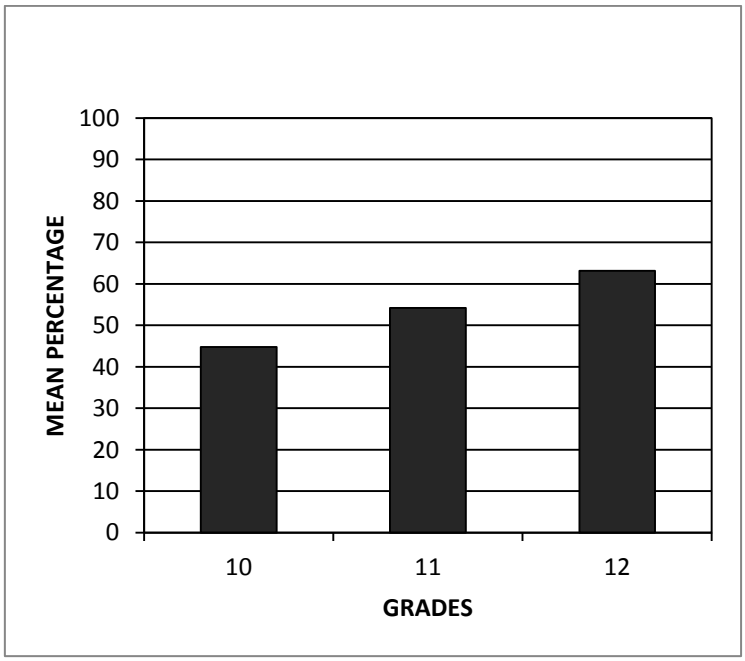

Figure 4.4 Second term examination mean for Mathematics by grade

To corroborate this, only 45% and 42% of the grade 10 sample (see Table 4.2) felt that they were "good in maths" and "confident when doing maths" respectively. The mean for Mathematics for the 2011 half-year grade 10, 11 and 12 examinations (see Figure 4.4) is 45, 54 and 63 respectively. These results concur with the findings of Bandura (1997, p.75) who

concluded, “Students may perform poorly either because they lack the skills or because they have the skills but lack the perceived personal efficacy to make optimal use of them”; and Pajares and Kranzler(1995) who found that Mathematics self-efficacy was significantly associated with learner achievement.

The learners’ responses to the item “I am sure that I learn maths” revealed that more than 70% of the learners in grades 11 and 12 were sure that they could learn Mathematics. These results infer that the learners were not just amenable to the idea of learning Mathematics but were convinced of their ability to do so. The question then arises: Are there challenges or impeding factors that hinder Mathematics learning of this sample group, as the mean mark obtained in the second-term examinations in all three grades were not convincing? (see Figure 4.4) This question is addressed later in this research study.

Learner anxiety

It was found that the learners from all three grades were generally anxious about Mathematics. On average 30% of all the learners said that they felt relaxed when they attended Mathematics lessons, whereas only 14% of grade 10 learners said that they felt relaxed in the Mathematics class. However this percentage increased to 36% in grade 11 and 40% in grade 12 (see Table 4.3).

Table 4.3 Learner responses to perceptions of anxiety

Item	Statements	% Agree			%Disagree		
		10	11	12	10	11	12
A10	I am always anxious when asked to solve maths problems	29	36	45			
A12	When I am in a maths class I feel relaxed	14	36	40			
A6	Doing maths makes me nervous and upset				50	64	50
A16	Studying mathematics makes me feel nervous.				43	64	50

These findings were in keeping with the two grade 12 participants, who revealed that they were not highly efficacious when they engaged with Mathematics during their grade ten year, implying that they experienced some levels of anxiety. The grade 12 participants made statements to the same effect in the interview. Kris indicated that he is not *as stressed during the maths lessons as I was last year because this year’s work is a repetition of the last two years and we kind of understand the work better now than in grade 10. Basically at grade 12*

it is easier to cope because we also understand what is required of us. During the interview, learners were asked why they had enrolled for extra maths tuition. The majority said that they did so in order to improve their mark in Mathematics. Anecdotally it would appear that Grade 11 and 12 learners are using extra tuition to supplement the teaching and learning that prevails in the Mathematics class. Hence these specific grades had a higher percentage of learners who felt relaxed. On the one hand, while Table 4.3 reveals increasing percentages of learners in grades 10, 11 and 12 who felt relaxed in the Mathematics class, on the other hand, the results also show an increasing percentage of learners in grades 10, 11 and 12 respectively that were anxious when asked to solve Mathematics problems (see A10). Of particular interest is that 45% of the grade 12 sample were anxious about solving problems. Lily, a grade 12 learner, said during the interview that by grade 12, there is a common understanding amongst the learners that *every mathematical problem has a score attached to it. When I have to work out problems in maths, how effectively I use certain skills would be assessed and I would be awarded a certain mark. This causes a great deal of anxiety for me because I know that I need good marks in mathematics to be accepted to pursue my studies at university and that ultimately my career depends on this mark.* This suggests that a possible reason for the high percentage of learners experiencing anxiety is that the Mathematics that learners learn in school is to a large extent examination-oriented. It is also not surprising to observe that only mere 50% of grade 12 learners disagreed with the last two statements in Table 4.3.

This result indicates that learners were anxious about their Mathematics learning, as Mathematics is a core subject for entry into the Mathematics, science and technology disciplines at universities. Ma's (1999) meta-analysis studies on the relationship between anxiety toward Mathematics and achievement in Mathematics at primary and secondary school levels, revealed a significant relationship between the two variables – higher Mathematics anxiety gives the potential for lower Mathematics achievement. It is important to note that research has revealed that it is virtually impossible to find a situation where learners do not experience any anxiety about Mathematics at all. Tapia (2004)'s research revealed that learners with little or no Mathematics anxiety scored significantly higher than learners with some or high Mathematics anxiety, while learners with some Mathematics anxiety scored significantly higher than learners with high Mathematics anxiety.

When learners were asked to talk about their perceptions of Mathematics during the group interview, some of the interviewees stated that they were convinced at primary school level that Mathematics was going to be a difficult subject. Nelly expressed her belief that she *works so hard before an exam or test but the examples that we get in the paper are always challenging.* Suffice to say that all the learners who participated in the interview agreed with the statement made by Lily when she said *my primary school maths teacher always told the class that you can't do simple work now, wait till you come to high school. You will never cope because maths is a very difficult subject and its either you have it or you don't.*

Table 4.4 Learner responses to perceptions of mathematical difficulty

Item	Statements	% Agree			%Disagree		
		10	**11**	**12**	**10**	**11**	**12**
A3	I find maths too difficult for me				33	67	55
A4	Most subjects I can handle but I just cannot do well in maths	52	33	40			
A17	I am able to solve mathematics problems without too much difficulty	24	37	40			

Table 4.4 reveals that on average 42% of the participants felt that they could not do well in Mathematics while an alarmingly low 34% of the learners considered that they had the ability to solve Mathematics problems without too much difficulty. Only around half of the learners disagreed with the statement that they found Mathematics difficult. However in the interview these responses were clarified. Asked whether Mathematics as a subject was difficult, all the interviewees responded that the content matter of the subject was not beyond their understanding, but that their level of difficulty in the subject arose from other factors. Lily said that *sometimes my educator teaches the subject and not the learners…and because I can keep to the pace of the teacher I do not have much difficulty. But I do feel for the other learners because you could see that they just do not understand the work therefore they invariably find mathematics difficult.* According to Zammy a grade 10 learner, her difficulty in Mathematics stemmed from her inability to solve Mathematics problems with ease. She stressed that *in my class you have to understand the work the first time that the teacher explains and if you don't get it then you will be lost.* Asked whether they could not request that the teacher explain what they did not understand, the response is cause for great concern. Both Zammy and Kimo indicated that such a request would draw the response, *I already explained this and it is so simple.* However Zammy made a point of emphasising that a

request for repetition of the explanation by the teacher depended on which learners wanted the explanation repeated. She said that if Kimo, the highest achieving Mathematics learner in the class wanted something repeated the teacher complied. She added that learners *are scared to ask him* [the teacher] *anything in mathematics because he is like…if you don't understand this you should not be in a mathematics class.* The data suggest that learners who perceive themselves as cognitively competent are less likely to avoid seeking help, whereas, learners who are unsure of themselves are more likely to feel threatened about asking their peers for help. Ryan and Pintrich (1997) explain that learners with high confidence in Mathematics do not attribute their need for help to lack of ability and thus are more likely to seek help when they need it. Zammy said that many learners in her class are deterred to such an extent that they *developed a negative attitude towards maths and they want to actually change from maths to maths literacy.* She was very vocal in emphasising that she was determined to do well in Mathematics because of her career choice and this spurred her on to excel. It could therefore be deduced that learners' level of difficulty in Mathematics is not innate, but is rather inculcated to a large extent through their interaction with their teachers. When the focus group was asked whether Mathematics was a "manageable and passable subject", the entire group answered *yes* very emphatically in a chorus voice.

4.3.2 Learner perceptions of the usefulness of Mathematics: I will use mathematics as an adult

In subscale two the averages for grades 10, 11 and 12 were 3.9, 4.0 and 3.8 respectively. These averages are closer to 4, which imply that many learners across the three grades were in agreement that they will use Mathematics as an adult. This part of the questionnaire elicited responses that showed that an overwhelming majority of learners believed that knowing Mathematics would be instrumental in helping them to get a good job (89%). The data also revealed that 76% of the learners believed that they will use Mathematics in many ways as an adult. While 88% of the learners were of the view that Mathematics was important in everyday life, 83% believed that Mathematics was one of the most important subjects for people to study. In contrast, while a large percentage of learners believed that it was important for people to study Mathematics (see Table 4.5), only 39% of the learners said that they would like to further their studies in Mathematics.

Table 4.5 Learner responses to perceptions of the usefulness of Mathematics

Item	Statements	% Agree			
		10	11	12	Averages
D1	Knowing maths will help me get a good job	95	93	80	89
D3	I will use maths in many ways as an adult	83	76	70	76
D6	Mathematics is important in everyday life	88	93	85	88
D7	Mathematics is one of the most important subjects for people to study	86	82	80	83
F1	I would like to further my studies in maths	41	40	35	39

The discrepancy between learners' responses to the usefulness/importance of Mathematics and whether they would like to further their studies in Mathematics prompt the following questions: (1) what is learners' thinking when they refer to Mathematics as being useful in their learning? (2) how is Mathematics important to them? The high percentage of positive responses regarding the usefulness and importance of Mathematics could possibly be due to learners regarding Mathematics as a school subject and/or a functional tool.

However, the discrepancy between the high percentages of learners who believed that Mathematics is important in everyday life (88%) and those who would like to further their studies in Mathematics (39%) could be attributed to the belief system that the learners hold. It is possible that they felt that the Mathematics they learned at school had adequate value in the practical sense and hence that any further study would not necessarily increase their competency levels when engaging with it in their daily lives.

4.3.3 Learner perceptions of teacher and peer attitudes in the Mathematics class: I feel comfortable with my teacher and peers in the mathematics class

With regards to subscale three, the average for grades 10, 11 and 12 were 3.3, 3.6 and 3.7 respectively. This implied that many learners across the three grades were closer to agreeing that they felt comfortable with their teacher and peers in the Mathematics class. However, closer analysis of the data gathered from the questionnaire and the interview revealed that the grade 10 learners were more apprehensive about their teacher and the high achieving learners in their Mathematics class. In grades 11 and 12, some learners felt slightly comfortable with their teacher and peers.

Teacher attitude

The responses to this part of the questionnaire revealed that the learners see teacher attitude as playing a significant role in their learning of Mathematics. Of notable concern, the results

also showed that an average 47% of the total sample of learners said that they would like their teacher to pay more attention to their Mathematics learning in the class (see Table 4.6).

Table 4.6 Learner responses to perceptions of teacher attitude

Item	Statement	% Agree		
		10	**11**	**12**
C1	My maths teacher makes me feel I have the ability to go on in maths	45	58	65
C2	I wish my maths teacher would pay more attention to my maths learning in class	31	48	60
C5	My teacher makes me feel silly when I ask questions in maths class	19	09	00
C6	My teacher only worries about teaching the clever learners in class	33	00	10

Table 4.6 shows that 45% of the learners in grade 10 said that their Mathematics teacher made them feel that they are capable of going on with the subject. It could therefore be concluded that a greater percentage of the learners in this particular grade were not sufficiently motivated by their Mathematics teacher. This does not auger well for this group of learners, because they are likely to develop feelings of inadequacy, which would invariably impact on their experiences and achievement in Mathematics. The discrepancy in learner responses to the last two items in Table 4.6 could be attributed to the fact that there are different teachers to teach the learners in these grades; that is one teacher teaches the grade 10 learners while another teaches both grades 11 and 12 learners.

A closer analysis of the responses in Table 4.6 shows that 33 % of the grade 10 learners were of the view that their teacher focused on teaching the so-called "clever" learners in the class. In the focus group interview Lily, who was previously taught by the current grade 10 teacher, said that the teacher made remarks like *I don't care if the rest of you are not interested because I know that only these learners here are going to do well so I will simply focus on them only.* Table 4.6 shows that, only 19% of the grade 10 learners felt that their teacher made them feel silly when they asked questions in the Mathematics class, while 36% of the learners remained neutral and 45% disagreed with the statement. In the focus group interviews it was revealed that the latter two groups of grade 10 learners which made up 81% were the learners who did not ask questions in the mathematics class because as it was noted earlier according to Zammy, the response would be that *if you don't understand this you should not be in a mathematics class.* At this stage Lily interjected that *a response of this nature from a teacher could have a positive or negative effect on the learners. A strong willed learner would be determined to prove the teacher wrong making the learner to push harder*

so that he could get good marks while another learner could actually start believing that they cannot do maths. The teacher's attitude could motivate learners to perform in Mathematics or result in them resigning themselves to a mediocre mark. Zammy added that the teacher *ridicules and embarrasses learners* when they encountered difficulties with Mathematics.

Learners exposed to this kind of attitude could become despondent, and this may discourage them from developing proper study habits and problem-solving strategies. According to Hammouri (2004) schoolteachers need to be well grounded in learner motivation because this is relevant to Mathematics achievement. In contrast the grades 11 and 12 learners indicated in the focus group interview that their Mathematics teacher encouraged them to ask questions on aspects that they did not understand. This helped them to build confidence when working with Mathematics problems. The teacher also provided feedback to them on task-specific activities, which contributed positively to their learning and achievement in Mathematics.

Peer attitude

The responses to this part of the questionnaire revealed that the experiences of the learners in the Mathematics class were influenced by their peers' attitudes. Table 4.7 shows that the grade 10 learners had the highest percentage of responses indicating a negative impact of their peers on their learning in the Mathematics class. This possibly stemmed from the tone set in this class by the teacher.

Table 4.7 Learner responses to perceptions of peer attitude

Item	Statement	% Agree		
		10	**11**	**12**
E1	I am afraid to ask questions in class because my peers will think I am stupid	43	15	20
E2	The 'clever' learners in my class make me feel stupid	38	21	15
E4	My peers are understanding and help me to learn maths	73	58	85

As noted earlier the grade 10 interviewees indicated that they were highly stressed in the Mathematics class. It further emerged in the interview that most of the Mathematics lessons in the grade 10 class were conducted in the form of group activities and self-discovery. The groups were carefully selected by the teacher, who strategically elected one of the high-achieving learners to be the group leader.

The learners who participated in the interview were group leaders. They indicated that generally the learners in their groups did not ask them any questions and this could possibly account for the fact that 43% of the learners in grade 10 having the perception that the group leaders would think that they are stupid, and are therefore afraid to ask questions. The two grade 10 learners that were interviewed were despondent. Zammy said that *we also as group leaders have to ask each other if we do not understand anything and sometimes we feel uncomfortable about that.* However she did indicate that *when our friends meet to study maths we assist each other to understand the work,* which could possibly account for the 73% of grade 10 learners being in agreement with item E4 as observed in Table 4.7.

4.3.4 Learner perceptions of parent attitude: my parents encourage me in mathematics

In subscale four the averages for grades 10, 11 and 12 were 4.2, 4.4 and 4.1 respectively (see figure 4.1). It is evident from the graph that the learners in all three grades agreed with the statement that their parents encouraged them in Mathematics. Parents are perceived to be significant role players in their children's learning of Mathematics. The majority of learners said that their parents were very encouraging when it came to them learning Mathematics. A high percentage of the learners responded positively to the statement that their parents thought it was important for them to study Mathematics.

During the interview, when asked if their parents offered any assistance, the learners indicated that none of their parents knew any Mathematics. In terms of the low number (11%) of respondents who indicated that their parents would feel disappointment if they did not do well, Nelly's response was that *they know that it is not easy to do well in maths so they do not pressurise us into getting good marks.* It appears that parents have a preconceived notion that Mathematics is difficult and are therefore quite cautious when it comes to addressing their children's Mathematics results.

4.4 ATTITUDE AND ACHIEVEMENT

This study showed that there was a correlation between attitude towards Mathematics and achievement.

Table 4.8 Correlation between attitude and mark by grade

Grade			Mark	I have a positive attitude towards Mathematics
10	Mark	Pearson Correlation	1	.405**
		Sig. (2-tailed)		.008
		N	42	42
	I have a positive attitude towards Mathematics	Pearson Correlation	.405**	1
		Sig. (2-tailed)	.008	
		N	42	42
11	Mark	Pearson Correlation	1	.576**
		Sig. (2-tailed)		.000
		N	33	33
	I have a positive attitude towards Mathematics	Pearson Correlation	.576**	1
		Sig. (2-tailed)	.000	
		N	33	33
12	Mark	Pearson Correlation	1	.768**
		Sig. (2-tailed)		.000
		N	20	20
	I have a positive attitude towards Mathematics	Pearson Correlation	.768**	1
		Sig. (2-tailed)	.000	
		N	20	20

** Correlation is significant at the 0.01 level (2-tailed).

In table 4.8 achievements correlated positively with attitude in grades 10, 11 and 12. Attitude correlated most positively with achievement (r =0.768 p=.000) in grade 12. This study showed increasing correlation by grade from 10 to 12.

The scatter plot represented in Figure 4.5 below depicts this positive correlational relationship.

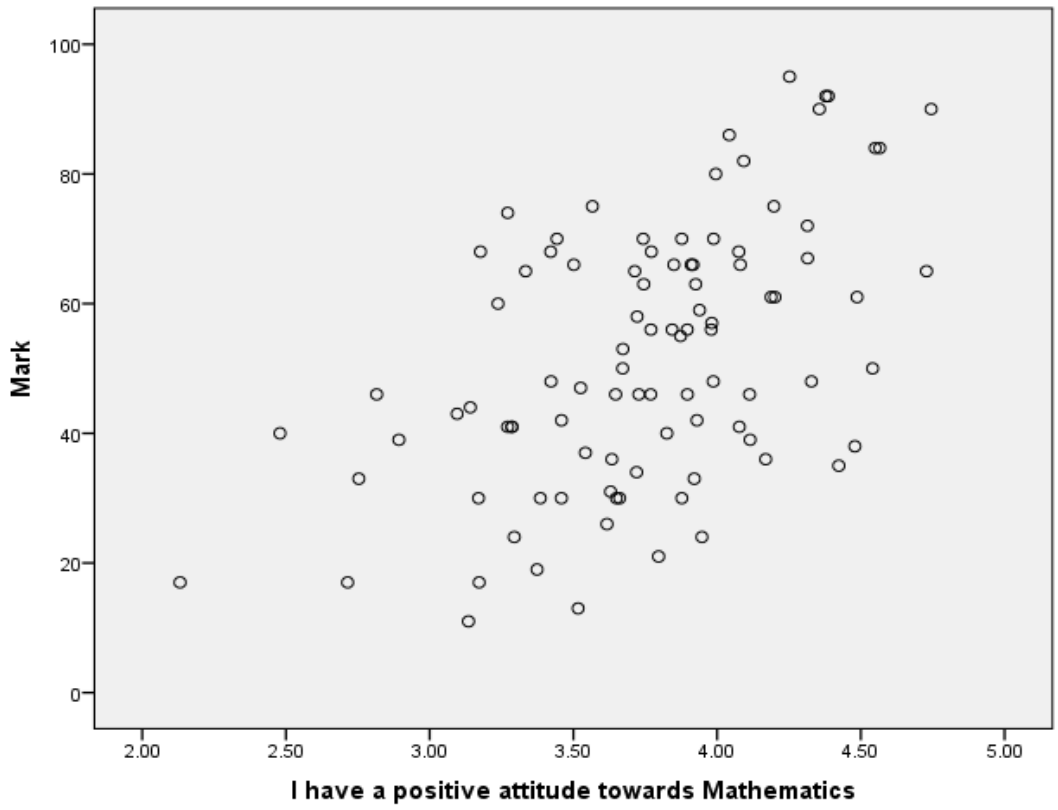

Figure 4.5 Scatter graph to show positive attitude against June exam Mathematics mark

4.5 FACTORS TO WHICH LEARNERS ATTRIBUTE THEIR ACHIEVEMENT IN MATHEMATICS

In the context of Mathematics education, the affective domain is a broad term encompassing feelings, emotions, attitudes and values that are attached to an idea, subject or object (Leder & Forgasz 2006). The *affect* refers to *the range of emotions* (feelings, beliefs and moods) that learners develop towards a subject as a result of their experiences with it in the classroom (McLeod, 1994). The affective domain is critically important in all teaching and learning but especially in Mathematics (Leder & Forgasz, 2006; McLeod, 1994).

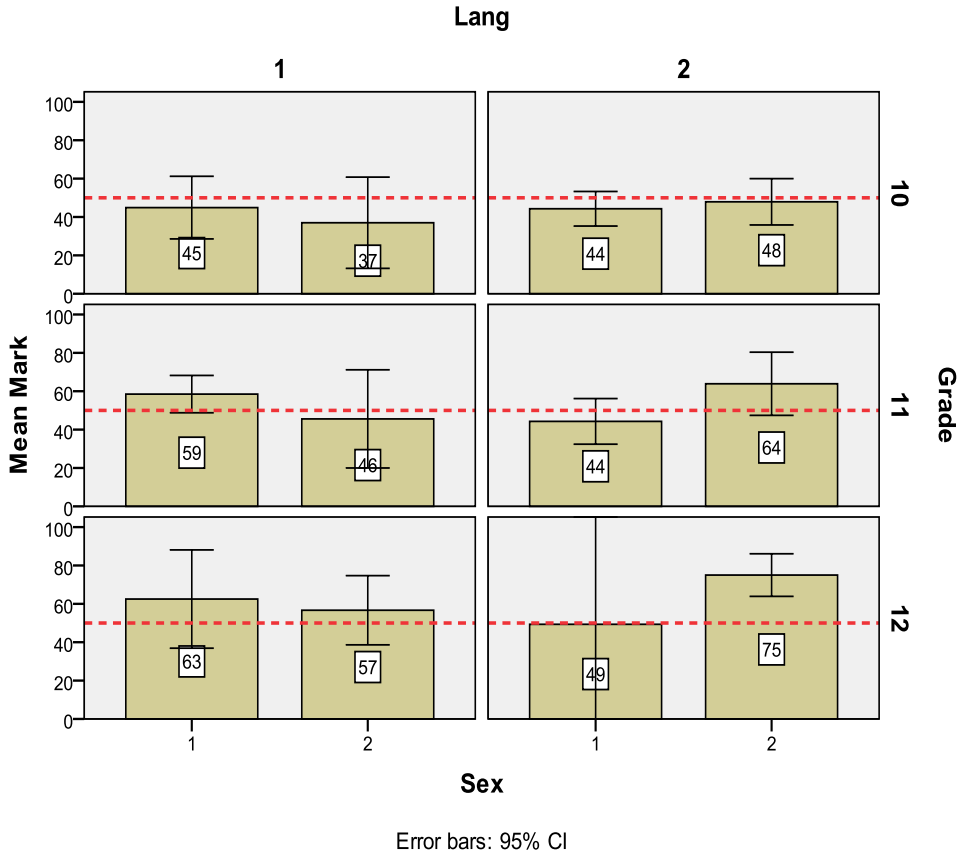

Figure 4.6 Achievements of learners in June Mathematics Exam, by grade, gender and home language

An analysis of the data presented in Figure 4.6 shows that in the case of the isiZulu-speaking learners represented as 1, the girls (indicated by 1) showed an increase in the mean mark from grades 10 through 12. The boys (indicated by 2) also showed an increase in the mean mark from grades 10 through 12. There is no significant difference between the mean marks for isiZulu-speaking girls and boys from grade 10 to grade 12. This could be so because these learners were the beneficiaries of an external intervention project and received extra tuition once a week in Mathematics. The learners affirmed that the additional tuition helped them to achieve good marks in Mathematics. In contrast the English home language speaking (represented as 2) boys showed a significant increase in the mean mark from grades 10 through 12 while the mean for the girls appeared to be static.

The results of the interview showed that the current grade 12 learners were previously taught by a teacher whom they claimed displayed gender bias in favour of the boys. According to Lily, he used to taunt the girls about being slow to solve Mathematics problems and said that

Mathematics was for boys and not girls. It is possible that this teacher's comments could have impacted negatively on the grade 12 girls performance in Mathematics, whilst the boys' performance could have been influenced positively. One learner said that … *if I volunteered to put an answer on the board then he would make statements like I'm sure it would have taken her very long to figure the answer out.* This type of attitude could result in the girls feeling demotivated and lacking in self-efficacy while the boys could have developed high levels of confidence, which could have made them become more proficient in Mathematics. Pajares and Miller (1994) reported that boys tend to be more confident than girls in Mathematics. Similarly, research by Pajares and Miller (1994) noted that girls typically showed low levels of inclining self-efficacy beliefs. The research findings indicated an overall increased mean mark along with an increase from grades 10 to 11 to 12. In the interview the learners emphasised that the grade 10 mean was lower because the content of the grade 10 syllabus was different from what they encountered in grade 9. Kimo affirmed that by the time the learners *go to grade 11 their understanding of mathematical concepts increases and this helps us to get a good mark.*

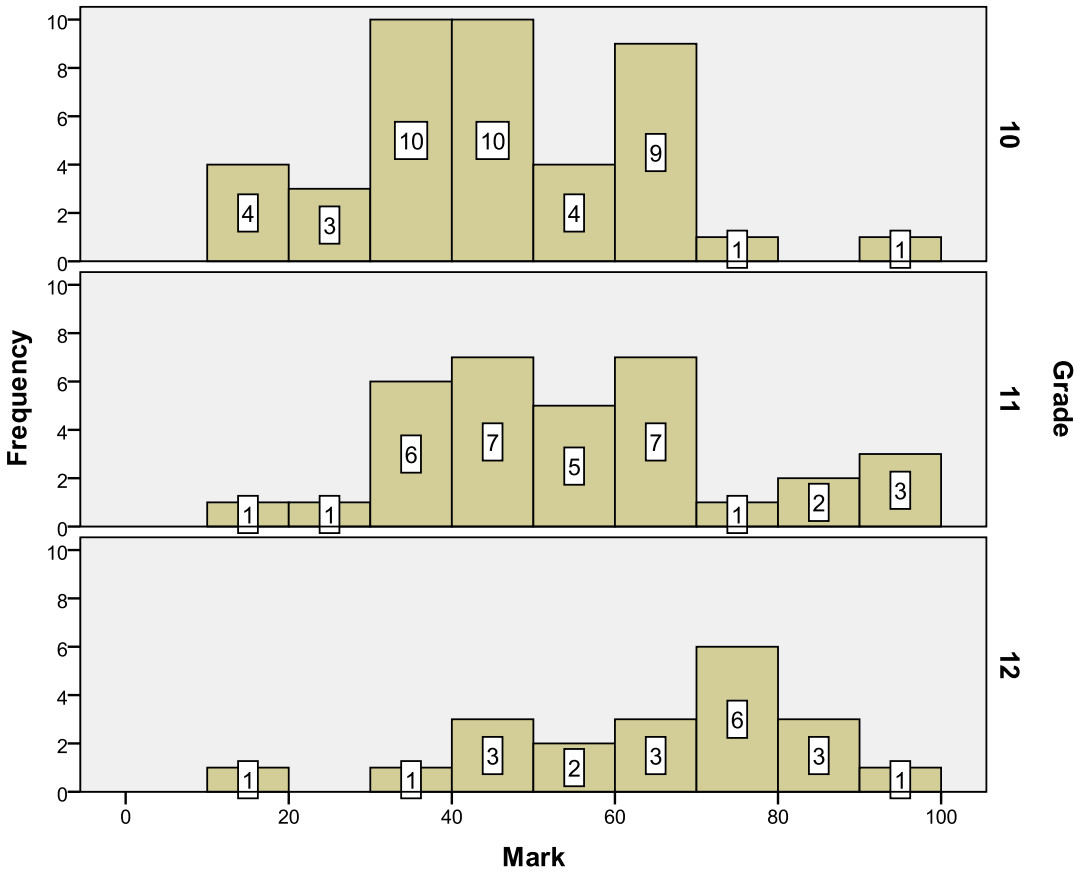

Figure 4.7 Frequency of June Mathematics exam marks by grade

It was made implicit in the interview that generally the learners' efficacy in Mathematics increased from grades 10 through 12, which accounted for the greater frequency of marks in the over 60% range in grades 11 and 12. From the frequency distribution in Figure 4.7, 26% of the learners in grade 10 obtained over 60%, with 39% of the learners in grade 11 obtaining marks of over 60% and a total of 65 % of grade 12 learners obtained over 60%. As noted, interview participants pointed out that the grade 10 learners were still getting adjusted to the Mathematics content which is quite vast; hence the smaller percentage of learners obtaining more than 60%. The learners explained that by the time they got to grades 11 and 12 their competency levels in Mathematics increased; hence the greater frequency of marks of more than 60%.

Table 4.9 Learner responses to perceptions of factors that their achievement in Mathematics could be attributed to

Statement	% Agree		
	10	**11**	**12**
My positive attitude towards maths	64	76	79
My teacher's teaching style	43	61	47
My teacher's caring/ encouraging attitude	36	64	53
My parents encouraging attitude	83	88	84
My parents are good in maths	26	24	42
My career choice involves my doing well in maths	50	64	63
Attending private tuition	29	52	68
My school has extension classes	07	15	42
My use of learning material provided by the media	26	40	42
My use of technology for example software	26	40	42

An analysis of the results highlighted in Table 4.9 reveals that a large percentage of the participants believed that their parents' encouraging attitude played a significant role in their achievement in Mathematics. This observation corroborates with the average score of 4.23 in subscale four which read "M*y parents encourage me in Mathematics"* implying that many learners agreed with the statement.

Table 4.9 exhibits a progressive increase in the percentage of learners from grades 10 to 12 who attribute their achievement to their positive attitude towards Mathematics. Both Lily and Kris reiterated in the interview that their improved achievement and attitudes in Mathematics were due to their desire to meet educational goals, career goals, or fulfil their personal goals. Lily elaborated that *sometimes when my marks drop I don't just give up but I pick myself up by focussing on my career and this motivates me to work harder in maths.* Kris said that, *in*

some tests when I do not get good marks I don't allow myself to develop a negative attitude to maths. I think about my goal and this motivates me and makes me determined to work harder to get those good marks. Hence the link between the increasing percentages of learners in grades 11 and 12 who attributed their achievement to their positive attitude and a corresponding increase in the percentages of grade 11 and 12 learners, who attributed their achievement to their career choice.

On the issue of extension classes, the school had arranged to have compulsory extension classes for the grade 12 Mathematics learners. The grades 10 and 11 learners on the other hand had access to extension classes through the Mathematics club that was established at school. Since attendance for those learners was optional it could be that very few of them actually attend. This I would suggest could account for the very small percentage of learners from grades 10 and 11 who felt that they benefitted from extension classes at school.

The results depicted by Table 4.9 revealed that there was a considerable increase from 29% to 52% to 68% of grades 10, 11 and12 learners respectively who attributed their achievement in Mathematics to private tuition. One could deduce that the demand for private tuition by Mathematics learners at this school escalated as the learners' progressed to grade 12. My experience has shown that the learners in grade 12, who wished to pursue a career in the Science field, tend to enrol for private tuition on the understanding that they would obtain a better mark and would be eligible to apply for the aforementioned course. However this study did not seek to address this issue and would therefore not be able to make any claim for or against.

4.6 LEARNER PERCEPTIONS OF STRATEGIES THAT WILL OVERCOME IMPEDING FACTORS TO IMPROVE THE LEARNING OF MATHEMATICS

During the interview with two high achieving learners from each of grades 10, 11 and 12 to ascertain the strategies that learners use to overcome impeding factors, the learners identified various strategies, including mastery experience, attitude, motivation, private tuition and peer group teaching-learning.

4.6.1. Mastery experience

The learners indicated that by working out more examples they acquire the skills that are required to solve mathematical problems, which then helps them to achieve good marks in Mathematics. Kris said that, *after my teacher discusses the work in class I work out more examples at home until I know exactly what's happening. In this way when we are writing a test or an exam, I do not have to spend time trying to understand the work but I just work through past year papers … that help a lot.* Sivi also remarked that *working through simple questions and getting them right motivates me to work through more challenging questions.* The learners indicated that working through examples gave them high levels of preparedness and confidence before an examination in Mathematics. In other words high self-efficacy beliefs in learners tend to conjure up feelings of calmness and confidence in the way they approach a task. The interview revealed that a few of the learners viewed tasks as challenges to be overcome and these learners displayed perseverance and resilience during the task. These learners suggested that one could improve their Mathematics mark by referring to past years' papers.

4.6.2. Attitude

The present study adopted a simple definition of attitudes that included different kinds of feelings towards Mathematics, such as love, hate, interest, and a perception of the usefulness of Mathematics in life, in order to assist learners to express their views. During the interview it became clear that a teachers' method of teaching Mathematics and their personality greatly accounted for the learners' attitude towards Mathematics. Kris attributed his high level of achievement in Mathematics to his positive attitude towards the subject. Kimo also agreed that in order to excel in Mathematics one had to firstly have a *positive attitude and secondly work hard of course.* All the learners that were interviewed claimed that they displayed good attitudes and beliefs and they are therefore less likely to attribute success in Mathematics to luck or natural ability. Rather, they attributed it to hard work or good strategies. Lily did raise the issue that attitudes are developed as a consequence of learners' past and present experiences in the Mathematics class. Nelly expressed the view that *maths is an exciting and challenging subject that is enjoyable provided that your teacher teaches you and makes you understand the work.* The grades 11 and 12 learners reaffirmed that their teacher played an active role in their learning of Mathematics and this stimulated interest amongst the learners.

4.6.3 Motivation

The learners that participated in the interview emphasised that motivation played an important role in their achievement in Mathematics. They elaborated that their parents constantly encouraged them and this served to spur them on to aspire to greater heights. Zammy indicated that when they felt despondent after receiving their test scores, their friends formed a support structure to motivate one another, more especially when their teacher made them feel *as if we are incapable of doing maths.* Lily said that she is determined to excel in Mathematics, despite being told by her primary school Mathematics teacher that she was not capable of doing Mathematics, as *I did not know the answer to nine times nine.* According to Lily, while a negative attitude on the part of a teacher can act as an impediment to learning for some learners, it could be a positive attribute for others.

4.6.4 Private/Extra tuition

The interview revealed that learners believed that parents arrange private tutoring for academically able learners who are seeking to capitalise on their abilities. Private tutoring is more likely to be used as an enrichment strategy in education systems where there are high-stakes decision points like public examinations for selective secondary schools and/or intense competition for limited university places. According to the participants private tuition was a necessity for most learners because it enhanced their mathematical competency.

4.6.5 Peer group teaching –learning

During the interview Zammy said that for her, learning Mathematics was quite daunting because she was never prepared and confident before a test, since she had to understand the work by herself. She said that this problem was solved through peer teaching. A group of learners sharing the same level of interest in Mathematics and sharing a common goal, that is to excel in Mathematics, worked in a coherent manner to assist one another. Within a particular peer group, attitudes toward educational aspirations are likely to be similar; learners hold positive views about Mathematics and their learning of Mathematics in terms of interest, anxiety, confidence, and belief. The grade 10 participants adopted this solution because they were afraid to ask their Mathematics teacher for assistance in the class. Recent theories about the influence of adults on children have focused attention on peer groups. For

example, Alrwais (2000) concluded that peer affiliations are becoming increasingly more influential in shaping attitudes than parents and teachers.

4.7 SUMMARY

This chapter provided an analysis of the diverse perceptions of learners about their (a) experiences of the Mathematics class, (b) the factors they attributed to their achievement in Mathematics and (c) strategies that the high achieving learners used to overcome impeding factors. It was evident that learners had different perceptions of their Mathematics teachers and their learning environment. The results revealed that some learners displayed a positive inclination towards Mathematics whilst others displayed negative feelings towards Mathematics. Chapter five presents a discussion of the findings set out in this chapter using the theoretical framework that has been reviewed to make interpretations and to draw conclusions.

CHAPTER 5
CONCLUSION

This chapter summarises the findings of this research study and presents conclusions and recommendations for further research. The findings and recommendations are organised using the framework of the three research questions: (a) what are secondary school learners' attitudes towards Mathematics? (b) in what ways are these attitudes linked to factors to which the learners attribute their achievement in Mathematics? (c) what strategies do successful Mathematics learners use to overcome the factors they identify as impeding to their performance in Mathematics? This research was conducted at Fairfield Secondary School. All the Mathematics learners from grades 10, 11 and 12 from the school formed the study sample.

This study involved both quantitative and qualitative methods of data collection. The quantitative data for this study was collected by means of the Fennema-Sherman Mathematics Attitude Scales (FSMAS) questionnaire, which was administered to 95 Mathematics learners at the school. The responses were tabularised using Microsoft Excel software. This data was analysed through SPSS by applying statistical measures accordingly. Before analysing the questionnaire, the reliability and validity of the results was verified. The qualitative data for this study was collected by means of two focus group interviews. Two participants who obtained over 60% in their half-year examination in Mathematics for the current year from each of grades 10, 11 and 12 constituted the focus groups. The transcriptions of the interviews were analysed to determine the attitudes and feelings these learners experienced in their respective Mathematics classes. The data solicited from the interviews enabled the researcher to clarify the responses to the questionnaire and to provide answers to the second and third research questions.

5.1 PERCEPTIONS AND EXPERIENCES OF LEARNERS IN MATHEMATICS

The data solicited from the questionnaire and interviews showed that the Mathematics learners at Fairfield Secondary School encountered varying experiences in their Mathematics class. These experiences directly or indirectly contributed to the learners' perceptions about Mathematics, which further instilled in them specific attitudes towards the subject. Hannula

(2002) found that a learner's attitude towards Mathematics was a significant factor accounting for whether or not that learner pursued a career in Mathematics.

In the analysis of the quantitative data solicited from the FSMAS scale four subscales emerged. In subscale one, "I feel competent and confident when I do Mathematics", learners in all three grades had a positive attitude towards Mathematics. This study also found that there was a positive correlation between attitude and achievement. This claim could be supported by a study by Ma and Kishor (1997), which found that there is a positive interaction between Mathematics attitude and Mathematics achievement. Research studies by Pajares and Schunk (2001) emphasise that learners with low self-efficacy beliefs tend to be less confident and therefore more anxious and stressed when attempting a task. The present study found that many learners were anxious when asked to solve mathematical problems if the tasks were examination-oriented.

In subscale two on the question "I will use Mathematics as an adult", many learners agreed that they will use Mathematics as an adult and that knowing Mathematics would help them get a good job. Abu-Hilal (2000) found that learner perceptions regarding the importance of Mathematics exerted a significant effect on achievement. In this study it was found that more boys than girls believed that they will use Mathematics as an adult. Recent studies have indicated that boys have positive attitudes towards mathematics, more self-confidence in their abilities to learn mathematics, and less mathematics anxiety than girls (Gasiorowski, 1998).

With regards to subscale three "I feel comfortable with my teacher and peers in the Mathematics class", the qualitative data confirmed that some learners were more apprehensive about their teacher and the high achieving learners in their Mathematics class than others, which caused some learners to experience much difficulty when preparing for a Mathematics examination. Of significance to the findings of the study is that the boys were much more comfortable with the classroom environment than the girls. The finding of this study could be supported by Gasiorowski, (1998) who claimed that boys have more self-confidence in their abilities to learn mathematics than girls.

In subscale four on the question of "my parents encourage me in Mathematics", the responses showed that learners believed that their parents were very encouraging when it came to their learning of Mathematics and were rarely disappointed with their performance

because they understood that Mathematics was a challenging subject. This finding concurs with the study by McLeod (1994), which alludes to parents finding poor grades in Mathematics more acceptable than poor grades in other subjects. This study therefore found that parents were seen as significant role players in their children's learning of Mathematics and that it was the parents' desire for their children to be successful in Mathematics.

5.2 ATTRIBUTION FACTORS TO ACHIEVEMENT IN MATHEMATICS

There were many factors to which learners attributed their achievement in Mathematics. Firstly, many learners attributed their achievement to their parents' encouraging attitude. Secondly, many learners said that their positive attitudes were conducive to good performance in Mathematics and that there was a direct link between learners' attitudes towards Mathematics and learner outcomes. Finally, the learners' educational goals or career goals motivated them to excel in Mathematics. The findings of this study concur with Ames (1992), who noted that learners who are extrinsically motivated engage in academic tasks to obtain rewards, for example good grades to meet career choices.

5.3 STRATEGIES FOR OVERCOMING IMPEDING FACTORS TO IMPROVE THE LEARNING OF MATHEMATICS

Various strategies that learners employ to achieve in Mathematics were identified. These include mastery experience, attitude, motivation, private tuition and peer group teaching-learning. By working out more examples learners were able to acquire the skills that were required to solve mathematical problems. It was also noted that success in Mathematics was more likely to be attributed to good attitudes and beliefs and less likely to be the result of luck or natural ability. Motivation played an important role in their achievement in Mathematics. While a teacher's lack of confidence acts as an impediment to learning for some learners, it could also instil a positive attribute towards other learners' performance in Mathematics. Private tuition is a necessity for most learners because it is an avenue to enhance competency, especially where there are high-stakes decision points like examinations for selective secondary schools and/or intense competition for limited university places. Finally, learners sharing the same level of interest in Mathematics and sharing a common goal, that is to excel in Mathematics, work in a coherent manner to assist one another in a peer group.

5.4 RECOMMENDATIONS

Teachers play an important role in shaping learners' attitudes toward Mathematics. It is recommended that teachers motivate their learners to excel in Mathematics. Teacher-led motivated learning that helps develop self-efficacy and increases motivation could encompass the following: encouraging learners to identify the relevance of learning in their lives; engaging learners on the use of learning strategies and feedback on how these strategies helped improve performance; adapting content so that learners understand it and providing instructional presentations catering for individual differences; setting learning goals and guiding learners to monitor daily progress; and providing feedback on progress in learning. Teachers could adopt motivational principles in the classroom, including well-defined, realistic expectations, a comparison of learners' present achievements with their past achievements, and greater emphasis on cooperation rather than competition (Margolis & McCabe, 2004).

Since learners become very anxious when asked to solve mathematical problems, it is recommended that school teachers provide more opportunities for students to work on more challenging tasks and non-routine tasks and recognise the importance of the practice of higher-order thinking skills so as to fully develop their learners' mathematical abilities. As other researchers have noted, it is important for learners to comprehend the nature of Mathematics in order to increase their desire to undertake challenging tasks, which will potentially promote higher-order thinking (e.g. Ryan, & Pintrich, 1997; Papanastasiou, 2002). Mathematics should not be limited to the representation of rigid processing, routine manipulation, and theoretical operation. Mathematics could be demonstrated in a more authentic way, which enables learners to spontaneously associate mathematical knowledge with their everyday environment. The engagement and exposure will result in learners understanding Mathematics better, and enhance their Mathematics learning, which in turn will help learners to develop more positive attitudes toward the subject and therefore further promote their learning ability. This study, in concurrence with Pajares, (2002) suggests that teachers should aim for tasks that are only slightly higher than the learner's actual capability, so that while they are encouraged to aspire to something, that something is achievable. Research in this area will be valuable to the practicing teacher and beneficial to the learner.

Peer group members are responsible for group contrast effects such as forming attitudes. Successful experiences must be made personal to the learner and should not be seen as being in competition with others. Larcombe (1985) suggests that learners be encouraged to compare their current performance with their previous performance and not that of their peers. It is recommended that when teachers set up peer learning groups, it is important for the teacher to take cognisance of the fact that learners that have the same goals and aspirations are able to work in a coherent manner, and could form the peer group. This study has shown that if a teacher places a high achiever as the group leader, mediocre learners do not engage actively in the group. It is further recommended that learners be placed into peer groups in which they feel comfortable, since any form of anxiety would be a barrier to learning Mathematics.

This study found a significant relationship between Mathematics self-efficacy and Mathematics achievement. A number of other studies have reached a similar conclusion, including, (Pajares and Miller, 1994; Schunk, 2001). Based on the findings of this study, it is recommended that secondary school learners should see Mathematics as the same as, or even similar to, any other subject. This will enable them to begin to do well in the subject. Mathematics teachers in secondary schools are also called upon to always make the Mathematics class an interesting one. This will improve the self-efficacy and achievements of the learners.

Attribution theories have been used to explain causal factors in learners' achievement in Mathematics. Much research has been done in the area of affect and factors that influence the learning of Mathematics have been highlighted. An important area for future research would be the development of intervention programmes that focus on building positive learner attitudes in Mathematics through an investigation of learner attitudes.

The involvement of parents in education is drastically reduced when children reach secondary school and teachers often do very little to encourage parental involvement. It is important for teachers to take cognisance of the significant role that parents could play in improving the learners' achievement in Mathematics. My recommendation in this regard is for teachers to supply a Mathematics year plan or work schedule to parents. This work schedule would show what topics or sections are being covered in the Mathematics classroom. The assessment tasks are also included in the work schedule. In this way, parents may keep up with what is happening in the Mathematics class and see how they can assist their children with

homework or other assessment tasks. Parents can also keep track of the work by signing the children's homework diaries and cross checking the homework diary with the work. According to a study by Hoover-Dempsey & Sandler (1995) parents choose to become involved in their child's Mathematics homework because they believe that their involvement will make a positive difference in their children's learning, and perceive that their involvement is invited, expected, and valued by school personnel. It is equally important for parents to look at ways to motivate and encourage their child through those times of difficulty in Mathematics and should not assume that their child should be duplicating their own successes or failures.

Finally, it should be noted that this study focussed on learners at the Further Education and Training level of secondary schooling. It would be interesting to establish whether the attitudes held by learners in lower grades towards Mathematics are similar, to what extent they differ, and the reasons for such differences.

5.5 CONCLUSION

This study sought to investigate learners' attitudes toward Mathematics and the relationship between attitudes and achievement in Mathematics. The results showed that learners have positive attitudes toward Mathematics, but more can be done to motivate learners intrinsically. Deci (1975) suggests that learner's intrinsic motivation can be enhanced by creating opportunities for learners to have more control over their learning environments. As a new democracy, South Africa is far from developing learners that are mathematically proficient. Mathematical proficiency cannot be achieved through isolated efforts. All interested stakeholders, including parents, teachers, administrators and policy makers, must work together to improve the teaching and learning of Mathematics at school. Successfully articulating learners through their Mathematics classes would provide them with a better chance of succeeding in today's global workplace.

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APPENDIX A

QUESTIONNAIRE

Start Here

(1) My name is _____

(2) I am in grade _____.

(3) I am a: male ☐ female ☐

(4) My home language is _____

(5) Write down the first thing that comes to your mind about maths in the block below.

The purpose of this questionnaire is to gather information about your experiences about and attitudes to mathematics and to ascertain the degree to which specific affective factors affect your learning in the mathematics classroom.

Please answer honestly and completely. Your answers are completely confidential. There is no right or wrong answers. Work quickly and record your first impression.

I thank you sincerely for completing this questionnaire.

A. Personal confidence about maths : Confidence/Self-efficacy 79

	A Strongly Agree	**B Agree**	**C Not Sure**	**D Disagree**	**E Strongly Disagree**
1. I am good at maths.					
2. I do not enjoy maths.					
3. I find maths too difficult for me.					
4. Most subjects I can handle but I just cannot do well in maths.					
5. I am confident of myself when I do maths					
6. Doing maths makes me nervous and upset.					
7. I'm not the type to do well in maths.					
8. I'm just not good in maths					
9. I am sure that I learn maths.					
10. I am always anxious when asked to solve maths problems.					
11. Maths is my worst subject.					
12. When I am in a maths class I feel relaxed.					
13. I don't think I can learn maths.					
14. I am always under a terrible strain in the maths class.					
15. I often get scared when I open my maths book and see a page full of problems					
16. Studying mathematics makes me feel nervous.					
17. I am able to solve mathematics problems without too much difficulty					

B. Perceptions of parent /guardian attitude

	A Strongly Agree	**B Agree**	**C Not Sure**	**D Disagree**	**E Strongly Disagree**
1. They encourage me to do well in maths.					
2. They think that I could be good in maths.					
3. They would be disappointed if I do not do well in maths.					
4. They think it is important for me to study maths.					
5. They think that private tuition would improve my mark.					

C. Perceptions of teacher attitude

	A Strongly Agree	**B Agree**	**C Not Sure**	**D Disagree**	**E Strongly Disagree**
1. My maths teacher makes me feel I have the ability to go on in maths.					
2. I wish my math teacher would pay more attention to my maths learning in class					
3. My teacher thinks that I could do well in maths.					
4. I feel that my maths teacher ignores me when I try to ask questions in class.					
5. My teacher makes me feel silly when I ask questions in maths class.					
6. My teacher only worries about teaching the clever learners in class.					

D. Perceived usefulness of maths

	A Strongly Agree	**B Agree**	**C Not Sure**	**D Disagree**	**E Strongly Disagree**
1. Knowing maths will help me get a good job.					
2. Maths will not be important to me in my life's work.					
3. I will use maths in many ways as an adult.					
4. I don't know why I have to learn maths.					
5. Doing well in maths is not important for my future.					
6. Mathematics is important in everyday life.					
7. Mathematics is one of the most important subjects for people to study.					
8. High school math courses would be very helpful no matter what I decide to study,					
9. I would like to avoid studying mathematics after matric.					

E. Attributing factors

	A Strongly Agree	**B Agree**	**C Not Sure**	**D Disagree**	**E Strongly Disagree**
1. I am afraid to ask questions in class because my peers will think I am stupid.					
2. The 'clever' learners in my class make me feel stupid.					
3. I never do well in maths no matter how hard I try.					
4. My peers are understanding and help me to learn maths.					
5. Learning maths is too pressurising and stressful.					

F. General

	A Strongly Agree	**B Agree**	**C Not Sure**	**D Disagree**	**E Strongly Disagree**
1. I would like to further my studies in maths.					
2. I would study maths at tertiary level only if I absolutely had to.					
3. I do not mind studying maths after matric, if it is necessary for my studies.					
4. I would prefer never to study maths ever again.					
5. Maths is dull and boring.					

G. Views on achievement in Mathematics Place a cross next to any of the blocks that you think is true for you. You may cross as many blocks that applies to you.

My achievement in mathematics could be attributed to:

My positive attitude towards maths	
My teacher's teaching style	
My teacher's caring/ encouraging attitude	
My parents encouraging attitude	
My parents are good in maths	
My career choice involves my doing well in maths	
Attending private tuition	
My school has extension classes	
My use of learning material provided by the media	
My use of technology for example software	

APPENDIX B

Group Interview Questions and Transcript

Group Interview Questions

The purpose of this interview is to gather information about your experiences in the maths and to ascertain the degree to which specific affective factors affect your learning in the maths class. Your identities will remain completely confidential. This interview will be of no use unless you give your honest views.

1. The average mark for the second term for mathematics was 45%, 54% and 63% for grades 10, 11 and 12 respectively. Why do you think that the mark seems to increase from grade 10 to 11 to 12?

_____
_____
_____
_____
_____

2. 75% of the learners who do maths in grades 10, 11 and 12 at our school feel that they could learn mathematics. What is your view on that? What do they mean by that?_____
_____
_____
_____

3. One of the questions was related to emotional state in the mathematics class. In grade 10, 11 and 12 the percentage of learners that feel relaxed is 14%, 36% and 40% respectively. Why do you think that more learners feel relaxed in grade 12 than in grade 11 and 10? _____

_____
_____

Do you think that there are any other factors that help the grade 12 learners to feel more relaxed?_____

4. The questionnaire showed that 29%, 36% and 45% of the learners from grades 10, 11 and 12 respectively feel anxious when asked to solve maths problems. Why do you think that that the grades 11 and 12 learners are more anxious than the grade 10?_____

_____
_____

5. Do you think that your primary school perception of maths influenced your reaction towards the subject? If so say how. _____

_____
_____
_____

6. 42% of the learners feel that they cannot do well in maths and 34% of learners consider themselves as having the ability to solve maths problems without too much difficulty. What makes people to feel this way?

_____

_____
_____

7. If a teacher only focuses on a handful of learners, what does that mean for the others in terms of coping and doing well._____
_____
_____
_____

8. Many learners feel that they wish that their mathematics teacher could pay more attention to them. Why do they feel this way? _____
_____
_____
_____
_____
_____

9. What factors do you think is enabling you to achieve in mathematics?
_____
_____
_____

10. What strategies do you use to improve your learning of mathematics?
_____
_____
_____
_____
_____

THANK YOU FOR YOUR CO-OPERATION

I would like you to respond by saying the first thing that comes to mind. I welcome any suggestions that you make on ways in which to improve your learning of maths. My task as a researcher is to listen and gather information, and whatever is being mentioned would be treated confidentially. This information would not be made available to their maths educators.

Teacher : The average mark for the second term for mathematics was 45%, 54% and 63% for grades 10, 11 and 12 respectively. Why do you think that the mark seems to increase from grade 10 to 11 to 12?

All : Yeah…..its because…

Lily : From grade 9 to grade 10 is an adjustment. By the time you get to grade 11 and 12 you more or less used to the teacher's style of teaching. You understand what is required of you so you go home and complete your work…so the marks are higher …. And as you proceed you are familiar with the teacher's style of teaching.

Kimo : Experience and also in grade 10 you have children who think that they can do maths. In grade 11 they drop off so you only have the children who can do maths and not the others who are wasting their time and the children's time.

Kris : Basically … I mean … in grade 12 it is a repetition of the work that you did in grade 10 and 11 so…

Teacher : So there is no new work in grade 12?

Lily : Majority of the work is covered in the foundation that is in grade 10 and 11. So when you are in matric you are comfortable because you have done the majority of the work.

Teacher : Okay fine. Now in this school 75% of the maths learners in grades 10, 11 and 12 feel that they could learn mathematics. What is your view on that?

Zammy : I think that many people under-estimate maths.

Lily : I think that when people don't do well in maths they think that mathematics is hard.

Kris : That's because in grade 8 and 9 they get good marks and they are motivated so they think that okay I have an ability to do mathematics.

Kimo : They could not be more wrong because in grades 8 and 9 the syllabus is watered down just to make learners pass. But grade 10, 11 and 12 is not like that… it is much harder and it brings you up to university level.

Teacher : One of the questions was related to emotional state in the mathematics class. Now I want you to take note of the figures. In grade 10, 11 and 12 the percentage of learners that feel relaxed is 14%, 36% and 40% respectively. Why do you think that more learners feel relaxed in grade 12?

Lily : It goes back to the point made earlier …that majority of the work is already covered in grades 10 and 11. So they are more comfortable. And even though they do new work in grade 12 most of the work has been covered.

Teacher : Okay grade 10 learners why aren't you all relaxed in the mathematics class?

Zammy : We haven't experienced anything like this before. We are under a lot of pressure.

Kimo : The future grades tell us it's simple but it is not because we have not done anything like this before. And also since we performed better because the work was simpler in grade 9 our family and teachers expect us to do better … they expect us to carry on doing better in the further grades which is not so simple.

Teacher : So that is causing some kind of stress.

Lily : The adjustment between eleven subjects and seven …

Kimo : Even though seven is harder than eleven.

Kris : In grade 10 they are introduced to a new style of work and when they go to grade 11 they are getting the hang of it. By the time they reach grade 12 they are much confident 'cos they know the style of work and they have strategies to learn the maths. In matric they are not as stressed during the maths lessons as I was last year because this years' work is a repetition of the last two years and we kind of understand the work better now than in grade 10. Basically at grade 12 it is easier to cope because we also understand what is required of us.

Teacher : Do you go for tuition?

All : Yes

Teacher : Do you think that allows you to feel more relaxed in class 'cos… could it be a case of I do not have to pay attention in class because my tutor will cover that work with me …or

Kimo : The work is probably covered already.

Nelly : You kind of feel better 'cos you know what's going on.

Teacher : So that helps you to feel relaxed.

Teacher : But yet those very same learners in grade 11 and 12 who said they feel relaxed …look how the figures differ. But in solving problems the grade 12 learners are more anxious when solving problems even though there are a greater percentage of learners that are more relaxed. Why are there more grade 12 learners more anxious about solving problems yet in grade 10 there are a greater percentage of learners who are not anxious about solving problems and a greater percentage of them that are not relaxed?

Kimo : Perhaps there are a reduced number of learners so there is a better chance of being picked. The work

Lily : Every mathematical problem has a score attached to it. When I have to work out problems in maths, how effectively I use certain skills would be assessed and I would be awarded a certain mark. This causes a great deal of anxiety for me because I know that I need good marks in mathematics to be accepted to pursue my studies at university and that ultimately my career depends on this mark.

Teacher : So you are saying that learners in grade 11 and 12 are anxious because there is a mark attached and this would effectively determine your maths mark and your choice of career.

Lily : Yes, yes …

Teacher : Do you think that your primary school perception of mathematics influence your reaction to the subject in secondary school …whether it was your mathematics teacher or the maths at primary school, did it ever influence you in any way?

Lily : Yes it can influence in a positive or a negative way. There are some people in primary where if you had six out of ten they would say yeah you may cope with high school maths and that makes you feel better. Then there are some people who would say you would never cope with high school maths and now the learners in grades 10, 11 and 12 are proving her wrong. So I think it can impact on a person in a positive or negative way.

Teacher : Do you know whether learners experienced any negative comments in primary school?

Lily : My primary school maths teacher always told the class that you can't do simple work now, wait till you come to high school. You will never cope because maths is a very difficult subject and its either you have it or you don't. I was convinced that mathematics required you to be very intelligent and since I was not the top learner, receiving all the awards in primary school, I felt that no matter how much of effort I put in I am not going to be "good" in mathematics anyway. Automatically by the time you are in grade 9 you know that you are going to choose maths literacy because my teacher told me that I can't cope with maths.

Teacher : So your primary school maths teacher impacted on you in a certain way.

Lily : The teacher said that you will never be able to manage maths. A response of this nature from a teacher could have a positive or negative effect on the learners. A strong willed learner would be determined to prove the teacher wrong making the learner to push harder so that he could get good marks while another learner could actually start believing that they cannot do maths. I was told that I could not do maths 'cos I did not know the answer to nine times nine.

Teacher : Learners feel that they cannot do well in maths. What could be the reason for this?

Kimo : Because they realise the stark increase in difficulty in maths. Even though they may have done well in grade 9, grade 10 is so different. It is so much harder.

Kris : I think that comes down to the attitude of the learners. If you tell yourself that you are going to do it, then you can… Nobody can stop you. So if you have a negative attitude you basically won't be able to do anything.

Teacher : Do you find yourself in a situation where you feel you cannot do well in maths sometimes?

Zammy : When I look at my results sometimes I think why I did maths.

Lily : When you are going to choose subjects at the end of grade 9, you find out from other learners about maths. And sometimes if you ask the wrong person, someone who is battling with maths then they go eish… then you also going to feel that you are going to find maths difficult. But if you ask someone who is on the same page as you then you get a better understanding of the subject. And also if you talk to someone who is obtaining "As" in maths then they will tell you that it is not difficult as long as you put your mind to it and when you get to grade 10 you feel motivated and you feel that you can manage to do well in maths. If you ask someone who is battling they put the subject down and if you come across a problem that you can't work out then you are going to go this is not for me and anyway they said that maths is difficult and you won't put your mind to it. So a lot depends on whom you ask about doing maths.

Teacher : So is that how learners get an understanding of whether they can cope with maths or not.

All : Yes.

Lily : In grade 9 you have never been exposed work like that so you find out from other learners and again it depends on whom you ask. Many people who have the potential have gone the wrong route because they have been misinformed. Maybe if they chose correctly they would have done a better career and not have taken the easy way out.

Teacher : There was a statement in the questionnaire that read a teacher only focuses on a handful of learners. What does that mean for?

Nelly : That's like basically a teacher telling you that you not good enough so just step aside let me deal with these learners. A teacher should not deal with us like that because we all are not the same … our intelligences are different. The way a teacher treats us has a major impact on maths 'cos I could change maths now because of the way sir acts towards other children and towards me.

Teacher : So there is this feeling of wanting to give up maths because of this situation.

Nelly : (with tears in her eyes) To me it's like sir is basically telling me but sugar coating it to stay one side and let me deal with these kids …yeah…

Teacher : But you know your real potential. Do you think that is a fair judgement of your potential by the teacher?

Nelly : No but we can't control the way a teacher feels about us.

Lily : Even though I might not have been put down by my teacher but I feel guilty if a teacher does it in my presence. Sometimes there are some learners who listen to the teacher once and know what is going on and there are others that need just a little bit more time. And if the teacher is going to go do you understand, okay

good let me just go on then what happens to those learners. And some remarks that teachers make like as long as I get one A its fine or as long as only these learners here in front know what's going on then its fine. You could just see it when they are teaching. It's like hey do you get it…okay good …or you are a bit bored so there's an extra problem for you to work out…. These comments just put some learners down.

Teacher : Does this happen at this school?

Nelly, Zammy and Lily : Yes it does.

Lily : And then when you have maths kids are like oh no..

Teacher : Do you have a love for the subject?

Nelly, Zammy: Yes.

Lily : Yes but it depends on the teacher you put in charge of teaching maths.

Zammy : But sometimes you don't know what to expect next. So you are a bit scared.

Nelly : You afraid to ask questions.

Teacher : Do your maths teachers motivate you in maths?

Lily : Its either you have a teacher that worries about you and says if you don't understand anything you should come to my table or the type of teacher who says this is how you do it, end of story have a problem sort it out yourself. I have a teacher who is caring even though sometimes she makes remarks like for those people that are not doing so well just stick to these examples or even sometimes the teacher points out certain learners in the class and goes like you just focus on statistics or whatever. Even though she does not tell me that but I feel for the other learners.

Teacher : So now the teacher works out certain sections of the paper that certain learners should answer. So the teacher has it in their mind who can cope with these and who cannot.

Lily : There are some situations where a teacher has tried encouraging you and failed. So they ridicule you in front of other learners just so that they can get you to do well. Sometimes it works because you want to prove the teacher wrong but for the weaker learner they just feel demotivated. Unfortunately at our school that's not how it works, they just tell you that you are going to fail. A big part is played by the teacher.

Teacher : So do you think your achievement in maths could be attributed to your teacher and teaching style?

Lily : Yes because when I was in grade 8 my teacher made me feel like I can't do maths. But my teacher in grade 9 used a different approach. She was like attempt the work and we will go over any problems that you have. And that's when I knew I had maths. In grade 8 I had a teacher who made fun of you if you got anything wrong and that makes you feel that you are not going into maths.

Teacher : So if you had the same teacher would you have chosen to do maths?

Lily : No not at all. I would not have done maths at all.

Teacher : So you would have underestimated your ability in maths. Kimo what do you think? Do you feel differently?

Kimo : Sometimes the teacher has to keep to a pace to complete the curriculum. In our class the teacher combats that by putting us into groups and having group leaders to teach the people in the group. So if the people in the group don't understand the work then they should ask the group leaders and if the group leaders don't understand the work then they can ask the teacher.

Teacher : Does this work well in your class?

Zammy : No

Kimo : The problem is that the learners in the group are scared to ask the group leaders.

Zammy : No. The group leaders are afraid to ask sir.

Teacher : Is that the only teaching style that is used in your class.

Zammy : Sometimes sir explains and then we have to teach the rest of the learners in the group. And sometimes we don't get it then it's difficult to explain to the others.

Teacher : Is there any strain that is placed on you as group leaders?

Zammy : Yes because the group depends on you and then you can't help them. So you feel like you have let them down. But they understand 'cos they know that we are scared. We also as group leaders have to ask each other if we do not understand anything and sometimes we feel uncomfortable about that. Other group leaders would think that we are stupid and are therefore afraid to ask questions.

Kimo : But sometimes the learners don't ask you for whatever reason.

Teacher : Can the other learners bypass the leader and ask the teacher?

Kimo and Zammy : Yes

Kimo : But the learners don't do that because they are scared. I'm probably the only one out of 43 learners that asks questions.

Teacher : What are the learners scared of?

Lily : You are going to be made fun of in front of the whole class. And nobody wants to be embarrassed in front of their peers.

Kimo : But I ask questions. I am not scared.

Lily : That's because you will get the A. And he won't embarrass you. How could he after all you are his A student.

Kimo and Zammy : He would say I already explained this and it is so simple.

Lily : When a teacher says I don't care if the rest of you are not interested because I know that only these learners here are going to do well so I will simply focus on them only, … it is very demotivating.

Zammy : A repetition of the explanation by the teacher depended on which learners wanted the explanation repeated If Kimo who is the highest achieving mathematics learner in the class wanted to find out something that he did not quite understand then the teacher explains for the second time. Other learners including me are scared to ask him anything in mathematics because he is like… if you don't understand this you should not be in a mathematics class.

Lily : Sometimes the educator teaches the subject and not the learners. And because I can keep to the pace of the teacher I do not have much difficulty. But I do feel for the other learners because you could see that they just do not understand the work therefore they invariably find mathematics difficult.

Teacher : Many learners feel that they wish that their mathematics teacher could pay more attention to them. Why is this so?

Zammy : In my class you have to understand the work the first time that the teacher explains and if you don't get it then you will be lost. Then I am unable to solve mathematics problems with ease and this is what makes maths difficult.

Teacher : What factors do you think is enabling you to achieve in mathematics?

Nelly : We work so hard before an exam or test but the examples that we get in the paper are always challenging.

Zammy : The learners in my class developed a negative attitude towards maths because the teacher ridicules and embarrasses them over certain difficulties they might encounter in mathematics. And they want to actually change from maths to maths literacy. I am determined to do well in mathematics because of my career choice and this spurs me to excel. However when our friends meet to study maths we assist each other to understand the work. I am never prepared and confident before writing a mathematics paper since I have to understand the work myself. So peer teaching helps because we are afraid to ask their mathematics teacher for assistance in the class. A group of learners sharing the same level of interest in mathematics and sharing a common goal, that is to excel in mathematics, work together to assist each other. After receiving our test scores, our friends form a support structure to motivate each other, more especially when our teacher makes us feel as if we are incapable of doing maths.

Kris : After my teacher discusses the work in class I work out more examples at home until I know exactly what's happening. In this way when we are writing a test or an exam, I do not have to spend time trying to understand the work but I just work through past year papers 'cos that helps a lot.

Sivi : Working through simple questions and getting them right motivates me to work through more challenging questions.

Lily : Sometimes when my marks drop I don't just give up but I pick myself up by focussing on my career and this motivates me to work harder in maths.

Kris : In some tests when I do not get good marks I don't allow myself to develop a negative attitude to maths. I think about my goal and this motivates me and makes me determined to work harder to get those good marks. I have a positive attitude towards the subject.

Kimo : In order to excel in mathematics one has to firstly have a positive attitude and secondly work hard of course.

Lily : Attitudes are developed based on learners' past and present experiences in the mathematics class.

Teacher : What role do your parents play in your learning of maths?

Nelly : They know that it is not easy to do well in maths so they do not pressurise us into getting good marks. Maths is an exciting and challenging subject that is enjoyable provided that your teacher teaches you and makes you understand the work.

Lily : And one more thing I had a teacher, who's not at our school anymore, who used to say that maths was for boys only and that girls can't solve problems because maths is not for them. If I volunteered to put an answer on the board then he would make statements like I'm sure it would have taken her very long to figure the answer out. But I'm sure that the boys would have worked it out much faster. Fortunately he is not at our school anymore.

Teacher : Is maths a manageable and passable subject?

All : Yes it is. (With a smile)

Teacher : Thank you for your time. Your responses will be used in my research
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APPENDIX C

LETTER FOR PERMISSION TO CONDUCT RESEARCH [PRINCIPAL]

6 Tariq Road
Riyadh Township
Verulam
4339 e-mail: raninaidoo@ymail.com

22 August 2011

The Principal

I am currently a second year Master of Education (M.Ed.) student at the University of KwaZulu-Natal, Edgewood and I am presently engaged in a research study on **Mathematical attitudes and achievement strategies of successful mathematics learners.** Mathematics plays an increasing role in all spheres of life. While mathematics education is a key element of schooling and high quality mathematics education is seen as important training for citizenship as well as for preparation for work, research has shown that mathematics in many countries is facing serious problems.

In this regard I am asking your permission to conduct research at your school. Please note: this is not an evaluation of learners or teachers' performance. I am simply interested in learners' views on achievement in mathematics. Learners will be asked to complete a questionnaire during school hours relating to what they are learning in mathematics, what they would like to learn about, their opinions on mathematics and their understanding of the challenges they face in mathematics. The questionnaire will take approximately 45 minutes to complete. There will be no additional cost to the school. I will be requesting the mathematics learners in grades 10, 11 and 12 to complete the questionnaire. Three interview sessions with about 10 learners would also be conducted to collect data. The venue and time of the interviews would be negotiated with the learners.

The identities of all who participate in this study will be protected in accordance with the code of ethics as stipulated by the University of KwaZulu-Natal. I undertake to uphold the autonomy of all participants and they will be free to withdraw from the research at any time without negative or undesirable consequences to themselves. However, the parents of participants will be asked to complete a consent form. The names of the learners and the name of the school will not appear in my report, or in any papers or presentations that I make after the study. A synopsis of the most important findings will be forwarded to your school, upon your request.

You may contact my supervisor, Dr. Sally Hobden on 031 2603435 at the Faculty of Education, University of KwaZulu-Natal (School of Science, Mathematics and Technology Education), should you have any queries or questions you would like answered.

I thank you in advance for your support and co-operation.

Yours faithfully

I.NAIDOO

APPENDIX D

LETTER FOR PERMISSION TO CONDUCT RESEARCH [PARENT/LEGAL GUARDIAN]

6 Tariq Road
Riyadh Township
Verulam
4339

Dear parent

My name is Mrs. I. Naidoo and I am a second year Master of Education (M. Ed.) student registered at the University of KwaZulu-Natal and I am a teacher at the school that your child attends. My telephone number is 032 9441665. I am presently engaged in a Mathematics research study based on **Mathematical attitudes and achievement strategies of successful mathematics learners.**

My research project is being supervised by Dr. Sally Hobden who can be contacted on 031 2603435 at the Faculty of Education, University of KwaZulu-Natal (School of Science, Mathematics and Technology Education). If you need further information about the project, please contact my supervisor.

I would like your consent to include your child in my research project. I would like the children in my study to answer a questionnaire relating to what they are learning in mathematics, what they would like to learn about, their opinions on mathematics and their understanding of the challenges in mathematics.

The project will be conducted during school time. I have asked the university, Department of Education and the school principal for permission to conduct the research. There will be no additional cost to you or the school.Your child's name and the name of the school will not appear in my dissertation or in any papers or presentations that I make after the study. If you decide not to allow your child to participate, she/he will not be disadvantaged in any way. Your child may withdraw from the study at any stage and for any reason. If you agree to your child participating in my research, please complete the attached consent form and return; it to the school. I thank you for taking the time to read this letter.

I.Naidoo

(Please complete the declaration below, and send it back to school)

I …… (Full names of parent) hereby confirm that I understand the contents of this document and the nature of the research and I consent to my child participating in the research project.

I understand that my child is at liberty to withdraw from the project at any time.

…… .....

Signature of parent Date

APPENDIX E

LETTER FOR PERMISSION TO CONDUCT RESEARCH
[LEARNER CONSENT]

6 Tariq Road
Riyadh Township
Verulam
4339

Dear learner
My name is Mrs. I. Naidoo and I am a second year Master of Education (M. Ed.) student registered at the University of KwaZulu-Natal. My telephone number is 032 9441665.
As my research project, I am conducting a research on **Mathematical attitudes and achievement strategies of successful mathematics learners.** Mathematics plays an increasing role in all spheres of life. Interest in mathematics at school level and in tertiary education has decreased in most countries and the research that I intend to conduct could give some indication of whether you think mathematics is important.

My research project is being supervised Dr. Sally Hobden who can be contacted on 031 2603435 at the Faculty of Education, University of KwaZulu-Natal (School of Science, Mathematics and Technology Education). If you need further information about the project, please contact my supervisor.

I would like your consent to participate in my research project. I would like you to complete a questionnaire relating to various aspects of mathematics education. The questionnaire should take about 45 minutes to complete. I would also be interviewing approximately 10 children of which you could volunteer if you wish to participate. The interview would pertain to the challenges experienced by successful mathematics learners and how they overcome these.

The project will be conducted during school time, and I have asked the school principal for permission to conduct the research. There will be no additional cost to you or the school.

Your name and the name of the school will not appear in my dissertation, or in any papers or presentations that I make after the study. If you decide not to participate, you will not be disadvantaged in any way. You may withdraw from the study at any stage and for any reason. Once the project has been completed, the questionnaires will be destroyed.

If you agree to participate in my research, please complete the attached consent form and return it to me. I thank you for taking the time to read this letter.

Yours sincerely

……
I. Naidoo

APPENDIX F

UNIVERSITY OF
KWAZULU- NATAL
INYUVESI
YAKWAZULU-NATALI

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mohunp@ukzn.ac.za

8 August 2011

Mrs I Naidoo (208525103)
School of Science, Mathematics & Technology Education
Faculty of Education
Edgewood Campus

Dear Mrs Naidoo

PROTOCOL REFERENCE NUMBER: HSS/0710/011M
PROJECT TITLE: Mathematical attitudes and achievement strategies of successful mathematics learners

In response to your application dated 5 August 2011, the Humanities & Social Sciences Research Ethics Committee has considered the abovementioned application and the protocol has been granted **FULL APPROVAL.**

Any alteration/s to the approved research protocol i.e. Questionnaire/Interview Schedule, Informed Consent Form, Title of the Project, Location of the Study, Research Approach and Methods must be reviewed and approved through the amendment /modification prior to its implementation. In case you have further queries, please quote the above reference number.

PLEASE NOTE: Research data should be securely stored in the school/department for a period of *5* years.

I take this opportunity of wishing you everything of the best with your study.

Yours faithfully

Professor Steven Codings (Chair)
HUMANITIES & SOCIAL SCIENCES RESEARCH ETHICS COMMITTEE

cc. Supervisor: Dr S Hobden
cc: Ms T Mnisi, Faculty Research office, Faculty of Education, Edgewood Campus

PROFESSIONAL EDITING SERVICES
62 Ferguson Road
Glenwood
DURBAN 4001
Tel: 072 442 7896
Email: deannecollins30@gmail.com

21 November 2011

This is to confirm that I have edited the dissertation "Mathematical attitudes and achievement strategies of successful Mathematics learners" by Indarani Naidoo, student number 208525103.

Yours sincerely,

(Ms) Deanne Collins (MA)