# Influences on Attitudes to Mathematics

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### ATTESTATION OF AUTHORSHIP

"I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person (except where explicitly defined in the acknowledgements), nor material which to a substantial extent has been submitted for the award of any other degree or diploma of a university or other institution of higher learning."

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Oniovosa Samuel Aruwa

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## Abstract

Attitudes to mathematics involve students' feelings toward mathematics, their view of their ability in mathematics, and the decisions they make in the classroom about doing mathematics. Attitudes are learned responses to external actions that are often characterised in positive or negative terms.

Students respond to mathematics instruction differently. Likewise, students display varying attitudes to mathematics. This study was undertaken to investigate some of the influences that impinge on students' attitudes to mathematics and to discuss, analyze, and assess the implications of these influences for people involved in the learning of mathematics.

To execute this study, a qualitative phenomenological approach of inquiry was adopted. This approach was deemed relevant because it enabled me to learn about people's experiences of a phenomenon by having them narrate their experiences and relay their perception of these experiences.

For this reason, eleven participants were sought from different work places. These participants were at least 20 years old and had all studied mathematics to at least secondary school level. The participants responded to questions about their attitudes to mathematics and the experiences that influenced their attitudes to the subject. At the end of the interview process, their narratives were transcribed, categorised, discussed, and analysed by the researcher.

The findings suggested that participants' attitudes to mathematics appeared to have been influenced by various school practices, such as, incentive schemes, achievement messages by school leaders, and classroom placement practices. Teachers' personal characteristics and the way they related to their students also seemed to have influenced the way participants related to the study of mathematics. Similarly, teachers' pedagogical practices, coupled with the expectations they had of their students regarding their achievement, appeared to have influenced students' achievement orientations.

Furthermore, participants' own motivational orientations, their belief about their mathematical ability and the reasons they gave for success and failure, appeared to have influenced their achievement and attitudes to mathematics. The presence of an extrinsic

achievement goal, particularly, toward the latter part of secondary school, seemed to have motivated participants to strive for mathematical achievement.

The exposure of participants to mathematical experiences at a young age by parents appeared to have helped them in mathematics in the last years of primary school through to secondary school. The value parents had for mathematics, their continuing support for their children's achievement, and the placement of realistic expectations on their children, seemed to have played a part in helping participants to strive for mathematical competence.

The problem of subjectivity and the possibility that the findings, their discussion, and analysis, could be influenced by the researcher's beliefs and attitudes, were noted as major limitations of a phenomenological study of this nature. It was also noted that the study's sample size of 11 participants was very small. This obviously limits the generalisation and applicability of the study's findings.

# CHAPTER 1 INTRODUCTION



## 1.1 Choice of topic

For nearly a decade of teaching mathematics, I have had several encounters with different types of students. Some of these encounters have been very pleasant. Others have left me wondering about some people's perception of the role of the school and why young people are required to attend school in their formative years. More importantly, some of these experiences have made me think about some people's understanding of the reasons students are required to study subjects like mathematics in the early years of their educational experience. Indeed, the title of this thesis; *influences on attitudes to mathematics*, results in part from one of the encounters I had with a student while thinking about a topic for my thesis. This student was a year 13 student doing year 11 Unit Standards mathematics to satisfy the numeracy requirement of 14 credits for eligibility for tertiary study. The student looked studious, or appeared to be, was always quiet and attentive, always well-behaved, usually sat in a corner of the classroom, never responded to questions, and never asked any questions. In addition, she avoided any conversations with the teacher. Therefore, our first real conversation took place after her first test in the course. I needed to discover the student's goals for the course and determine the way our expectations could be matched to ensure the realisation of her goals.

In response to my inquiry about her goals for the course, the student retorted;

> Don't worry about me. I know I won't pass this course. I can't understand why they'd compel me to do maths. I find maths to be very boring. Maths is too hard. I hate maths. Maths makes me freak out. I've never passed any maths examinations and there is nothing you will to do to change that. If you don't already know it, I'm very dumb at maths, but if you really believe you will be the miracle man to change this, I wish you the best of luck.

I could not understand why a student that appeared to have no learning disability and who was capable in other subject areas would accept failure in another subject. So I stopped the conversation and asked to have a chat with her at morning tea time. I suggested to the student that my feeling was that her problem with mathematics appeared to be perceptual and that if she was willing to be open-minded and involved, we could attempt to make some progress. Fortunately, we had a turn around by this student that culminated in her earning 16 credits by the end of the school year. This incidence sparked a desire in me to investigate what may influence intelligent people to reach a conclusion about a subject before they had given their best to attain success in it.

## 1.2 Defining attitudes to mathematics

Researchers have for long explored the impact of affective variables on students' attitudes to, and performance in mathematics. Affect relates to students' feelings about mathematics, their relationship to school, their perception of themselves as students of mathematics, and their understanding of the value of learning mathematics (Hackett & Betz, 1989; Reyes, 1984). Hackett and Betz (1989) found a connection between a student's performance and self-efficacy belief concerning mathematics and the student's attitude to mathematics. Self-efficacy belief is concerned with a student's conviction about his/her ability to successfully perform a particular mathematics task (Hackett & Betz, 1989). This is thought to influence the student's decision to start the task in the first place, to determine the amount of time to give to the task, and to persist to complete the task if in the process of carrying it out, the student experiences some difficulties (Di Martino & Zan, 2010; Relich, Way, & Martin, 1994).

The word attitude has been described variously by different writers. In its simplest form, an attitude is the way a person feels towards an object, an event, or a substance (Di Martino, & Zan, 2007; Martin, Mullis, Gregory, Hoyle, & Shen, 2002). Southwell, Way, White, and Perry (2005), suggested that attitudes are more than mere feelings, but are learned responses to external actions that can be assessed as being favourable or unfavourable. Hannula (2002) and Di Martino and Zan, (2010), focused on attitudes towards mathematics and suggested that there are three parts to attitudes toward mathematics. The emotional part signifies people's feeling when they are confronted with mathematics. The cognitive part depicts people's beliefs about mathematics, while the operative part refers to the behaviour people exhibit when they have to do

mathematics. Di Martino and Zan (2010) also suggested that when people's mathematics attitudes are qualified as being positive or negative, judgments about their performance in mathematics are enacted. They added that such judgments can only be contextualised and not generalised if they are to be meaningful.

Reyes (1984) suggested that there is a correlation between attitude to mathematics and achievement in mathematics. She observed that students who are favourably disposed towards mathematics are likely to display commensurate enthusiasm towards its study and be successful in it. These learners are likely to approach its study with open-mindedness, inquisitiveness, satisfaction, and a readiness to face the difficulties they may encounter in the course of studying the subject (Martin et al., 2000). On the other hand, students that have negative attitudes toward mathematics are likely to be less committed towards its study, likely to do little work, and may show reduced determination to surpass the challenges they may encounter while studying the subject (Arem, 2009; Fairbanks, 1992; Nokelainen, Tirri, & Merenti-Valimaki, 2007; Van Petegem, Aelterman, Van Keer, & Rosseel, 2008;). According to Curtain-Phillips (1999) and Tobias (1993), negative attitudes and lack of success may predispose students to mathematics anxiety. This has a further tendency to erode the self-confidence of students in mathematics and precipitate a cycle of underachievement in the subject (Gomez-Chocon, 2000; Reyes, 1984)

Despite the inferences above that attitudes have an influence on mathematics achievement; other researchers have questioned this conclusion. Martin et al., (2000), in their analysis of the Third International Mathematics and Science Study (TIMSS), observed that Japanese and Korean students posited that they had a negative attitude toward mathematics. However, students from these countries recorded higher scores in mathematics than students from other countries whose students declared they had a positive attitude to mathematics. These writers suggested that the mathematical experiences to which Japanese and Korean students were exposed may have accounted for the students' performance more than the effects of their attitudes to the subject. Separately, in a meta-analysis of data, Ma and Kishor (1997), concluded that attitude to mathematics has a weak connection to achievement in mathematics.

Ladson-Billings (1997) suggested that more consideration needed to be given to culture and its impact on mathematics achievement. Cultural differences could pertain to inter-country as well as intra-country cultural practices. Looking at differences in

mathematics achievement between different population groups in the United States, Ladson-Billings (1997) explored the differences in mathematics achievement between Caucasian-Americans, Asian-Americans and African-Americans and attributed it to differences in cultural socialisations among the population groups (E.g., Eccles, Kaczala, & Meece, 1982). Ladson-Billings (1997) argues that mathematics teaching demands that problems are done repeatedly until students gain mastery. Students are expected to think abstractly, reason, and to work toward a particular solution. This, she claims, is more suited to white middle class culture which emphasizes efficiency. On the contrary, she states that African American culture emphasizes verbal expression of ideas, group interaction, spiritual inclinations, and physical demonstration of activities as in music and dancing. This, she asserts, makes it difficult for them to relate to mathematics the way it is taught in schools.

Chen and Stevenson (1995) suggested that the difference in mathematics achievement between Chinese and other East Asian and Americans may be due to the value that each culture places on education. East Asian and Chinese parents are said to demand high achievement from their children, place high expectations on them, devote a lot of time to academic work, emphasize that achievement is dependent on effort, and are more involved in their children's schools. In addition, they are less easily satisfied with their children's performance (Stevenson & Stigler, 1992). On the contrary, American parents are said to be less demanding of their children, more easily satisfied with their academic performance, attribute academic success to ability, and are less involved in their children's schools than Asian parents (Geary, 1995; Fuller & Clarke, 1994; Stevenson & Stigler, 1992). These differences in culture may be the reasons for the differences witnessed in mathematics achievement (Ladson-Billings, 1995; Stigler & Baranes, 1988-1989).

However, based on the experience I narrated above, it is relevant to suspect that for certain category of students, their attitudes to mathematics may be impacting on their determination to be successful in its study. It is also not uncommon to have students repeating the statements of the student presented above and asking questions like; "where are we going to use this algebra in real life"? "What is the use of doing maths? It is such a useless subject". There are many similar sentiments of this nature. Yates (2009) calls these sentiments 'learned helplessness in mathematics' (p.86). She opined that students adopt these beliefs and abide by them thereby precluding themselves from working to improve their outcomes in mathematics. It is important that any set of

beliefs, sentiments, attitudes or conclusions that may be sufficiently potent to prevent people from striving to attain to their best potential deserve close scrutiny. Based on the foregoing, I believe it is important to investigate the factors that influence students' attitudes to mathematics.

### 1.3 Aim of study

Many of the studies I have seen on attitudes to mathematics are studies done in foreign countries. These studies often approach the topic from psychological, sociological and economic perspectives. Therefore, I concluded that it would be useful to hear the experiences of people who live in New Zealand and who may have experienced mathematics locally, with a view to exposing the factors that impinged on their attitudes to mathematics. I also believe that instead of proposing theories and soliciting people's views to validate or disprove these theories, it would make more meaning, in an educational context, to converse with people, and obtain from them, first hand, the stories of how they experienced mathematics when they were in school and the influences that shaped their attitudes toward the study of the subject. Consequently, the aim of this study is to;

- Explore a small number of people's lived experiences with mathematics
- Identify experiences that influenced these people into forming particular attitudes, either positive or negative toward mathematics;
- Consider these experiences and identify any possible trends that may be drawn from them
- Describe these experiences so that people involved in education may become conscious of them.

## 1.4 Research question

One of my principal objectives in this study is to investigate the following questions. What are some of the factors that impinge on the formation of students' attitudes to Mathematics? At what stages in the schooling process are these attitudes formed, assimilated and engraved in the minds of students? How can an awareness of these attitudes help students avoid forming them and thereby improve their chances of striving to attain to their potential in mathematics? Consequently, the principal question that this research project will attempt to answer is; *what are some of the influences that impinge on students' attitudes to mathematics*? This question is predicated on the understanding that no single study will be able to unearth all the factors that may impinge on students' attitudes to mathematics. Secondly, the attitude of learners, the learning environment, and learning resources may be constantly changing. As a result, influences that impinge on different learners' attitudes may be subject to the social milieu of the times in which they live. Other assumptions on which this study is based are raised in the section that follows.

## 1.5 Researcher's assumptions

I assume that mathematics is a very important subject that all learners would benefit from learning as it improves people's thinking and cognitive potential. It is probable that there are many factors that influence students' attitudes, either positively or negatively toward the study of mathematics. Consequently, if the goal of education is to have mathematically competent people who can thrive and compete in the global work force, any factors that may work to hinder the realisation of this goal are worthy of investigation.

Participants in this research were all able-bodied adults who displayed no physical or mental disability that was discernible to the naked eye. It is therefore supposed that the findings presented, and conclusions reached, may not apply to learners who possess special needs and have learning disabilities.

Furthermore, I assume, perhaps mistakenly, that for optimal success to be attained in mathematics, parents, the student, the teacher and school, will work together collaboratively to realise maximum student outcomes. Where deficiencies are identified and recognised with one of the stakeholders in the learning process, I hope that the other

interested parties will take all necessary steps to make up for any deficiencies or gaps that might have been created by the defaulting stakeholder.

I assume also that all learners, free of any mental or physical handicaps, are capable of learning mathematics if they place a high value on mathematical knowledge, find it relevant, are appropriately motivated, determined and desirous for success, have the ongoing support of their parents, and are nurtured and motivated by their teachers and schools.

I assume that students are moved by actions, words, emotional support, material support, peers, their own unique achievement characteristics, teachers and the school, to reach conclusions, form attitudes, and exhibit patterns of behaviour that may determine the way they relate to the study of mathematics. Finally, I assume that attitudes may play a major role in determining the level of interest, commitment, effort, and confidence that students bring into their study of mathematics.

### 1.6 Researcher's background

I was born in Nigeria, an erstwhile British Colony. Nigeria gained its independence from Britain on October 1, 1960. The country has many languages, about 250 of them, and more than 1250 dialects. Consequently, English is the only language common to everyone, so it is one of the official languages of Nigeria. None of the other official languages; Ibo, Yoruba and Hausa; are taught or used as a means of communication outside the tribes and states where these languages are indigenous and spoken. However, where speakers of these languages are resident in other states in large numbers, they often speak these languages among themselves or to other people who have learnt to speak these languages, as means of private communication. The English language is also the language of business, parliamentary debate, and official government transactions in Nigeria.

When I was in school, English was the sole language of instruction in all subjects except where 'vernacular', (a term used to refer to the language of the community where a school was situated) was taught at the school. The schools I attended were situated in the city. As a result, we were forbidden to speak in any other dialects apart from 'good English' while on the school grounds. This practice coupled with

increasing mix-marriages between the tribes means there is an increasing population of people of Nigerian origin like me, who can only communicate in the English Language.

Being a former British colony, the education system in Nigeria was patterned after that of the United Kingdom. However, many changes have been made since the 1980s to reflect local culture, learning conditions and needs. In those days, I sat for the first school leaving certificate at the end of six years of primary education and did the General Certificate of Education, Ordinary Level, at the end of five years of secondary education.

I completed my primary and secondary education in Nigeria in 1978 and 1983, respectively. I obtained a Bachelor of Arts degree from Andrews University in 1992 and a Bachelor of Commerce (honours) degree from the University of Malta in 1997. I immigrated to New Zealand with my family in the year 2000. The first institution of learning I attended in New Zealand was the Auckland University of Technology (AUT), where I learnt to teach mathematics, a vocation I still enjoy very much

When I reflected on the influences that shaped my attitude to mathematics, I identified personal determination to always come first or close to the top of my class as a major factor. This was partly influenced by my parents' expectations. They always insisted that we did well in our studies. At the end of every term, we had examinations with report cards issued to every student when the results were tabulated. In the third term, we did the promotion examinations. Students were moved from one class to the other based on their performance in the promotion examinations. In addition, class results were called out at the assembly. Therefore, if a student failed or did not do well, the entire student body would know that this student passed or failed. These practices also put pressure on everyone to work hard for a good result and avoid the disgrace associated with failure.

In my third year of primary school, we moved from one part of the city to another. This meant I and my immediate elder brother were put in a new school. At the end of the first term, my results were too poor for my liking. One reason for this was that we moved to that school two weeks before the examinations. Many topics on which the examinations were based were different from what we had done in our previous school. My results improved the following term, as I got better acquainted with the curriculum of the school and I started studying harder than I did the previous term. However, my results were poor in the third term which was the promotion examination, although I obtained a

pass grade and was promoted to primary four. I noticed during this time that the same student came first in the three terms. Such a situation had never happened in my previous school because we all strove to be on top of the class, and the first position usually changed between three students who strove hard to outperform the others. I remember telling my parents that the change of school had affected me and that I would do everything during the holidays to get to where I wanted to be.

I also discovered in the third year that I had major difficulties in mathematics with long division problems. I resolved to listen very attentively in class each time a question on long division was given, but I could not master the art of doing it on my own. Fortunately, on day one of year four, after the young teacher had completed the introductory routine, the topic that went on the board was long division. With a very big sigh of relief, I said to myself that this was my opportunity to understand this topic that had puzzled me for more than two years. By the end of that lesson, I had understood the process of doing long division problems. This marked a turning point in my approach to the study of mathematics.

Beyond this watershed experience in my educational career, I wrote many term papers during my undergraduate years, and also wrote a thesis for my honours degree at the University of Malta. My educational background and philosophy has been influenced by interaction with the educational processes and practices of Nigeria, the United States, Malta and New Zealand.

## 1.7 Overview of chapters

In chapter 2, I examined the existing literature on the topic. The literature on the various influences on attitudes to mathematics was grouped into home-related, student-connected, teacher-associated, and school-related influences. Home-related influences explored the influence of the physical home environment on learning, the influence of parents' income, beliefs, education, home numeracy and kindergarten practices, and the role of parents' expectations on mathematics knowledge development. Influences related to the student explored the impact of the students' intrinsic motivation, amongst others, on students' attitudes to mathematics. Teacher-related influences investigated the role of teacher-student relationship, teachers' beliefs and attitudes to mathematics, teachers' expectations, and teachers' pedagogical practices; on students' attitudes to

mathematics. The last section of the chapter examined the influence of school practices relating to student recognition, student class placement and class size; on students attitudes to mathematics.

Chapter 3 is the research design chapter. In it, I provided a justification for my choice of the phenomenological qualitative approach adopted for this study. An important point in this chapter is the philosophical position that in order to study people's lived experiences, which is what this study attempts to do, the qualitative research approach has some advantages over the quantitative research approach. Phenomenology, as a research approach is discussed with an emphasis on its relevance to human research. The use of the semi-structured interview method was explained in this chapter along with the data verification and data analysis method used for this study.

In chapter 4, I have presented the findings that resulted from my data collection. Two themes emanated from the findings; these were, success and failure and the reasons for success and failure. Participants indicated that their attitudes to mathematics were greatly influenced by their success or lack of it in the subject. Participants' attitudes to mathematics appeared to have been influenced by the experiences they had with their teachers, the school, their own individual learning motivation, their experiences with their peers and their experiences with their parents.

In chapter 5, I have presented a discussion of the findings from chapter four in the context of existing literature on the various topics covered in the findings. It was stated that participants in this study viewed their attitudes to mathematics as either being positive or negative. This reflected their perception of their degree of success in the subject. One interesting finding discussed is that, contrary to many studies, not all students in top stream classes; improve their mathematics competence from having brilliant mathematics students in their classes. In addition, the methods used by educated parents to try to teach their children mathematics, may actually turn them away from the subject if care is not taken.

In chapter 6, I conclude the study. In this chapter, I put forward a number of implications of the study findings for schools, teachers, students and parents. I have also stated what I deem to be the benefits of this study and enumerated its limitations based on the sample size and sample characteristics. My personal reflection on the process of the study was stated and a number of suggestions of areas for further research were provided. The final section contained my concluding remarks.

## CHAPTER 2 LITERATURE REVIEW



### 2.1 Introduction

A review of the literature on the various factors that may influence students' attitudes to mathematics indicates that these possible influences emanate from different sources. In this chapter, these influences have been classified under three categories; influences related to the home, influences connected with the unique features of the student, and teacher and school aligned influences.

### 2.2 Home related influences

The home is the site of a child's first instruction, so parents are a child's first teachers (Rubenson, 2004). The home is the place where the essential virtues of hard-work,

commitment, persistence, consideration and charity, are imparted to children (White, 2000). As society is composed of people from different homes, it can be positively asserted that the home is the foundation of society (Eccles, Adler, & Kaczala, 1982; Evans, 2003). A solid home education prepares the student for life-long success in later educational pursuits (Haveman, & Wolfe, 1995). The home is also the place where the child first encounters mathematics, either through normal daily conversations (such as take one lollipop and give one to your brother or sister), or in some cases, formal instruction (as in learning to count numbers) when the child prepares to commence kindergarten (Crane, 1996,Tsui, 2005).

### 2.2.1 Home ownership

Many studies suggest that there may be positive correlations between a child's physical environment in the home and the child's physical, intellectual and emotional development; factors that may in turn impact on the development of mathematical skills (Crane, 1996; Eamon, 2002; Rubenson, 2004; Tsui, 2005;). Haurin and Grabmeier (2003) found that homeownership has positive effects on children's educational achievement. They suggest that homeownership provides children with more stability, security, keeps homes in better conditions, and provides better learning space and resources. This study also reveals that owning a home as opposed to renting improves the quality of the home environment by between 13 and 23 percent. This is so because homeowners are more likely to undertake alterations and improvements that may provide better play and study areas for kids than renters. In addition, homeowners live in the same location for a longer time than people renting. This stability enables children to spend a longer time in the same suburbs and schools and develop more enduring friendships and relationships in the neighbourhood and community. They suggest that frequent home changes may be associated with stress and emotional difficulties, particularly, if parents relocate to other parts of a city where children have to go to new schools, make new friends, and adjust to new social and physical situations. Unstable home situations may also affect children's concentration and self-confidence and impact negatively on student achievement and attitude to learning (Dietz & Haurin, 2003; Lubell & Brennan, 2007).

As an addendum, the views expressed in the above paragraph were obtained from studies conducted in the United States. They may not be applicable to the circumstances of renters in every developed country. From my experience of having lived in New Zealand for more than a decade, anecdotal evidence show that renters that live in Housing New Zealand houses and managed accommodations, have been known to live in the same locations and houses for many years. As a result, their children are likely to live in the same localities and attend the same schools throughout their schooling life. Other factors such as making renovations may be the same, as renters are not usually legally permitted to carry out renovations on rented property without the consent of landlords. In most cases though, it is reasonable to suppose that a person renting a property may not show the same amount of care to the property like an owner-occupier would do.

### 2.2.2 Socioeconomic status

The relationship between family income, poverty and mathematics achievement is one that is also extensively explored in the literature. Family poverty is thought to have both direct and indirect effects on the acquisition of mathematical skills (Aldous, 2006; Stinson, 2006; Tsui, 2005). Direct effects may result when parents are unable to acquire the books, resources, and bring their children into contact with specific social and cultural experiences necessary for the development and improvement of mathematical skills. Indirect effects may be associated with increased stress, marital discord and disorientation that can be caused by poverty which in turn renders parents distracted from giving their children the attention, support and commitment they require for mathematical success (Crane, 1996; Tsui, 2005). Other writers suggest that the sufficiency of financial resources is not the principal problem but the willingness of parents to prioritise, sacrifice, and commit whatever resources they have to their children's education (Eamon, 2002; Pong, 1997; Wong, 1992). The readiness of parents to sacrifice for their children's education is thought to be affected by their regard for education and the perceived benefit they expect to accrue from it in terms of improved family income (Crane, 1996). If parents have a strong esteem for education, irrespective of the abundance of resources, they will give their children the emotional support and whatever material aid they can afford. In this perspective, the children will work to

overcome their economic disadvantage if they see the effort and support the parents are exerting to ensure their educational success. Therefore, despite the availability of resources that stimulate children's cognitive potentials, children will strive to improve their mathematical skills if they truly believe in their parents and can see the parents providing them with the emotional support, care, and encouragement they require to succeed in their studies (Cooper, Crosnoe, Suizzo & Pituch, 2010; Sirin, 2005).

Sirin (2005), questions the findings of several of the studies on the relationship between socioeconomic status and student achievement. In particular, Sirin argues that there is no single definition of socioeconomic status. Many of the studies in this area include parental income, parental education and parental occupation, as measures of socioeconomic status (Brooks-Gunn & Duncan, 1997). Sirin (2005) states that there is a connection between a person's level of education, the type of occupation they are in, and their income. He suggests that in many countries, parental income is a function of occupation and occupation is a function of education. As such, he asserts that these variables; parental income, education, and occupation, should not be treated in isolation of each other. I also see the fourth variable, home resources, which captures the availability of facilities such as, books, educational videos, magazines, and after school learning opportunities; for example, the chance of assistance with homework, as being moderated by parental education, income, and occupation (E.g., Davis-Kean, 2005; Jimerson, Egeland, & Teo, 1999; Lopez, Gallimore, Garnier & Reese, 2007).

### 2.2.3 Parents' education

In addition to home environment, parental attributes such as parents' intellectual resources, educational attainment, mother's birth age and the number of children in the family are also considered as having an impact on the mathematical attainment of children (Eamon, 2002; Trivette & Anderson, 1995). The more the number of children in a family, the less the amount of quality time parents may have to devote to each child (Eamon, 2002). Tsui (2005) adds that older and more educated mothers are able to provide a better quality environment in the home than younger and less intellectually enriched mothers. They also offer a better environment for communication and interaction between the mother and the child (Crane, 1996; Pomerantz & Eaton, 2001). Consequently, research has found that children of more educated mothers have better

mathematical scores than children of less educated mothers (Aldous, 2006; Eamon, 2002; Magnuson, 2007; McEwan, 2003). Therefore, it is believed that educated mothers affect their children's mathematical competence through the transmission of genes conducive to the acquisition of mathematical skills (Eamon, 2002).

### 2.2.4 Family structure

Family structure is believed to affect student's ability to learn mathematics in a significant way. Studies carried out on secondary school students from single parent families indicate that in general, the mathematics score of children from all types of single-parent families is below those of children from two-parent families, and this is worse for families headed by single mothers compared to those headed by single fathers (Aldous, 2006; Pong, 1997; Wong, 1992). The reasons advanced for this situation is that single parents are more likely to have reduced income, less capable of providing a quality home environment, have less time to devote to their children's learning, and are less capable of providing cognitively and emotionally stimulating activities for their children than two parent families (Crane, 1996; Wong, 1992).

### 2.2.5 Parents' expectations and beliefs

Further to the quality of the home environment, research has also found that parental expectations and beliefs play an important role in the educational achievement of children (Neuenschwander, Vida, Garrett, & Eccles, 2007). The beliefs of parents patterning to learning mathematics have a great impact on children's beliefs and attitudes towards mathematics achievement (Eccles, Adler, & Kaczala, 1982). Sy and Schulenberg (2005) concluded that parents' beliefs about preschool education affect the way they relate to early education and this affects children's mathematics and reading achievement over time. If parents believe that young children should be exposed to learning and not just playgroups at an early age, they will work to assist their children to learn and this will influence the way the children respond to mathematics and reading instruction. According to Davis-Kean (2005), parents with high and moderate education show more interest in exposing their children to early learning than parents with little or no education. It was also asserted that educated parents hold beliefs more

closely associated with their children's achievement than parents of low educational background (Neuenschwander et al., 2007; Pomerantz & Eaton, 2001; Sy & Schulenberg, 2005)

Visser (1987) considers the differential performance of boys and girls in mathematics after the age of 13 and concludes that the differences in mathematics achievement between girls and boys after adolescence are due to the differential socialization they are given by both parents. This writer concludes that more mothers than fathers have a negative attitude towards mathematics and believe boys are better at mathematics than girls. In addition, the research finds that girls are more reluctant to go to their fathers to ask for help with their mathematics homework. To overcome this situation, both parents are encouraged to instill the same amount of confidence in their children and expose both girls and boys to the same level of mathematics opportunities at all times (E.g., Gonzalez, & Wolters, 2006; Marx & Roman, 2002; Muller, 1998; Pomerantz & Eaton, 2001).

Stevenson and Stigler (1992), compared the mathematical beliefs of mothers in the United States to those of mothers from Japan, China and Taiwan, and considered the implications of these beliefs on children's mathematics achievement and attitude to mathematics. They found that many mothers from the United States believe that mathematics is difficult, that some students are better endowed with intellectual properties to excel at mathematics, and were more easily pleased with their children's performance. In contrast, mothers from the Asian countries believe that children are capable of learning mathematics, that competence in mathematics is a product of the amount of time their children commit to its study, and that the children can do better if they work hard at the skills they require to improve on their knowledge of the subject. According to these writers, both sets of mothers believe in their children's ability but the mothers from the United States overestimate their children's abilities while the mothers from Asia underestimate their children's abilities and push them to work hard. To explore this concept further, the researchers gave both sets of students a mathematics problem that they knew was unsolvable. The children from Asia persisted on trying to find a solution to the question several hours after the students from the United States had given up. Their confidence in their ability to find a solution to any mathematics problem may have geared them to persist and continue to work on the problem until they had exhausted all possibilities. In a test administered by these researchers to the

students, they found that the students from Asia performed better than the students from the United States when they were given the same test. Other writers also appear to assert that parental beliefs and attitudes to mathematics influence the attitudes that children form toward the subject (E.g., Eccles, Adler, & Kaczala, 1982; Trusty, 2000; Visser, 1987).

A closely related concept to parental beliefs is parents' expectations for their children. A research project carried out by Neuenschwander, et al., (2007) found that even when the effects of previous attainment in other subjects are controlled, parental expectations foretell a student's achievement in mathematics. Parents base their expectations on previous test scores and on their understanding of their children's mathematics ability (Overbaugh & Lin, 2006/2007). These expectations are important in infusing confidence in their children and enhancing their ability self-concept in mathematics (Nokelainen, Tirri, & Merenti-Välimäki, 2007). Parental expectations encompass the grades parents expect their children to obtain, the highest level of education they expect their children to attain, whether they want their children to go for a four-year degree course after secondary school or do a two-year training course, or whether they expect them to go into the labour force after school or get married (Davis-Kean, 2005; Ji & Koblinsky, 2009). It was found that parents' expectations mediated students' ability self-concept in mathematics and students' grade or test scores (Goldenberg, Gallimore, Reese, & Garnier, 2001; Lee & Bowen, 2006).

In a separate study carried out at Christchurch on the relationship between the formation of expectations by parents and children, Maloney (2004) posited that the students who expected their highest school qualification to be sixth form certificate actually terminated their studies at that level. One-third of the students observed in this study expected to attend university, an expectation that tallied with those of their parents. Maloney concludes that, "parental expectations are relatively more stable over time, and relatively more accurate in terms of actual outcomes. The expectations formed by children and their parents over attending university become increasingly similar over the observed age range" (p. 36) (The age range observed was 13 to 18 year olds). Low expectation may give rise to low achievement while high expectation may engender high achievement.

A further aspect of expectation that may influence children's determination and desire to achieve to their best ability is the communication of parents' expectations to their

children (Eccles, Adler, & Kaczala, 1982). When parents let their children know their expectations regarding education, the reasons they expect them to obtain a good level of education, and show them the pathway to accomplishing their expectation, children will be motivated to work hard so as not to disappoint their parents, particularly, in the early years (Haveman & Wolfe, 1995; Jeynes, 2007; Visser, 1987). Lastly, parental expectation is given practical effect through parents' involvement in children's education (Peressini, 1998).

### 2.2.6 Parental involvement

Parent involvement encompasses the assistance parents give to their children at home and their participation in school programs and events tailored toward the enhancement of students' educational outcomes (Epstein, 1995; Ji & Koblinsky, 2009). The extent to which parents become involved in their children's education is determined by their unique beliefs about their role as parents, their educational beliefs about the role of the school, teachers, and the particular school practices regarding involving parents in different aspects of the school life (Epstein, 1995; Hoover-Dempsey & Sandler, 1997). Parental educational beliefs and expectations may also affect their involvement practices at home. Involvement practises may be at the invitation of the child or school, or may be in response to the demands of the child or identified needs of the child (Anderson & Minke, 2007; Tsui, 2005). If parents believe in the value of homework in helping children to inculcate concepts learnt in a subject, they may take active steps to inquire about the topic being covered, for example, in mathematics, from their children when they return from school. In addition, if children are constantly telling their parents that they do not get any homework from day to day, concerned parents will initiate contact with the children's teachers to discover the operation of the subject or request for an outline of the course. Interested and involved parents are likely to take the time to access course information online, as many secondary schools now put course information online and give parents passwords that enable them to access their children's assessment and assignment data. On the contrary, if parents do not believe in the value of homework or believe that it is the duty of the government, schools, and teachers to take care of the educational needs of their children, they may not inquire about their children's work and may not take time to assist their children in their school work. This situation is thought to be common with low and uneducated parents who are

incapable of assisting their children with course work, particularly, as the complexity of the work increases with time (Anderson & Minke, 2007; Jeynes, 2003; Seginer, 2006).

There are multiple layers of possible parental involvement in children's education. At the basic level, parents' participation in their children's learning may involve providing them with physical and emotional care, creating a peaceful and convenient home environment that can facilitate the acquisition of good learning skills, making available intellectually stimulating learning resources, and setting rules at home that enable children to operate within agreed and acceptable boundaries (Hoover-Dempsey & Sandler, 1997; Sy & Schulenberg, 2005). It may also involve parents making time available to liaise with their children's teachers so that they understand the operation of the curriculum, course requirements, and the designation and interpretation of grades (Murray, 2009). By doing this parents come to clearly understand their children's academic progress in different subjects and determine the type of assistance they might give with respect to homework. This enables parents to find sources of resources and acquire the necessary equipment their children need to be up-to-date with the curriculum and attain a level of achievement that accords with their expectations and their children's ability (Sy & Schulenberg, 2005).

At a higher level, parents can be involved by contributing their expertise in special curriculum areas, conducting seminars for students and even staff, and participating in after-school programs, promotional events, and activities (Epstein, 1995; Lee & Bowen, 2006). Parents may also take part in the school's decision-making by participating in parent-teacher associations, or other organisations that try to promote the image of the school or in other school advisory groups. They may also participate in community based leisure, welfare, health and educational groups that organise programs to support and promote student learning and advancement (Seginer, 2006; Sy & Schulenberg, 2005).

Parental involvement varies at different stages of children development. At the early, kindergarten and junior primary stage, parent support might include helping to regulate behaviour at home and in the classroom and also assisting in intellectually stimulating activities (Hoover-Dempsey & Sandler, 1997). At the junior and senior secondary school level, parental involvement may shift from intellectual to physical activities, such as helping in sports coaching, managing school teams and transporting teams to sports and social events (Trusty, 2000). Notwithstanding the level in which parents are

involved in their children's education, researchers have found that positive parental engagement with schools enhances children's educational achievement (Seginer, 2006). The beneficial impact of parental involvement related to mathematics in particular, is pronounced when parent-teacher contact is regular, qualitative, takes place at home, and happens at school (Izzo, Weissberg, Kasparove, & Fendrich, 1999). In addition, the children of involved parents exhibit greater connection with the aspirations of their school than children of less involved parents. They take more pride in their school, are more focused in class, attend school more regularly, complete more work both in class and at home, and are less likely to be school drop-outs than children of parents who are not involved with their education (Epstein, 1995; Peressinni, 1998). By being involved in their children's education, parents give their children a message about the importance of education that is likely to harmonise with the messages children receive from school (Izzo et al., 1999). Some researchers have found that the effect of parental involvement on achievement is moderated by parental beliefs and expectations. Pong (1997) found that low income Asian immigrant parents to the United States were not as involved in their children's schools as White American parents due to language barriers, long working hours, and difficulties in understanding the academic system. However, the students performed well and better than many of their white American counterparts because of the beliefs and expectations of their parents for their achievement (Neuenschwander et al., 2007; Sy & Schulenberg, 2005; Wong, 1992).

Despite the sterling beneficial effects of parental involvement highlighted above, Fan and Chen (2001) have revealed inconsistencies in the literature about the effect of parent involvement in children's academic performance (E.g., Trivette & Anderson, 1995). They indicate that not all variables in the parent-engagement construct affect student achievement in the same way and to the same degree. Consequently, they opined that researchers should delineate the different variables in the parent-engagement portfolio, study each variable separately and select the ones that are more effective for student achievement. According to their findings, home related practices that establish rules for watching television and doing homework have very little effect on student achievement. On the contrary, the expectations and hopes of parents for their children's achievement have more profound effect on children's achievement. In addition, they considered the different socialisation practises of fathers and mothers. Fathers were considered more autocratic than mothers and were regarded as putting pressure on their children to do homework and achieve at school. On the contrary, mothers were seen to

display a calm attitude in the management and organisation of study time and homework and show more support and encouragement for children than fathers. Fan and Chen (2001) concluded that fathers' model of involvement that used pressure and force to make children do homework and improve their academic competence, had minimal impact on student achievement. The reason is that the use of compulsion and pressure has a negative impact on children's individual motivation, morale, and self-worth, and predisposes the formation of negative attitudes towards learning (Goldenberg et al., 2001). However, mothers' model of involvement that uses encouragement and support to make children do homework and complete school related activities, have more positive impact on student achievement (Fan & Chen, 2001; Visser, 1987). In connection with this, Hoover-Dempsey and Sandler (1997) suggest that an understanding of the reasons parents get involved in the homework activities of their children will provide a rationale for understanding its effects on achievement. If parents' involvement is regular and pursuant to their belief in their children's learning, the effect is likely to be positive. However, if parental involvement is an intervention device to arrest the student's behavioural and academic difficulties, the outcome is likely to be mixed (Jeynes, 2003; Rogers et al., 2009; Seginer, 2006).

Gonzalez and Wolters (2006), who studied the correlation between parenting practices and achievement motivation in mathematics, classified parenting practices as 'authoritarian, permissive and authoritative'. Authoritarian parents demand total compliance with their instructions without any contribution from the children. These parents may choose the classes, sports, and social activities that their children take part in. Permissive parents are on the other side of the spectrum. They allow their children to decide whatever they want to do without any input, control or boundaries. Teenage children of permissive parents may not have any assigned duties they execute at home, may not be given a time they must return back home in the evening, and may not have their parents discussing their school work with them. On the other hand, authoritative parents guide and allow their children to discover the person they are, respond to inappropriate behaviours in a rational and redemptive way, get their children involved in setting the rules for the home, and make the children understand that it is their duty to improve on their learning. The research found that the authoritative style of parenting is more effective in helping children to develop good mathematics skills by encouraging individuality, maturity, self-confidence, and helping children to develop an intrinsic

motivation for learning (E.g., Grootenboer & Hemmings, 2007; Stevens, Olivarez Jr, Lan, & Tallent-Runnels, 2004).

Mattingly, Prislin, McKenzie, Rodriquez and Kayzar (2002) undertook a review of 41 research projects designed to improve parents' participation in education in response to the belief that such participation enhances students' achievement. While not completely rejecting the beneficial effects of parents' involvement on student achievement, they concluded that there was insufficient basis to conclude parents' involvement programs enhanced students' achievement or modify the relationship between parents, teachers, students and schools. They asserted to have found major weaknesses in the data collection methods and evaluation processes used for many of these studies. In addition, they questioned the reliability of many of these researchers as they failed to disclose the composition of participants, had no control groups, and depended on subjective measures of attainment to make inferences. Many of the researchers also ignored the family structure and the social, economic, and racial composition of participants in these studies despite the general acceptance that these factors have important consequences for students' achievement. Due to the regard placed on research on parent involvement and student achievement, these writers recommend that many parent involvement practices need to be meticulously re-evaluated.

### 2.2.7 Summary

In the foregoing pages, the literature on factors connected with the home that influence student achievement and attitude to mathematics have been summarised. It was found that parents' income, home stability, parents' education, parent socialisation practices towards boys and girls, and parents' beliefs and expectations, all have effects on student achievement. Student achievement elicits motivation towards learning and the formation of student self-efficacy beliefs toward mathematics. Consequently, these influences have a strong bearing on the formation of attitudes to mathematics (Trusty, 2000; Tsui, 2005). In the next section, factors unique to the student, such as, the student's own internal motivation and drive for success, attribution pattern and learning theory, student's susceptibility to peer pressure, student's perception of teacher's attitude to mathematics, and the influence of student-teacher relationship on the formation of student attitude to mathematics will be explored.

## 2.3 Student-related influences

Influences resulting from the home that impact on students' achievements and attitudes were grouped together under this heading. These include the impacts of home numeracy practices, kindergarten and early childhood centre attendance, students own concept of their mathematics ability, the impact of role models, peers, and working memory on achievement and attitudes to mathematics.

### 2.3.1 Home-numeracy practices

Every student comes to a mathematics class with a repertoire of previous experiences, learning, achievement, practiced strategies, attitudes and expectations. The wealth of the mathematical knowledge stock that the student brings to the class is informed by the quality and quantity of the mathematical experiences to which the student has been exposed. A student that comes to a mathematics class with strong competencies in basic mathematical concepts and procedures is positioned to build on that foundation with ease. Though it appears there is a dearth of research and no consensus by researchers on the impact of home-numeracy practices on student achievement, LeFevre et al., (2009), conclude that parents' report of doing numeracy activities with their children positively correlate with the children's mathematics' achievement in their first two years of schooling. These researchers classified home numeracy practices into two groups; direct practices, which involved parents teaching their children to count and recognise numbers; and indirect practices, that involved the use of cards, board games played using dice, timing children while they are playing, having chats with children involving money, and the use of cooking measurement devices, to expose children to number cognition and measurement competencies. The frequency, variety, quality and quantity of numeracy resources used with children by their parents are thought to have a positive effect on the children's mathematics achievement in the early years (Balfanz, Ginsburg, & Greenes, 2003).

### 2.3.2 Kindergarten and early childhood centres

Ginsburg, Lee and Boyd (2008) looked beyond home-numeracy practices and considered the impact of early childhood education centres' practices in helping children improve their knowledge of numeracy and mathematics. Citing several studies on children cognition and development, they posited that children informally develop a refined array of mathematical concepts, including summing, subtracting, position, size, appearance and symmetry in the normal growth process. This knowledge is deemed integral to children's development in the absence of which they could not function normally. As such, the duty of educators is to harness these early experiences, translate them into formalised mathematics concepts, and relate them to real life situations (LeFevre et al., 2009). However, as observed by Lee and Ginsburg (2010), the prior knowledge of children is not optimally harnessed in Early Childhood Education Centres for several reasons. These writers observed that there is an assumption that children in Early Childhood Education Centres are too young to be exposed to mathematics education. They further stated that most Early Childhood Centre practitioners share the following characteristics. They (that is, Early Childhood Teachers) are unsure if the children possess the mental acuity to do mathematics; they believe it is sufficient for children to be exposed to number and shape, given equipment for play and allowed to enjoy their time; they think emphasis should be given to the improvement of language and literacy skills instead of mathematics; they suppose it is improper for children to be subjected to any assessments in mathematics; they assume the only way children learn mathematics is through engagement with physical materials and so mathematics should not be taught as a separate subject; and they do not see the relevance of computers in helping children to learn mathematics. Ginsburg, Lee, and Boyd (2008), state that Early Childhood Education Centre teachers continue with these practices because they are either not adequately trained to teach mathematics and harbour a fear of the subject or they are not willing to modify their practices and incorporate mathematics instruction into their program (E.g., Muir, 2008; Arem, 2007). While these writers agree that children must be given ample opportunity to play in order keep them motivated and ready to learn, they argue that a failure to expose them to mathematically stimulating and cognitive practices undermine and deny them the opportunity of laying a solid foundation for future success in mathematics. This is particularly true for children from low socioeconomic backgrounds that fall further behind in the curriculum with the

passage of time (Balfanz, Ginsburg, & Greenes, 2003; Lee & Ginsburg, 2010; LeFevre et al., 2009).

### 2.3.3 Students' self-concepts

Students' self-concepts or self-efficacy beliefs towards mathematics also influence their attitudes toward the subject (Gonzalez & Wolters, 2006; Vanayan, White, Yuen, & Teper, 1997). Beliefs may be described as sundry intellectual and emotional perceptions to which students ascribe particular meanings and degree of importance (Tsui, 2005). If a student perceives mathematics as a tool of intellectual enrichment and emancipation from numerical ignorance, and as a means of preparing for a career of the student's choice, the student will voluntarily and happily go to mathematics classes and work hard at assigned tasks, both in class and at home (Wilkins & Ma, 2003). However, if a student sees no value for mathematics and is only in the mathematics class because of a legal dictate, the student is likely to develop a negative attitude towards mathematics (Grootenboer & Hemmings, 2007; Thomas, 2000). Self-efficacy beliefs describe a student's perception of his or her ability to perform a given mathematics task. This belief of ability influences whether the student takes initial steps to do the task, the amount of time the student commits to the task and whether the student endures to complete the task if unforeseen obstacles arise that slows the task's completion (Hackett & Betz, 1989; Thomas, 2000; Vanayan et al., 1997). Hackett and Betz (1989) state that mathematics self-efficacy more accurately foretells a student's future performance in mathematics than other suspected factors such as a student's sex, years spent in high school, number of mathematics courses already completed, previous grades earned in mathematics tests or mathematics anxiety. They say self-efficacy beliefs also forecast whether a student will pursue mathematics as a career or choose a mathematics related course at university (Marx & Roman, 2002; Spencer, Steele, & Quinn, 1999; Thomas, 2000). Wilkins and Ma (2003) found that students who aspire to pursue careers in mathematics and mathematics related disciplines continued to show positive attitudes toward mathematics and expressed positive beliefs in the usefulness of mathematics to society. They also found that the attitudes that students formed towards mathematics at year 8 remained relatively unchanged by year 13. Thus, students' self-efficacy beliefs play an important role in influencing their attitude towards mathematics.

Aldous (2006) argued that students' self-efficacy beliefs related to mathematics are affected by prior performance in the subject. Aldous posited that self-efficacy positively affects mathematical performance. In addition, students with a high degree of mathematics self-efficacy will display more concentration, determination, and patience, and employ a range of strategies when solving a mathematics problem (E.g., Ozturk & Singh, 2006; Pajares, 2008). According to Thomas (2000), a poor mathematics self-efficacy has direct and indirect effects. Directly, it results in poor grades. Indirectly, it erodes the self-confidence of students, limits the time they spend on mathematics' tasks, and weakens their motivation to study mathematics. Low motivation produces lack of determination and persistence with tasks. Potentially, poor self-efficacy and low motivation negatively influence students' attitudes to mathematics (Hackett & Betz, 1989; House 2002).

Students' self-theories of intelligence and learning also influence their attitudes to mathematics. Dweck and Master (2008) categorized self-theories into entity theory and incremental theory of intelligence. Students who hold to the entity theory perspective believe that ability is innate, intelligence is invariant, hard work denotes low intelligence and people fail because they are inherently dull. These students are characterized by a superficial display of cleverness, a belief that success means they earn better grades than others, and a tendency to be satisfied with their current knowledge. When faced with difficult tasks, entity theory adherents employ surface techniques to solve problems, are less comfortable with seeking remedial help, are defensive of their performance and offer excuses for failure. On the contrary, students who subscribe to the incremental theory viewpoint believe that ability can be changed by effort and the acquisition of new skills. They define success as the enhancement of their performance and proficiency in learnt skills, and see failure as the commitment of inadequate effort and deployment of unrefined techniques. When faced with difficult tasks, incremental theory adherents use deep reasoning strategies to solve problems, they give attention to their mistakes and take corrective action to improve on subsequent performance (E.g., Stipek, 2002).

It is highly probable that many students are unaware of the motivational theories described above. The classification of students' achievement orientations appears to be more of an academic exercise than an actual influence on students' work behaviour.

However, the conclusions of Dweck and Master were supported by the results of research carried out by Nokelainen, Tirri, and Merenti-Välimäki (2007). This research involved about 203 highly talented mathematics students from Finland who participated in Olympiad studies in mathematics between 1965 and 1999. On investigation of the impact of attribution styles on the development of mathematics talent, these writers found outcomes with differing emphasis. The most highly talented students attributed their success to ability. These students were highly motivated learners who strongly believed in their abilities to tackle any mathematics problem and who were sure they could adjust their effort level to suit the level of difficulty posed by a mathematics problem. Highly talented students attributed their success to both ability and effort. They attributed their success to ability because they believed that a certain level of intelligence was required for mathematical competence. In addition, they attributed their success partly to effort because it served as a morale booster and gave the impression that they were in control of their learning. The implication is that the beliefs students hold about their mathematics ability and their attribution tendency have profound influences on their attitude to the subject and their performance in it (E.g., Schunk, 2008; Soric, 2009; Stevens, Olivarez Jr, Lan & Tallent-Runnels, 2004).

### 2.3.4 Role models

The availability of role models plays a part in shaping students' attitudes to mathematics. For students, their parents' mathematical level and educational status give them a clue on the level to which they should aspire (Neuenschwander et al., 2007). It is thought the children of university educated parents are more likely to study up to university level because of the example of their parents than children of non-university educated parents (Davis-Kean, 2005). Spencer, Steele, and Quinn, (1999), found that stereo-type threat, the concept that an individual is not good at a task, for example, the idea that women are not as good at mathematics as men, can cause anxiety to a woman taking part in a mathematics test and this threat can affect women's performance in mathematics. Marx and Roman (2002) conducted a study in which they used female role models as presenters of mathematics examinations. They found that the presence of a female role model boosted the girls' mathematics self-concept and improved their performance. The presence of the female role model who was seen as being competent

in her field conveyed a re-assuring message to the women that they too are capable of achieving in mathematics like their role model. Consequently, the presence of role models could influence the attitude of students towards mathematics. If parents are good at mathematics and have taken mathematics papers at university, they serve not only as role models but can give practical advice to their children about the courses they should take and sometimes, give them help with their mathematics assignments. One to one assistance is one of the best ways people grasp important concepts in subjects they find difficult (Gonzalez & Wolters, 2006; Haveman & Wolfe, 1995).

### 2.3.5 Peers

Closely aligned with the impact role-models have on students' mathematics achievement is the part played by peers on student achievement in general, and in mathematics performance in particular. The impact that peers have on their colleagues operates in different ways. It may operate through more mathematically competent students coaching less mathematically capable students in the class. It may also operate when higher socioeconomic students share good mathematics resources procured by their parents with students of lower socioeconomic status (Gamoran, 1992, 1987; Slavin, 1990). On the other hand, a disproportionate presence of students with learning disabilities and behavioural problems in a class may take teacher time away from other students in the class and thereby deny them the chance to be well taught (Hoxby, 2002; McEwan, 2003). Similarly, if there are a large number of students in a class who have very poor attitudes to learning and to mathematics, there is likely to be a contagion effect on students on the borderline of achievement in the class.

In connection with the impact class composition can have on student performance, Hoxby (2002), found that the make-up of a classroom could influence students' mathematics achievement. Hoxby found that years 4, 5 and 6 classes composed of more girls than boys saw an increase in the students' test scores in mathematics, and this result was consistent when placed against different measures of performance. Whitmore (2005) found that in years 2 and 3 of elementary school, both boys and girls benefit from classes with more girls. However, in year 4, boys' performances fall if they are in a class with more girls than boys. It rebounds though in year 5 and above. This led Whitmore to the conclusion that single sex schools or classrooms may be beneficial for boys' achievement as they go higher in their education from elementary to high school.

There appears to be a consensus in the literature that being in class with high achieving mathematics students has a positive influence on a students' mathematics achievement and attitudes to mathematics (Whitmore, 2005; McEwan, 2003; Roberts & Petersen, 1992). This view is supported by Wilkins and Ma (2003), who found that peers have a positive influence on students' attitudes and beliefs towards mathematics. A student with a circle of friends that are mathematically competent and display positive attitudes and beliefs toward mathematics and who esteem mathematics as being relevant to society, will exhibit similar positive attitudes and beliefs toward the subject (Chen, Chang & He, 2003; Hanushek, Kain, Markman, & Rivkin, 2003).

Chen, Chang, and He (2003), suggest that peer groups are often formed on the basis of common interests, abilities and aspirations. A group based on academic goals would foster support for group members and acquire a reputation for academic competence, social cohesion and collaborative learning. An academically oriented group would also discourage its members from engaging in conducts that would disparage the image of the group. On the contrary, a non-academically oriented group may have members who are there to enhance their social self-image and may not care about academic achievement. Therefore, members of this group might be disruptive in class, find it a norm to infract school rules, and are likely to exhibit socially deviant behaviours (Roberts & Petersen, 1992). In these ways, peer socialisations have a potential of positively or negatively influencing students' academic and mathematical achievement.

### 2.3.6 Working memory

The literature is replete with the role played by working memory in the execution of mathematical tasks. Lyons and Beilock (2009) defined short-term memory as a "memory system involved in the control, regulation, and active maintenance of a limited amount of information with immediate relevance to the task at hand" (p. 190). In other words, working memory is akin to the Random Access Memory (RAM) of a computer (Chinn, 2004). However, some researchers argue that working memory is different from short-term memory (Engle, 2002). Chinn (2004) regards the long-term memory as the mathematical memory. Working memory is thought to influence people's ability to carry out mathematical operations, how quickly they carry out these operations, their ability to solve problems mentally, and the choice of methods they

employ to solve complex mathematics problems (Ashcraft & Moore, 2009; DeStefano & Lefevre, 2004; Price, Catrambone, & Engle, 2007; Raghuba, Barnes, & Hecht, 2010). In any classroom, students will have a range of working memory capacities (Chinn, 2004; De Neys, 2006). People with a higher stock of working memory will do problems quicker than people with lower resources of working memory (Schunn & Reder, 2001). Beilock and DeCaro (2007) suggest that working memory affects mathematical problem solving in two ways; either by associative problem solving or by rule-based problem solving. Associative problem solving occurs when a student compares the current problem to a problem the student has previously encountered and arrives at a solution by looking at the similarity between the problems (E.g., Ashcraft & Krause, 2007). On the contrary, rule-based problem solving is when a student uses standard mathematical algorithms to solve a problem (DeStefano & LeFevre, 2004). Associative problem solving does not put great demand on working memory resources, while rule-based problem solving places more demand on working memory (Chinn, 2004). People with low working memory use associative procedures while people with high working memory use rule-based strategies to solve mathematical problems (Conway et al., 2005; Kane & Engle, 2000).

People with a low working memory stock may have difficulties when attempting mental arithmetic problems, may struggle to cope with the pace of instruction in a classroom, and may not readily retrieve the strategy required to solve a problem (Chinn, 2004). Unless, tactfully and appropriately addressed, these factors may erode the self-efficacy of some students in mathematics and lead to mathematics anxiety (Norwood, 1994). Mathematics anxiety obstructs the component of working memory required for the successful completion of tasks and could lead to failure (Beilock & Carr, 2005; Engle, 2002; Gimmig, Huguet, Caverni, & Cury, 2006). Mathematics anxiety has a negative influence on attitudes to mathematics (Ashcraft & Moore, 2009). However, when subjected to pressure conditions, it was found that people with high working memory capacity were affected more than people with low working memory stock (Bornemann et al., 2010). Indeed, the performance of people with high working memory capacity sank to the level of those with low working memory capacity while the performance of people with low working memory stock was unchanged under conditions of stress (Bornemann et al., 2010). High pressure situations were found to use up a disproportionate component of the resources needed by high working memory capacity individuals to complete tasks (Beilock & Carr, 2005; Bornemann et al., 2010; Gimmig

et al., 2006; Kane & Engle, 2000). The implication is that working memory influences cognition and mathematical task execution (Schunn & Reder, 2001). As such, it has potential implications for people's achievement in mathematics and could affect people's attitudes to the subject.

The various writers on working memory did not state if working memory capacity is genetically acquired or capable of being received and improved by learning. The context of their discussion and conclusions suggest both. However, it is beyond the scope of this study to delve into the details of working memory, the methods of its acquisition and the nature of its operations.

## 2.4 Teacher related influences

This part of the literature review examines the activities of teachers that may impinge on students' ability to learn and do well in mathematics. The factors investigated includes; teacher-student relationships, teachers' attitudes to mathematics and mathematics teaching beliefs, teachers' expectations, and teachers' pedagogical practices. Each of these subsections are explored below.

### 2.4.1 Teacher-student relationship

The relationship between teachers and students is one that has important implications for student learning, particularly in the transition to school in elementary and junior high school years (Cornelius-White, 2007; Gruenert, 2005). Birch and Ladd (1997) observed that a close teacher-student relationship facilitates students' adjustment to school, where school adjustment encompasses student achievement, positive attitudes toward school, and engagement in the classroom. Daniels and Arapostathis (2005) asserted that a cordial teacher-student relationship affects student motivation and work ethic, and when students have strong faith in their teachers, they perceive them as associates whose ultimate motive is the students' success. In addition, they observed that effective teacher-student relationships enhance students' interest in learning and engender student engagement. Van Petegem et al., (2008) see student-teacher relationships as influencing the well-being of students and determining the aura of the

classroom. Student wellbeing is enhanced when teachers create a happy and collaborative working environment, encourage student thinking, show confidence in students' abilities thereby augmenting their self-efficacy beliefs and speak to students frankly, warmly and respectfully (Cornelius-White, 2007; Gruenert, 2005). Mathematics teachers were found to positively influence student learning and achievement when they exercised authority but were cooperative, gave students responsibility for their learning, showed genuine interest in students, and respected them as distinct individuals (Averill, 2009; Van Petegem, Aelterman, Van Keer, & Rosseel, 2008). Optimal student-teacher-relationships were ones that were safe, organised, accommodating, understanding, and characterised by reciprocity (Cornelius-White, 2007). According to Van Petegem et al., (2008), these features contribute to student well-being and achievement and offer students the chance to develop positive attitudes towards mathematics. On the contrary, if the relationship between the teacher and student is one marked by frequent disagreement or over reliance on the teacher, the student eventually becomes disinterested with school, unengaged in class, and performs poorly in tests (Birch & Ladd, 1997). The same thing happens when adolescent students feel the teacher has no interest in them, are constantly told they are trouble makers, and continually treated as children who should do whatever they are told to do (Eccles et al., 1993; Jussim & Harber, 2005; Libbey, 2004). Consequently, an unpleasant relationship between a mathematics teacher and a student is likely to predispose in the student a dislike for mathematics, disengagement in class, reduced commitment and effort toward completing assigned tasks and ultimately, the development of a negative attitude toward mathematics (Jussim & Harber, 2005; Libbey, 2004).

### 2.4.2 Teachers' attitudes and mathematics teaching beliefs

A teacher's attitude to mathematics and belief in mathematics teaching are believed to affect the tools and strategies employed by the teacher in the teaching of the subject (Gresham, 2009). According to Gresham, a teacher's beliefs may include whether the teacher believes mathematics is difficult and could only be effectively learnt by certain categories of students; whether the teacher believes in a particular way of teaching mathematics; and whether the teacher thinks that the use of manipulatives, for example, are good aids or not, to the teaching and learning of mathematics. These factors are

capable of affecting students' achievement and their attitudes toward mathematics (Relich, Way, & Martin, 1994). The concern is that if teachers hold negative beliefs about the teaching of mathematics, they are likely to transmit these negative beliefs to their students (Gresham, 2009). Negative beliefs include teachers' lack of confidence in their mathematics ability; teachers' anxiety about teaching certain parts of the mathematics curriculum and tendency to avoid these areas of the curriculum; teachers' remarks to their classes about their weaknesses in certain areas of the curriculum and declaration to their classes that they do not need to understand every part of the curriculum in order to do well in mathematics; and teachers' reluctance to try new and innovative ways of teaching mathematics and making it interesting and meaning to students (Relich et al., 1994). As a critique to the above perspectives, Andrews and Hatch (1999) found that there is no strong evidence that teachers' attitudes and beliefs about mathematics automatically affect students' attitudes. However, they state that it is preferable that teachers display a positive attitude toward the subject. A positive attitude will include the teacher making positive remarks about the importance of the subject; about the way the teacher worked hard to improve his or her knowledge of the subject; and providing students with positive and optimistic feedback about the possibility of them doing well in mathematics if they work hard at improving their knowledge of the subject (E.g., Schunn & Reder, 2001).

Gresham (2009) carried out a study that looked at the relationship between pre-service teachers' self-efficacy beliefs and mathematics anxiety. It was found that teachers with a high self-efficacy have reduced mathematics anxiety while teachers with low self efficacy have an increased incidence of mathematics anxiety. High self-efficacy is seen as a teacher's confidence on the ability to perform set mathematical tasks and to grasp any concepts that may be encountered in future mathematics activities (Relich, Way, & Martin, 1994). Teachers with a high self-efficacy display a positive attitude toward the subject. This is reflected in the teachers' enthusiasm toward teaching the subject, their organisation of content material and their use of different tools, such as manipulatives, computers, out-door activities, and other resources to teach the subject (Midgley, Feldlaufer, & Eccles, 1989). Clarke (1997) states that a teacher's mastery of the subject matter enhances self-efficacy and this is discernable by students in the teacher's verbal and non-verbal communication. Students' perception of teacher self-efficacy is a major factor that influences students' attitude to mathematics, particularly, with mathematically weak students (Gresham, 2009).

Hill, Rowan, and Ball (2005) add that a teacher's content knowledge includes the teacher's understanding of the content area to teach, the way to explain the concepts of these content areas to students, and the teacher's ability to use context relevant resources to make the content area meaningful to students. They conclude that a teacher's content knowledge has a beneficial impact on student achievement (E.g., Kahan, Cooper, & Bethea, 2003; Rayner, Pitsolantis, & Osana, 2009).

Begle (1979) found that a teacher's content knowledge of subject matter is beneficial to student achievement up to a point. However, it soon approaches an optimal point (up to 5 mathematics courses taken at university), beyond which further accumulation of content knowledge by the teacher has no bearing on student achievement (E.g., Monk, 1991). Monk also found that a teacher's knowledge of how to teach mathematics has more impact on student achievement than a teacher's content knowledge of mathematics. This view was corroborated by Darling-Hammond (2000) when she stated that several studies have established a stronger positive correlation between the number of papers taken by a teacher in mathematics pedagogy and student achievement than between the number of papers taken by a teacher in academic mathematics and student achievement (E.g., Mills, 2007).

Furthermore, Ma (1999) expressed reservations about using the number of mathematics courses a teacher took at university to measure mathematics content knowledge. Ma found that Chinese teachers with an equivalence of year 11 mathematics qualification and three years of teacher training performed better than mathematics graduates from the United States in a test of mathematics knowledge. Content knowledge may be beneficial to student achievement through the processes mentioned above but research findings on this factor are inconclusive (Hill et al., 2005; Darling-Hammond, 2000). However, as stated above, content knowledge enhances self-efficacy and self-efficacy endows the teacher with the confidence to try different teaching strategies and resources. Highly efficacious teachers have a positive attitude toward mathematics (Ma, 1999). Consequently, students of such teachers are likely to display a positive attitude toward mathematics (Gresham, 2009; Andrews & Hatch, 1999).

### 2.4.3 Teachers' expectations

Do teachers' perceptions and expectations affect students' mathematical beliefs and achievement? Many researchers believe this is the case (for example, Nye, Konstantopolous, & Hedges, 2004). Teacher perceptions relate to the beliefs a teacher holds about a student's ability and as a consequence, the level of performance that the teacher expects from the student (Alvidrez & Weinstein, 1999). Teachers' perceptions and expectations are informed by students' prior performances, scores in diagnostic or formative tests, displayed commitment, aspiration, and determination for learning (Bol & Berry 111, 2005). In a review of 16 research studies, Alvidrez and Weinstein (1999) observed that teacher perceptions could be influenced by students' socioeconomic circumstances and race, and these could be erroneous (Bol & Berry 111, 2005; Ferguson, 2003). However, they concluded after reviewing both positivistic and interprevistic research studies, that the evidence is substantial and unequivocal that teacher expectations influence students' achievement and teachers' perceptions accurately foretell students' achievement for up to 6 years after their contact with the student. In some cases, judgements made by teachers when students were in kindergarten still had implications for children achievement by the time the children were concluding their junior high school studies. Furthermore, teachers' perceptions of students' achievement in intermediate school remained relatively accurate when the students were in year 13 (Smith, Jussim & Eccles, 1999). Additionally, Alvidrez and Weinstein contend that the effects of teacher expectations could account for between 9 and 18% of performance in highly differentiated classrooms and between 1 and 5% of performance in minimally differentiated classrooms; if the effects of previous performance are excluded. Differentiated classrooms are classrooms where students are given work based on their ability in the topic and are gradually given more difficult tasks to move up to the level they are expected to attain in the particular year

Smith et al., (1999) also investigated if teacher perceptions and expectations become self-fulfilling prophecies that increase, weaken or remain constant over time. They provided a perspective contrary to the one above when they concluded that though teachers' perceptions and expectations may accurately predict student achievement, their effect weakens with the lapse of time. Consequently, judgements by teachers could not be regarded as principal influencers of students' achievement patterns in the course of time.

Siegle and Reis (1998) explored the relation between teachers' perception of boys' and girls' ability. They stated that most teachers rate girls higher than boys in language arts and boys higher than girls in mathematics, science and social studies. A difference was also noted in the way feedback is given to boys and girls. They noted that when girls that are considered equally as gifted as boys are given feedback about their test performance, their success is attributed to hard work. However, when boys are given feedback about their performance, their success is attributed to talent (Dee, 2007). This difference in causative attributions of success has the potential to make boys believe they are successful in mathematics because they are very talented in it and girls to believe that they are doing well in mathematics because they are working very hard at it. Adolescents' perceptions of ability influence their self-efficacy beliefs and could influence their attitude to mathematics (Jussim & Eccles, 1992; Siegle & Reis, 1998). However, various researchers have concluded that students show more favourable attitudes to mathematics at the elementary school level. These attitudes become progressively negative as students go higher in secondary school, with boys showing more negative attitudes towards mathematics than girls (Jussim & Eccles, 1992; Levpuscek & Zupancic, 2009; Midgley et al., 1989; Nye et al., 2004; Siegle & Reis, 1998;)

### 2.4.4 Teachers' instructional practices

Teachers' instructional practices may have a great influence on mathematics achievement and on the formation of attitudes to mathematics. Pianta, Belsky, Vandergrift, Houts, and Morrison (2008) stated that students' achievement in mathematics is enhanced when teachers concentrate on concepts and promptly provide feedback to students on their achievement. In their words, "teachers' instructional interactions with children have greatest value for students performance when they are focused, direct, intentional, and characterised by feedback loops involving student performance" (p.368). They also assert that the amount of time committed to mathematics instruction in elementary school; particularly in the fourth and sixth years of schooling, have important bearing on students' achievement in mathematics. In addition, the socio-emotional characteristics of the classroom contribute to students' achievement in mathematics (Cornelius-White, 2007; Daniels & Arapostathis, 2005; Wentzel, 2002). A pleasant and respectful classroom characterised by clear

expectations (Averill, 2009), the presence of quality and cognitively stimulating resources (Meece, Anderman, & Anderman, 2006), effective class management, the possibility for students to reflect on their learning and ask questions, in addition to the chance for adolescents to exercise their individuality and independence, are deemed essential attributes for the improvement of mathematical skills and achievement (Lüdtke, Robitzsch, Trautwein, & Kunter, 2009).

Norwood (1994) explored the effect of instructional approaches on students' attitudes to mathematics. Participants in this research were subjected to two modes of instruction; the 'instrumental' approach and the 'relational approach'. The instrumental approach involved the use of rote learning where students were required to learn mathematical algorithms and lessons were highly structured. In this category, the students believed that mathematics problems could be solved by learning specific rules and formulas. Therefore, the goal was to retrieve these rules and formulas when required to solve problems. On the contrary, the relational approach employed a conceptual framework to the teaching of mathematics. It regarded mathematics as a body of interlinking concepts that could be solved by drawing on different concepts and employing sundry strategies to solve problems (E.g., Goodenow, 1993). The relational approach encouraged individualised learning, group work, the use of different strategies and resources to aid learning, and supported exploration to solve problems (E.g., Gagnon & Bottge, 2006; McCaffrey et al., 2001). Norwood concluded that the two approaches augmented students' achievement with mathematically anxious students preferring the instrumental approach, and students that were less mathematically anxious opting for the relational approach (E.g., Rayner et al., 2009). In addition, the relational approach was found to stimulate intrinsic motivation while the instrumental approach encouraged extrinsic motivation (E.g., Hudley, 1997).

However, the use of the instrumental approach is deemed to lead to decreased achievement as students do more advanced mathematics that have a multitude of rules and less structure and students are unable to rely on the memorisation of rules to solve problems (Norwood, 1994). Furthermore, McCaffrey et al., (2001) concede that the contribution of individual attributes such as, group work, appropriately set tasks, time allotted to tasks, and exploratory learning to mathematical achievement are difficult to measure. In addition, the use of cognitively stimulating resources tended to wane over time (Hudley, 1997; McCaffrey et al., 2001). Consequently, ongoing research is needed

to delineate the optimal effect of each instructional approach on different categories of students. As noted by Miglietti and Strange (1998), an assessment of the effect of instructional approach has to take into account the myriad of other factors that have potential impact on achievement, because, good teaching is liable to subjective interpretation.

## 2.5 School related influences

In this section of the review, emphasis will be given to the impact that the unique features of a school may have on student achievement. Specifically, this section will look at the effect that school culture and climate and class size have on student achievement. As has been established from previous sections, academically successful students show interest in schooling and are favourably disposed toward their subjects. In the same way, mathematically competent students display positive attitudes toward the study of mathematics. These views are given detailed consideration below.

### 2.5.1 School culture and climate

School culture refers to the way things are done in a school and school climate captures people's feelings, perceptions, and understanding, as they interact with different sectors of the school (Fullan, 2001a). Van Der Westhuizen, Mosoge, Swanepoel, and Coetsee (2005) did not see a distinction between culture and climate. They defined school culture as "the intangible foundation that encompasses common values, assumptions, norms, and convictions, which serve as guidelines for the behaviour of individuals in a school" (p.93). Sherblom, Marshall, and Sherblom, (2006) investigated the relationship between school climate and elementary school students' achievement in mathematics and reading. They concluded that a positive school climate enhances students' achievement in mathematics and reading. A positive school climate is also characterised by respectful and cooperative student-teacher relations (Fullan, 2001b), a strong sense of students connectedness to school, a culture of high expectations by the school for student success, mutually agreed goals between teachers and staff (Sherblom et al., 2006), a feeling of connectedness to the school by teachers and staff, a feeling of confidence by students about their learning (Sherblom et al., 2006), concerted and

supportive classroom practices, the administration of fair assessments, effective leadership, and the promotion of democratic norms (Creemers & Reezigt; 1999).

Furthermore, a positive school climate promotes students well-being, abets academic success and reduces students' drop-out rate and failure (Pariso, 1991; Sherblom et al., 2006). According to Epstein (1995), the way students are regarded by schools has important implications for the cultivation of a positive school climate. In Epstein's view, if schools perceive children as students, the schools will deal with them as customers who should be served and allowed to leave at the conclusion of the contract. However, if schools regard students as children, their children, they will take a mutual interest in collaboration with parents, to work for the students' success both in school and thereafter (Creemers & Reezigt, 1999; Sergiovanni, 2000).

Dumay (2009) adds that transformational leadership (which is leadership that adopts a collaborative decision making approach involving administrators, staff and students) creates a school climate that fosters harmony between students and staff, particularly for schools in low and high socioeconomic areas but finds weak evidence between an effective school climate and student achievement. Similarly, Miller and Rowan (2006) analysed 54 tests on the effect of organic management on student achievement (organic management displays the attributes of effective school climate listed above). They concluded also that there is no strong evidence that organic management has a strong effect on student achievement. Finally, Stewart (2008) opined that student attributes are better predictors of a student's achievement than school related features, such as school climate.

### 2.5.2 Class size

The issue of class size is one that is hotly debated between teacher unions and many departments of education (Rice, 1999). Ehrenberg, Brewer, Gamoran, and Willms, (2001) see class size as the number of students being taught by a teacher at the same time. This may vary from one subject to the other and may differ from day to day. Different stakeholders in education are interested in this issue for different reasons (Rice, 1999). For parents, the smaller the number of students in a class, the more attention their children may receive from the teacher. Teachers will prefer smaller

classes because it reduces their workload. Educational Authorities think smaller classes enhance student achievement (Rice, 1999).

Many researchers have studied this question with interesting outcomes. In a review of literature on class size, Rice (1999) reported that some studies have found that student achievement is inversely proportional to class size. However, she points out that this relationship depends on the willingness of the teacher to adopt different teaching approaches in response to the changing size of the class. If the teacher of a class with 35 students that has been reduced to 20 students continues to use the same teaching methods that were used to teach the 35 students, students will learn in the same way as they had done before. However, if the teacher adopts strategies that give students more individual teacher time than had been done previously, student learning is likely to be positively impacted by the reduction in class size. Rice found that class size has impact on the amount of time teachers spend on administrative tasks, class management, working with small groups, having whole class discussions and time committed to preparing innovative teaching resources. In addition, she reports that smaller classes were more beneficial for high-performing students and made no difference to the performance of low-achieving students. Akerhielm (1995) agrees that a smaller class size is desirable for certain categories of students such as students from poor financial backgrounds, students with poor histories of attainment, and primary school students. Akerhielm however, adds that the effect of class size becomes negative when low-achievers, students from poor backgrounds, and students with behavioural difficulties, are bundled together into one class. Ehrenberg et al., (2001) agree with the view expressed by Akerhielm. Consequently, they posit that a cost-benefit analysis must be made before the goal of small class sizes is pursued.

## 2.6 Chapter conclusion

In this chapter, some of the influences that may impact on students' achievement and attitudes to mathematics were explored. It was suggested that factors that affect students' achievement in mathematics may also influence their attitudes to the subject. The starting point of many of these influences may be the homes from which the students come. The physical, emotional, financial, and educational circumstances of the home, are likely to have influences on students' achievement in mathematics.

Furthermore, the individual characteristics of the learner may influence mathematical achievement. Learners that are determined, capable and committed to learning may most likely rise above obvious disadvantages to register academic success. In addition, the teacher plays an important role in stimulating student learning. This occurs through different classroom practices, goal structure, expectations and pedagogical practices. Lastly, the school may have a culture that sends a clear message to its students that they are expected to achieve.

## CHAPTER 3 RESEARCH DESIGN



### 3.1 Introduction

This chapter sets out the philosophy and procedures that were followed in this study. This is often described as methodology, which is the study of methods (Van Manen, 1990); and is concerned with the philosophy, assumptions and theoretical underpinnings associated with a particular research method (Van Manen, 1990). Within methodology, the research methods are the specific techniques, skills and processes that are used to carry out a study (Booth, Colomb, & Williams, 2008; Bryman, 2008; Van Manen, 1990). Sometimes, the phrases, research design and research method, are used to refer to the same idea (Booth et al., 2008; Ponterotto, 2005). In this study, research design is used to refer to the specific steps and processes that I adopted to prosecute the research study.

Phenomenology is the primary method used in this study to investigate people's attitudes mathematics. Phenomenology is a qualitative research method of inquiry (Flood, 2010; Van Manen, 1990). It investigates the experiences of people as they go about their daily lives and tries to understand how people understand these experiences and the interpretation they make of them (Moustakas, 1994; Sokolowski, 2000). As with other qualitative research methods, phenomenology uses language to describe people's experiences with a view to making meaning of them and attempting to establish the how of these experiences (Flick, 2006).

## 3.2 Theoretical background of study

Research is an intentional, specific and organized quest to discover new knowledge or give new and improved meaning to existing knowledge or expertise (Booth et al., 2008; Lett & McGilp, 2004; Rhedding-Jones, 2005). Research is not the conception of an idea never previously encountered by anyone, but it is the presentation of an idea in a way never previously done by anyone (Booth et al., 2008). Consequently, this study may not have discovered new knowledge, but it has been an attempt to present extant knowledge in a new light with the hope that a new perspective has been set forth.

In the field of formal research, two broad research perspectives are commonly encountered, namely; qualitative research and quantitative research. Qualitative research employs a wide array of research methods to study the subject, phenomenon, or question of investigation in its usual setting (Bauer, Gaskell, & Allum, 2000; Bogdan & Biklen, 2007). The qualitative researcher undertakes the research endeavour without predetermined theories (Denscombe, 2010b; Hesse-Biber & Leavy, 2006). In this regard, the qualitative research approach is considered to be interpretivistic (Bauer et al., 2000; Denscombe, 2010a). Interpretivism takes the view that people's values, attitudes, decisions, understandings, perspectives and judgments are not pollutants of the research and its outcomes rather they are seen as providing the reason for the research undertaking (Arksey & Knight, 1999; Flick, 2006; Mahoney, & Goertz, 2006). Accordingly, it is by delving into people's thinking processes, perceptions, and describing these experiences as elaborately as possible, that people can be fully known and their understanding and viewpoint appreciated and respected (Brechin & Sidell, 2000; Cohen, Lawrence, & Keith, 2007). Thus, the qualitative research approach connotes an assumption of subjectivity (Flick, 2006). In this study, people's understanding of phenomena, how they variously experienced mathematics and the implications the different experiences had on their attitudes to mathematics, will be used to extrapolate the major influences on their attitudes to mathematics.

The second research perspective which has a more established tradition is quantitative research. Quantitative research often relies on experimentation to explore the quantitative features of events, phenomena and the relationship between them (Fischer, 2006; Gall, Borg, & Gall, 2003; Myers, 2009). The goal of the quantitative approach is to create theories to study a phenomenon through the use of mathematical simulations (Cresswell, 2007; O'Leary, 2005). Measurement is pivotal to quantitative research and

it provides the link between the results of an experiment and the numerical representation of the relations between phenomena (Brechin & Sidell, 2000; Flick, 2006; Myers, 2009). In this regard, quantitative research is said to be positivistic (Cresswell, 2007). Positivism sees individual characteristics as having the tendency to undermine the objectivity and reliability of the research outcome (Bauer et al., 2000; Bogdan & Biklen, 2007; Cohen et al., 2007). Consequently, positivism asserts that phenomena can be understood through the application of scientific methods that are controllable, observable and capable of being repeated (Cohen et al., 2007; Glesne, 2006).

## 3.3 Reasons for choosing the qualitative research approach

The principal reason for the adoption of the qualitative research approach in this study was associated with the nature of the topic. The objective of this study was to explore people's experiences with mathematics and to identify the major factors that impacted on their attitudes toward the subject. People's beliefs may change and their perception of events at a point in time may be affected by moods and other events affecting them at those particular times in their lives, such as family circumstances (economic changes, sickness, bereavement, loss of job, and so on) (Van Manen, 1990). In addition, according to Flick (2006), qualitative approaches are more suitable for social science research in today's post modern societies because of the many different ways people experience the world (E.g., Seale, 1999). The multitude of ways the world is experienced demands that due sensitivity is shown to the practical ways experiences are investigated. Consequently, "advocates of postmodernism have argued that the era of big narratives and theories is over. Locally, temporally and situationally limited narratives are now required" (Flick, 2006, p. 12). These researchers believe that the usual scientific way of creating a theoretical framework, deducing questions and propositions from this framework and testing these propositions against experimental research facts, is no longer sufficient (Cresswell, 2007; Flick, 2006; Van Manen, 1990). Instead, stimulating strategies are required to study social phenomena, in order to ensure that the concerns of real people, and not just abstract concepts, are studied and dealt with (Cresswell, 2007; Flick, 2006; Heaton, 2004). Furthermore, qualitative research is more suitable for studying micro social issues such as the one in question (Denscombe, 2010b; Flick, 2006). Lastly, the qualitative approach is suitable for human research

because it employs tools people are accustomed to; language and expressions; to collect, describe and interpret a phenomenon, in a way that makes things clear to people (Bogdan & Biklen, 2007; Denscombe, 2010a; Flick, 2006).

## 3.4 Reasons for choosing phenomenology

I chose to base this study on phenomenological thinking because the main focus of the study is to investigate some of the experiences that influence people to form attitudes, negative or positive, toward mathematics. The word phenomenology has its roots in the Greek words that can be transliterated phaino, which means light, and logos, which means, word, awareness, understanding, knowledge, or learning (Glendinning, 2007; Laverty, 2003; Moustakas, 1994, Ray, 1984). When combined, it means, the art of illuminating or making meaning of, or out of a person's life experience (Ehrich, 2003; Moustakas, 1994). Furthermore, Sokolowski (2000) briefly defines phenomenology as the "study of human experience and of the way things present themselves to us in and through such experience" (p. 2). Van Manen (1990) propounds that phenomenology is the meaning people assign to events or experiences before they have had time to think back on them, or to analyze, group, and delineate the events or experiences into different meaning subsets.

Thus, as phenomenological research is concerned with people's experiences, how they see these experiences, and the meanings of these experiences to them, I concluded that it is the best approach to investigate the influences that impacted on the participants of this study's attitudes to mathematics. In addition, phenomenology focuses on the essences of an experience. These are the profound and unique features of the experience that set it apart from other experiences, and give it its essential distinguishing characteristics (Flick, 2006; Smith, Flowers, & Larkin, 2009, Van Manen, 1990). For example, the goal of this study is not to discover how participants learnt mathematics but to explore the import and impact on them of the factors that influenced their experience of learning mathematics. Similarly, I believe that phenomenology provides the best tool to explore the essences of the factors that influenced participants' attitudes to mathematics, be it encounters with their teachers, peers, and school systems.

## 3.5 Limitations of the choice of phenomenology

The main drawback of phenomenology is its excessively subjective and philosophical bias that renders the credibility of its research reports suspect (Cresswell, 2007; O'Leary, 2005). A major issue with phenomenology is that a person may tell a story at a point in time that is a completely true story. However, by the time the researcher is ready to finalize the research, the participant's circumstances may have changed. Consequently, the participant may be reluctant to validate the story (Flood, 2010; Heaton, 2004).

In addition, it may happen that after transcription, the participant may perceive what has been written down as not portraying him or her in the best possible light. As a result, the participant may no longer desire to have the views expressed used in the research. These scenarios may cause difficult problems for the researcher (Flood, 2010; Johnson, & Christensen, 2000; Laverty, 2003) particularly, if there are interesting concepts in the data that the researcher had intended to use (Gelling, 2010; O'Leary, 2005).

Furthermore, many writers avoid the use of phenomenology and those who attempt to treat it as a research approach do not give easy to follow and clear procedures on how to pursue this method of research (Bauer et al., 2000; Frank & Polkinghorne, 2010; O'Leary, 2005). Lastly, there are no generally agreed methods for carrying out a phenomenological inquiry (Bauer et al., 2000). The method followed is usually dictated by the research questions (Flick, 2006). This makes it very difficult for inexperienced researchers to adopt phenomenology as a research paradigm (Bauer et al., 2000; Gelling, 2010).

## 3.6 Theoretical assumptions

In line with phenomenological thinking, I understand that every individual lives in an environment and that people's lives are closely intertwined with the environments they inhabit (Heaton, 2004; O'Leary, 2005). Therefore, in order to truly know people, to get access to the innermost recesses of their beings, I have to study them in their natural environments (Smith et al., 2009). As a result, participants in this study have been interviewed at locations convenient for them and conditions have been created that enabled them to recall, reflect and narrate their experiences of mathematics.

I believe that participants are co-constructors of knowledge whose feelings and sensitivities should be considered and respected. Therefore, during the course of my interviews, when I perceived that a question aroused sensitive memories that made it difficult for the interviewee to answer a question, I tactfully skipped that question or introduced a different topic to allow the participant to regain his or her composure, and afterwards, I asked a different question when the participant was ready to continue with the conversation (Kvale & Brinkman, 2009; Moustakas, 1994; Van Manen, 1990).

I assume that people are experts of their own experiences and I value the way people think and go about their daily activities. In addition, I assume that there are things in other people's experiences from which everyone may draw valuable lessons. Consequently, I believe that people's experiences of mathematics have to be studied in their entirety. This is the reason I drew up questions that covered every facet of participants' interactions with numeracy and mathematics from preschool to secondary school (Bell, 2001; Bernard, 1995; Fischer, 2006).

In addition, I assume that flexibility is needed if maximum disclosure is to be obtained from each participant. As a result, participants were asked questions based on the same concepts but not every participant was asked every question in precisely the same order as some participants gave answers to some of the questions I intended to ask in the course of responding to other questions (Bogdan & Biklen, 2007; Gall et al., 2003; Myers, 2009). Furthermore, I chose to use the semi-structured interviewing technique to gather data. Therefore, during the interviews, if the response to a question brought up information or other aspects of the participant that I had not thought of, but which needed to be explored because of its potential to produce useful information, I asked follow-up questions (Bauer et al., 2000; O'Leary, 2005; Patton, 2001).

I have not proposed any theories as a starting point to this study because qualitative research approaches assume that theory should not be propounded independently of an investigation, but should be subsumed in, and emanate from the result of the investigation. However, I assume that the data that has been collected from the interview process and analyzed may elucidate current hypothesis on this topic or even lead to new hypothesis or theories (Bauer et al., 2000; Frank & Polkinghorne, 2010; Starks & Trinidad, 2007).

Finally, I assume that the epistemological goal of phenomenology is to reveal meaning; both cognitive and non-cognitive meaning (Bauer et al., 2000; Flood, 2010; Frank &

Polkinghorne, 2010; Moustakas, 1994; O'Leary, 2005; Van Manen, 1990). Cognitive meaning pertains to the main idea and information that can be gleaned from participants' narratives while non-cognitive meaning relates to the emotive, conjuring and imaginative properties of the narratives that participants felt enhanced their experiences of studying mathematics (Fischer, 2006; Flood, 2010; Starks & Trinidad, 2007). My expectation is that the resultant phenomenological knowledge would help in the construction of new meaning or re-interpretation of existing understanding (Booth et al., 2008; Creswell, 2007, Flick, 2006; Lett & McGilp, 2004).

## 3.7 Participant recruitment

Participants are variously referred to as informants, interviewees or respondents; they are the people the researcher solicits to participate in a research study (McCracken, 1988; Kvale & Brinkman, 2009; Peace, Bornat, Jones, & Dimmock, 2005). The choice and quality of participants is important because it has significant impact on the nature and quality of the data collected and the research outcome (Bogdan & Biklen, 2007; Gaskell, 2000). One of the issues I grappled with at the onset of this study was the number of participants to recruit. McCracken (1988) opines that for most research assignments, 8 participants are enough because it is preferable to work in-depth with a few people than do so cursorily with many people. Gaskell (2000) corroborates this viewpoint by stressing that a large number of participants do not necessarily guarantee higher quality or a deeper comprehension of facts. Secondly, if the number of participants is large, the amount of transcripts to make and the volume of data to analyze will also be large. Therefore, the number of participants to choose for a research should be dictated by the nature of the topic, constraints imposed by the social surrounding, and the time available to carry out the research (Arksey & Knight, 1999; Kvale & Brinkmann, 2009; Seidman, 2006). Accordingly, for the single researcher, Gaskell (2000) suggests an upper limit of between 15 and 25 participants. In tandem with the foregoing, I decided to recruit between 10 and 20 people for this study.

Participants were recruited from central and southern Auckland by going to their work places. The decision to use work places as sites of recruitment hinged on the need to seek participants who satisfied the research eligibility criteria for respondents to be at least 20 years old and to have studied mathematics in the past to at least secondary school level (year 11). To get access to recruitment sites, I contacted the management of

the work places concerned by telephone, informed them about the research, and made a request to be given permission to speak to their employees. Work places were chosen randomly with no preference for a particular work place, so long as such work places were in the areas proposed for this study in my ethics application. The managers were informed that if their employees agreed to take part in this study, interviews will be conducted outside working hours. They were further assured that this study will not in any way affect the ability of their employees to carry out their work duties.

Once permission was obtained from the management of an establishment from which I wanted to recruit participants, I went to the firm at the agreed time and date, and made a verbal announcement about my research during break time. I also left behind an advertisement on the notice board requesting participants. Copies of the information sheet were given out during my visit and extra copies were left at designated locations where people could get free access to them. Interested participants were requested to contact me by phone or email.

Once a participant communicated his/her wish to take part in the study to me, I communicated directly with that participant via email and telephone. I also sent him/her a consent form and arranged a time for the interview. Participants were requested to return the consent form prior to the interview. Majority of the people gave me their consent forms on the day of the interview. Interviews were conducted within a week of consent being received from participants at a place and time convenient for them.

It was fortunate that participants who accepted to participate in this study readily supplied their phone and email contacts. A few of the participants attached their business cards to their acceptance note. This made it easy to communicate with them. Within two weeks of visiting these work sites, I had received sufficient positive responses to my invitation. I found it gratifying that there were many people ready to talk about their experiences with mathematics contrary to my fears.

Once a participant's acceptance letter was received, the decision, identity, date of interview and any other information pertaining to a particular participant were not disclosed to other participants from the same establishment. Fortunately, I did not have a situation where two people working in the same office volunteered to take part in the study. This averted the possibility of having their narratives influenced by any interactions they would have had with their colleagues. However, at the commencement of every interview, I reminded participants that it was very important to me that they

gave answers that reflected their individual experiences with mathematics and not the experiences they had been told by other people or in reflection, experiences they imagined they could have had.

Interviews were held at different locations. In a situation where two interviews were scheduled for the same venue on the same day, I ensured that the start and finishing times of interviews were at least one hour apart. This was to ascertain that respondents did not meet at the location of the interview. It was also to ensure that the topics covered in the interviews did not become their normal subject of discussion with their colleagues. Lastly, the goal was to ensure on my part, in line with my undertaking, that the privacy and confidentially of views expressed by participants were protected at all times as I had assured them in my information sheet that their identity and views would be kept confidential (Denscombe, Dingwall, and Hillier (2009). Kvale and Brinkman (2009) and Seidman (2006), stress that participant protection is very important. Participants in a research should be confident that by taking part in a research, they will not suffer any financial, emotional or reputational costs (Denscombe, 2010b; Frank, & Polkinghorne, 2010).

Participants were recruited from various professions (engineers, teachers, doctors, and nurses); and occupations such as, office administrators, information technologists, and postmen. While this sample may appear slightly biased, it was appropriate as my study was a small-scale pilot study (Flick, 2006; Kvale & Brinkman 2009; Mutch, 2005). Furthermore, I am convinced that the range of views represented by this diverse sample provided a very good indication of factors that influence different individuals, those with strong mathematical competency and those with weak mathematical aptitude, toward forming specific attitudes about mathematics (Di Martino & Zan, 2010; Hannula, 2000; Seidman, 2006).

Furthermore, while experiences are unique to individuals, the social surroundings that inform these experiences are common to all people. Therefore, it became clear after conducting the first 5 interviews, that commonality of themes between participants' experiences started emerging. By the time I conducted the 11$^{th}$ interview, it was obvious that a pattern had emerged that unified the themes and perspectives of participants (E.g., Gaskell, 2000; Gubrium, & Holstein, 1999; McCracken, 1988; Schostak, 2002). At this point, I decided that the marginal cost of conducting the next interview outweighed its benefit. In addition, it was clear to me that enough data had been collected that would

enable me to make the analysis I desired. Consequently, I terminated the interview process after the 11th interview.

I am aware that this method of recruiting participants may be biased. My sample did not include unemployed people and in fact, many of my participants were professional people. My sample may not be representative of New Zealand adults.

## 3.8 Data collection method

The mode of data collection that I used for this study was the in-depth individual semi-structured interview. Seidman (2006) notes that in-depth semi-structured interviewing is particularly useful for phenomenological data gathering because it conveys to the participant the importance of his/her experience and brings to the fore the power of communication that allows people to express their experiences in language.

The in-depth semi-structured interview has been described as an art (Paget, 1999), a field where knowledge is mined (Gubrium, & Holstein, 1999), and a conversation (Seidman, 2006). The purpose of this interview is to gain access into participants' minds and encourage them to describe the influences that shaped their attitudes toward mathematics. As Arksey and Knight (1999) observed, interviewing attempts to discover the hidden meanings behind people's perceptions, emotions, and normal activities thereby enabling these feelings and understandings to be examined exhaustively. Gubrium and Holstein (1999) add that it requires tact and skill on the part of the interviewer to elicit maximum disclosure from the respondent. This demands that the interviewer painstakingly prepares for the interview and harnesses the virtues of friendliness, empathy, and astuteness, in order to discern and seize on opportunities to dig deep into the mind of the interviewee (Bogdan, & Biklen, 2007; Kvale, & Brinkmann, 2009).

Based on the views expressed above, I began reading widely on issues relating to this topic. I also prepared a list of indicative questions to serve as a reference point and guide during the interview process. This was one of the merits of my choice of the semi-structured interview method. A semi-structured interview harnesses the benefits of both a structured interview and that of an open-ended interview (Fylan, 2005). In a structured interview, the same questions are asked to all respondents with no possibility of variation (Kvale & Brinkman, 2009; Seidman, 2006; Wood, 1997). While in an open-

ended interview, the researcher prepares for the interview, but may not write down any questions. As a result, the flow of the interview is dictated by the dexterity of the interviewer and the flow of the conversation (Gibson, 1998; Kvale & Brinkman, 2009; Wood, 1997).

Between the two forms, there is the semi-structured interview where the researcher writes down some questions and poses these questions to all participants. However, the researcher leaves a space to follow up on ideas or concepts that might arise from the responses of each respondent (Fylan, 2005; Seidman, 2006). Interview questions are designed as open questions so that they cannot be answered by a mere yes or no. Thus, some skill is required on the part of the researcher to phrase the questions in a way that compels respondents to give detailed verbal descriptions of their experiences of a phenomenon (Seidman, 2006). Furthermore, questions are asked in a way that is not suggestive, so that participants give responses that reflect their actual experience. This helps ensure that participants' answers to questions are unbiased (Gubrium & Holstein, 1999).

## 3.9 Interviews

The interviews were conducted at different venues to satisfy participants. Two interviews were conducted in participants' homes, three in participants' offices, one at the Park, two in teachers' classrooms, and the remaining three were conducted in work site conference rooms. The sitting arrangement varied according to the nature of the physical environment. Holliday (2007) suggested that the atmosphere around the interview site was significant as it could influence participants ease to remain at the location for a considerable length of time, and could determine the ease with which participants were willing to communicate. In addition, it was recommended that an interview location should be well ventilated, well lit, and should be comfortable (Arksey & Knight, 1999; Gubrium & Holstein, 1999; Kvale & Brinkman, 2009; Lett & McGilp, 2004). Arksey and Knight (1999) also suggested that the researcher must show courtesy to the participant by making them choose where to sit. As some interviews took place in participants' offices and homes, they chose the most appropriate site for the interview after consultation with me.

Participants were informed beforehand that I would need a solid surface to place the tape recorder. They were also told that I would be casting a glance at the tape recorder from time to time to ensure that our conversation was being recorded. This was tactfully accomplished without disrupting the flow of the interview and participants' responses. In addition, participants were informed that if for any reasons, during the course of the interview, they had the need to move or respond to an urgent call, they were free to notify me so that I could put the tape on hold and resume the interview afterwards. By conveying this information beforehand, I was making it known to participants that I understood they were busy people who were giving up some important activities to share their experiences with me. I was therefore declaring in advance that I was willing to be flexible in order to recognise their sacrifice (Fylan, 2005, Holliday, 2007). Seidman (2006) states that making the respondent know you value their sacrifice and value their contribution is important.

Even though some of the interviews took place in participants' offices and homes, I ensured that every participant was warmly welcomed to the interview and expressed my appreciation for the opportunity to share in their experience of mathematics. For those who allowed me the use of their offices and homes and introduced me to their families, I expressed my appreciation to them for the confidence they reposed in me. I asked a few questions about each participant and introduced myself briefly to them to create familiarity and a friendly aura that would encourage participants to freely express themselves (Arksey & Knight, 1999; Gubrium & Holstein, 1999; Kvale &Brinkman, 2009). I then introduced the format of the interview and asked them to feel free to ask for clarification if they did not understand a question. I also tried to speak in a tone that did not show I considered myself to be superior to them in any way, and participants were involved in the choice of their sitting position and the location of the tape recorder. When preliminary procedures had been carried out and participants had indicated their preparedness to commence the interview, I started the interview by asking participants to describe their attitudes to mathematics.

A further key to successful interviewing is good listening (Fylan, 2005; Kvale & Brinkman, 2009; McCracken, 1988; Seidman, 2006). When a question had been posed to participants, I ensured that I listened attentively and interestedly to what they were saying by nodding and affirming the points they made. They were allowed to speak freely on the question that had been asked without any interruption (Arksey & Knight, 1999; Gaskell, 2000; Marshall & Rossman, 1999). I respectfully brought them back to

an issue if their answers deviated from the question asked, or there was a need to clarify a point further (Holliday, 2007; Kvale & Brinkman, 2009).

I had provided blank spaces below each question on a schedule to enable me write down some important points made by participants. This had the impact of reassuring participants that they were responding appropriately to the questions asked and that I was listening attentively to their answers (Arksey & Knight, 1999; Fylan, 2005; Seidman, 2006). I found every participant in this study to be very cooperative, supportive and forthcoming. The shortest interview lasted 28 minutes and the longest one lasted 58 minutes. The younger participants answered questions briefly while older participants appeared to have elaborated on their responses.

### 3.10 Data verification

One of the issues with phenomenological inquiry according to its critics is the trustworthiness of acquired data and reports (Bauer et al., 2000; Kvale & Brinkman, 2009; McCracken, 1988). To ensure that accumulated data was a true reflection of participants' assertions and narratives, interview tapes were transcribed by me. After each interview was transcribed, they were returned to participants for cross-checking and verification. Participants were given two weeks within which to communicate any changes they wished to make to me. They were also informed that if after this period, no feedback was received from them I would assume that they were happy with the transcript of their interviews and accordingly had given permission for their data to be used for the purpose of writing my thesis.

No participants requested any changes to the transcripts of their interviews. Transcribing the interviews myself enabled me to note the tones, mood changes, nuances, emphasis and expressions that accompanied participants' answers to questions. This made it easy for me to be familiar with different respondents' answers to the same question, and take note of the similarities and differences in the different responses. In addition, it facilitated the development of themes and categorization of themes and meanings for the purpose of text and structural analysis. Trustworthiness was also enhanced as I tried to separate my own experiences and attitudes to mathematics from those of participants.

## 3.11 Data analysis

Qualitative data analysis involves meaning making (Lee & Fielding, 2004; Paget, 1999). In order to describe, categorize, and interpret participants' responses to interview questions, interview tapes were repeatedly listened to and transcripts were read several times. I started the coding process by assigning a number, 1 to 22, to the questions I asked to all participants. Not all participants were asked every question because in the course of answering some questions, some participants gave the answers to other questions. I opened 22 separate pages on Microsoft word and assigned every question a page. I then copied and pasted the answers of all participants to the same question on the relevant page. The goal was to gain sufficient familiarity with participants' narratives so that the same concepts, phrases, and words, could be coded (Boden, Kenway, & Epstein, 2005; Dearnley, 2005; Kvale & Brinkman, 2009; Wolcott, 2009).

To derive meaning from participants' narratives, I began to isolate the key words, phrases and sentences used by participants. I assigned codes to these words, phrases and sentences. When there were enough codes in the same theme, I classified them as a category. In addition to reading the narratives of participants in relation to the questions, I also kept a hard copy of each participant's interview so that I could refer to it regularly to ensure that the themes to which I assigned a word, sentence or paragraph, reflected the content of the participant's narrative (Cresswell, 2007; Denscombes, 2010b; Myers, 2000).

After careful analysis of the data, seven categories became evident to me and I titled them attitudes, reasons for attitudes, teacher associated influences, school connected influences, student related influences, parents related influences, and family related influences. Fourteen themes were also devised and assigned to each of the sub-categories. See chapter four for more information on these categories and themes.

## 3.12 Chapter conclusion

This chapter outlined the reasons for the choice of qualitative research approach and the reasons for using the phenomenological research method. The 11 participants interviewed for this study were selected from central and southern parts of Auckland. All the participants were at least 20 years old and had studied mathematics to at least secondary school level. Semi-structured interviewing techniques were used to collect

data from participants. By using this method of data collection, I ensured that the same array of questions was put to all participants, but in a non-specific order. Interviews were transcribed by me and transcripts of interviews were returned to participants for verification. Finally, the data were coded, themed, categorized, interpreted, analyzed and discussed.

## CHAPTER FOUR FINDINGS

## 4.1 Introduction

In this chapter the findings that resulted from the data collection process are presented. After an initial examination of the interviews, participants' responses were categorised and itemised. Participants' views were classified into seven main categories; attitudes to mathematics, reasons for attitudes, teacher associated influences, school connected, influences, student related influences, parents related influences and family related influences. Under these categories, fourteen themes were recognised. These themes were; perception, success and failure, teacher attributes, instructional practices, teacher expectations, school practices, individual goal orientation, influence of peers, parents value for education and mathematics, parents' education, participants' preschool experiences, and family size. Table 1 on the next page displays the categories, themes and definitions on which the rest of this chapter is structured.

**Table 1**

**Outline of Categories and Emergent Themes**

| Categories | Themes | Definition |
|---|---|---|
| Attitude | Perception | States the way participants see their attitudes to mathematics |
| Reasons for attitude | Success | Cites success as the reason some participants give for their attitudes to mathematics |
| | Failure | Mentions failure as the reason some participants give for their attitudes to mathematics |
| Teacher associated influences | Teacher attributes | Enumerates the qualities of teachers that influenced participants attitudes |
| | Instructional practices | Lists the styles of teaching that influenced participants attitudes |
| | Teacher expectation | Cites how participants were influenced by teacher expectation |
| School connected influences | School practices | Lists school practices that influenced participants' attitudes |
| Student related influences | Individual goal orientation | States how participants reacted to mathematics difficulties |
| | Influence of peers | Looks at how participants' attitudes were influenced by peers |
| Parents' related influences | Parents' value for education and mathematics | Looks at participants' view regarding the priority their parents' accorded education and mathematics and their influence on participants' attitudes to mathematics |
| | Parent's education | Investigates participants' view of their parents education and its influence on them |
| | Parent's expectation | Looks at the effect parental expectation played on participants' attitudes |
| Family related influences | Preschool numeracy exposure | States participants' impressions of the influence of preschool numeracy experiences on their attitudes |
| | Family size | Considers participants' view of the effect of family size on their attitudes |

## 4.2 Participants' backgrounds

Eleven participants were interviewed for this study. Participants came from different work situations and have qualifications in different fields of study. The youngest participant in the study was 21 and the oldest was 60 years old, and participants were born in 6 different countries. In terms of education, 7 participants did all their schooling in New Zealand. One participant studied in South Africa. Another participant studied in Uganda and the United Kingdom, and the last participant did all her studies in Nigeria. Table 2 provides an overview of participants' Information. The names shown on the table are pseudonyms. They are known only to the participants to enable them identify themselves and see the contribution their views made to the findings of this study.

**Table 2**

**Summary of Participants' Information**

| Pseudonyms | Age | Gender | Country of Origin | Ethnicity | Occupation | Country of Education |
|---|---|---|---|---|---|---|
| Hayley | 55 | Female | New Zealand | European | Counsellor | New Zealand |
| Wiseman | 60 | Male | New Zealand | European | Teacher | New Zealand |
| John | 21 | Male | Fiji | Native Fijian | Technologist | New Zealand |
| Granette | 30 | Female | Uganda | African | Nurse | United Kingdom |
| Boyce | 43 | Male | South Africa | White | Doctor | South Africa |
| Duke | 59 | Male | New Zealand | European | Teacher | New Zealand |
| Savron | 24 | Male | New Zealand | European | Physical trainer | New Zealand |
| Samman | 47 | Male | Iraq | Arab | Teacher | Iraq/New Zealand |
| Dave | 42 | Male | New Zealand | Pacifica | Postman | New Zealand |
| Chelsey | 39 | Female | New Zealand | Maori | Administrator | New Zealand |
| Florence | 43 | Female | Nigeria | African | Nurse | Nigeria |

The respondents in this study were mostly professional people. The nature of the topic required that participants were people who had experienced mathematics to at least

secondary school level, which in most cases would be up to year 11 in New Zealand. This was to ensure they had sufficient mathematical experiences to reflect on and relate to. Coincidentally, participants in this study had all partaken in some form of tertiary training. Some had engaged in research in the past, and one was a medical practitioner who was also involved in the training of medical students. Four of the participants were teachers of which two were mathematics teachers. One was an engineer, and the other one was a physical education and health teacher. Two of the participants were practicing nurses, one was an administrator of an entity with about 12 employees; one was a psychologist who worked as a counsellor and of the other two, one was a physical trainer who also worked as a postman. The other one was an information technologist. These people have all gone through secondary school. As such, I believe they were well positioned to personally reflect on, reminisce, and make valuable and unique statements on their experiences with mathematics.

## 4.3 Participants' perceptions of attitudes to mathematics

At the outset of each interview, each participant was asked to describe or characterise his or her attitude towards mathematics. The responses received from the participants were divided into positive, neutral and negative as shown in table 3 below.

**Table 3**

**Number of Participants Showing Attitude**

| Attitudes to mathematics | Number of participants showing attitude |
|---|---|
| Positive | 5 (Boyce, Dave, John, Samman, Wiseman) |
| Neutral | 2 (Granette, Savron) |
| Negative | 4 (Chelsey, Duke, Florence, Hayley) |

Participants that reported a positive attitude to mathematics stated their conviction in this way.

Wiseman:

> I grew up in a home where mathematics was easy and I was also successful in it.

John:

> My attitude towards mathematics; I have a very positive attitude towards mathematics. I had very good experiences when it comes to mathematics in terms of my primary education and coming up through secondary school. I enjoyed mathematics. I've enjoyed the challenges it poses. What I also like about it is that it is logical and makes sense, and the way it influences you to think also trickles down to other areas of your life.

Samman,

> I would say its positive ... in comparison to other subjects taught in secondary school. I enjoyed thinking in a mathematical way. I enjoyed solving maths problems or puzzles or trying to solve tricky questions. I enjoyed it, if you think of it in this way.

Dave:

> I'll say it was a healthy attitude towards maths. ... I enjoyed anything with logic basically, and riddles, puzzles, anything along those lines.

Boyce offered:

> I will probably say that my attitude is that it is difficult, challenging, and that you have to be pretty, pretty bright to understand it. That will be my kind of attitude.

Savron was good in mathematics according to his latter revelations. However, he characterised his attitude to mathematics as being neutral. In his words:

> I'm kind of ... in the middle. ... I didn't have a bad attitude to mathematics but I didn't love it. ... I would say my attitude to mathematics is just normal.

Although Granette claimed to have a neutral attitude to mathematics, she appeared to tilt towards the negative side in terms of her attitude to mathematics. She said:

> To be honest, I think there are certain areas of mathematics I am alright with and there are other areas that I want nothing to do with because I just don't understand them.

The participants that stated they had a negative attitude to mathematics expressed their views in this way.

Florence:

> My attitude if I could remember very well towards maths, maybe, I may base that on ... the beginning of the whole thing. Personally, I didn't like maths.

Duke and Hayley's attitudes were well captured in the words of Hayley when she said her attitude to mathematics was shaped by "fear and no confidence"

Chelsey colourfully put her attitude to mathematics in these words,

> I guess my attitude towards mathematics has always been stand-offish. Mathematics is probably not one of my strengths and it hasn't been. I've never looked at it as one of my strengths and I guess I fear it. I guess there is a little bit of fear because for me it's lack of understanding. That is my attitude towards it. I have to put a block up whenever I deal with too much maths. It's like my mind gets blocked, if you can imagine that. That is my attitude towards it.

When participants' attitudes to mathematics had been established, the next goal was to find the reasons for these attitudes. Consequently, participants were asked to identify the principal reasons and factors that influenced their attitudes to mathematics. The responses obtained are outlined in the categories and themes below.

## 4.4 Reasons for attitude: Success

The participants who had a positive attitude to mathematics stated one of the reasons for their attitude was their success in mathematics. One of the participants who said his attitude to mathematics was neutral has been included in the success category here because he did well in mathematics in secondary school. The various participants presented their views as follows.

Wiseman observes that he had a positive attitude to mathematics because he "was successful in it". Furthermore, he enjoyed learning new things. So to him;

> Mathematics was only part of the learning process. I just wanted to know everything. I wanted to know. I just was inquisitive, and whatever it was, science or mathematics or English or whatever, I wanted to know.

John indicated that he was the top mathematics student in his class and was always cited as a standard towards which his peers should strive to reach. According to him,

> As mathematics gradually became more complicated I guess you could say I didn't necessarily need as much help as my peers to understand what was going on. ... Because I liked the subject, I got into it when I got home. So I was always keeping ahead of the curve in some areas.

Boyce was very successful in mathematics at primary school, scoring in excess of 90% in his examinations. According to him,

> Mathematics in those early stages was easy for me. I really didn't struggle with addition, subtraction, multiplication and division. We use to have some games of competition in mathematics answers and so on, multiplication, basic fact type of questions, and I did very well in those.

Savron could relate more to his mathematics experience in high school. In his words,

> I think I enjoyed maths at high school. ... It became harder because you involved algebra and stuff, which for some people is … like bringing letters into it, kind of a little bit hard, but, I think it became, now you can kind of see why you are doing maths; like you could relate it to things in your everyday life and the world, and you started to understand … why maths is so important.

Savron who stated his attitude to mathematics was neutral also stated he was successful in mathematics in secondary school. He added that he valued his success in mathematics due to the subject's perceived difficulty. According to him,

> … If you got a good mark in maths, it kind of felt like it was worth a lot because it is a hard subject, or I felt. So I think when you got a good mark, it kind of motivated you to keep going with that, and I think, because, … my parents put a lot of emphasis on maths. So, when I got a good mark, it kind of helped me to want to work harder at it.

Dave found "mathematics pleasant and enjoyable". As a result, he "looked forward to the mathematics" class and "found that" he "could bridge it along with other subjects and so it became very handy".

Samman was continually successful in mathematics from primary school through secondary school. According to Samman, the impact of success on him was that:

> It gave me more enjoyment ... because if you did well and you answered and studied, you continued in the same way, possibly, even with more fun.

## 4.5 Reasons for attitude: Failure

The participants that said they had a negative attitude to mathematics also said they did not enjoy the experience of studying mathematics in school. As a result, they did not look forward to the mathematics class. Granette, who said her attitude to mathematics was neutral, has been included in this section because from her narrative, her attitude to mathematics appears to be more negative than neutral. As a result, participants who claimed to have a neutral attitude to mathematics have not been classified into a separate theme in this section as one, Savron was included in the Success theme above and the other is included in the failure theme here..

Looking at the individual narratives in detail, Hayley said she was a bright student. She was top of her class through her primary school years. However, as mathematics got diversified and complicated in intermediate school, she realised she was not prepared to handle the complexities she was encountering. At high school, she got into the top stream class. Her exceptional performance in other subjects making up for her weakness in mathematics. Hidden beneath, was the nagging awareness that her mathematical skills were inadequate to maintain the level of success she had enjoyed in earlier years. She stated that this awareness bred diffidence and anxiety in her mind towards mathematics. When asked about her attitude to mathematics, Hayley responded that it was "an attitude of fear, and avoidance and no confidence". The following conversation then ensued.

Researcher:

> What would you think led to that type of experience?

Hayley:

> Failure led to that type of experience. When I went to secondary school, my mathematics was clearly not as good and at as good a level as other people who were with me in the class. ...It was clear that my mathematics was lower than my other subjects and I just didn't have any confidence. ...I can remember being anxious about mathematics even in primary school and anxious that I wasn't as good as I should be.

Researcher:

> Do you think that sort of anxiety affected the way you related to the subject?

Hayley:

> Absolutely! It definitely did. I could not understand why I wasn't as good at mathematics as I was in everything else. I sailed through my primary school years thinking that I was really onto it, really smart, because all my other results were really good, as I was top of the class, but there was always that little anxiety that there was a whole area of my learning that wasn't up to scratch.

Hayley also reported that her lack of success in mathematics made her incapable of planning to overcome her weaknesses in the subject. Although she did additional lessons to augment her performance in English, she said it did not occur to her to do the same in order to ameliorate her knowledge and performance in mathematics.

Hayley's situation was similar to the way Chelsey felt about the influence poor performance in mathematics had on her. Chelsey puts the influence of under performance in mathematics on her in the following words.

> I have to put a block up whenever I deal with too much mathematics. It's like my mind gets blocked, if you can imagine that. ... Maths wasn't my favourite subject. It was a subject I remember trying to avoid if I could. I remember mucking around a lot in maths. At times I would try really hard to put my mind into it and focus, but for some reason, it didn't make sense to me and I couldn't understand it. That is what strayed (sic) me away from having a positive attitude about maths. ... In secondary school, maths for me, was even more scary than primary, because I was not willing to put in any time whatsoever. To the point where I actually dropped down in a mathematics class because I wasn't getting it. ...

Granette on the other hand reported that she approached her mathematics difficulties in a different way. She selectively focused on some topics to obtain the pass grade she desired to pursue tertiary studies. Asked how she related to mathematics in high school, Granette responded; "in secondary school obviously, they introduced a bit more complex topics and some of them, I just couldn't, I was totally clueless, absolutely clueless". Asked to describe her reaction if she found a topic difficult, Granette retorted; "to be honest, I just switched off. I just couldn't care less any more".

Duke also did not like mathematics and he did not do well in it. As a result, he did not highly esteem topics that he perceived would not contribute anything valuable to his aspiration. He classified such topics as irrelevant and unworthy of his time and effort. As Duke enjoyed drawing and had an aspiration to do technical drawing and woodwork, he was only willing to focus on learning when he saw the topics being discussed as relevant to his areas of interest. In his words,

> I wanted to do technical drawing; those other things..., those other units, didn't really; I could see nothing in them that was going to help me in my future. So I found them boring. At times I failed them because I did not see any interest that was going to help me later on in what I wanted to do. ...I sort of had an idea of what I wanted to do.

Duke also reported that his negative attitude to mathematics influenced his perception of mathematics teachers. He observed that mathematics teachers in his school were seen as arrogant and aloof. According to him;

> ... I don't know whether they are stereotyped or because they thought, as we do, because we think our subject is the most important; there is nothing else apart from mathematics. ...It was like, maths teacher; professor. ... They had a stigma; they had something attached to them. Every student would go; don't they look like a professor? ... It was like if you taught maths, you were a bright person; so in our school, they had that sort of tag. So I didn't, at secondary school, I didn't have anyone that really inspired me to want to carry on with mathematics.

Similarly, Florence had a negative attitude to mathematics but persisted if the topics were easy and they were the ones she understood how to do and could do them. However, in her words, "if they became complicated or difficult, I gave up".

Participants who reported having a negative attitude to mathematics stated that they were anxious when confronted with mathematics problems. They also said that they did what they could to avoid doing mathematics.

## 4.6 Teacher associated influences

Many participants cited different attributes, relational styles, and instructional practices of the teacher as constituting important influences on their attitudes to mathematics. These various aspects of the teacher are discussed here.

### 4.6.1 Teacher attributes

Participants were asked to enumerate the qualities of mathematics teachers that positively influenced their attitudes toward the learning of mathematics. In response, participants cited attributes such as calmness, passion, pleasantness, teacher regard, teacher accessibility, teacher care, creating a comfortable learning environment and patience with students, as comprising important characteristics that encouraged them to

want to learn mathematics. In addition, many participants felt mathematics teachers with a positive attitude enhanced their outlook toward mathematics. Here is an excerpt from Wiseman's description of two teachers that had considerable influence on him when he was in years 12 and 13.

> So yes, the teacher was the most important. ... There were two teachers actually; one was an English gentleman who came and taught for two years at our school ..., this was in the 1960s and he was a very enthusiastic, energetic, and passionate young man, who never had any trouble. He was always happy. He was always positive. He explained things differently as an English teacher, an Englishman. My other teacher also, he was a kiwi man, a younger guy, but he was also very passionate. ... Both of them were very calm people. You never saw him angry, never shouted at you, and he was very calm. He always encouraged you. So that was the thing. I had difficulty with maths in my sixth form year (year 12), because I did no work, and he was the one who got me back on track.

Continuing further on this theme, Wiseman opined that mathematics teachers that related well with him positively influenced his attitude to mathematics and enhanced his performance in the subject. Asked if the nature of the relationship that existed between him and the teacher affected the way he related to mathematics, Wiseman stated his perception as follows.

> I think it made it easier. I think if you struggled with something and the person was caring and explained it well, as he did, you would listen to him. You would listen to him because you weren't fearful of him. I think that if a teacher talks to you as if you are stupid ..., well, you just shut off and you won't listen to what he is saying. But ..., he'll go out of his way to you, he was always available; outside class, sometime you could stay behind after class and ask him something. There was never a hassle. He never seemed stressed.

How is the teacher to display that he or she cares about the students? Hayley and Chelsey were of the opinion that the teacher cared when he or she noticed the student, knew the student and could respond to the student's needs. Chelsey opined regarding her mathematics teachers' attitudes to her, "I think I was just like a number... in secondary school". Chelsey stated that for her the teacher who really cared was the one who took note of her mathematics level and recommended her for a suitable class where she did an alternative mathematics course for one year.

For Savron, the teacher cared "if you felt that the teacher understood and was patient with you or understood where you were coming from". For Duke and Granette, the teacher cared when he or she treated the students equally without showing differential

regard for students who were good in mathematics. Granette presented her view in these words;

> ... What I noticed, off course, the good students; teachers kept asking them. So those who are not good, obviously, the teacher didn't even know their names. So you kind of resigned to that kind of thing. You know where you belong so just let it be.

For Boyce and Florence, the teacher cared when he or she was prepared to commit extra time, even out of official hours, to provide additional tuition to enhance their success in mathematics. For Dave and John, the teacher cared when they were patient, showed interest in the things affecting the student as a person, and took these things into consideration when dealing with the student and the student's ability to learn mathematics. In addition, according to Dave, the teacher should give equal time and attention to those who are good in mathematics and to those who struggle in it. Dave summed up his perspective in the following account.

> ... I found that kind of teaching, that kind of teacher; she was a caring person, because all the other teachers, they didn't care if you got it or not. They just dedicated all their time to those that maths came easily to and progressed more and more when the rest of the class were just left to their own devices, and I found that, probably more so, in my secondary years, I saw more of that. Therefore, the relationship in the class was just with those who did well. They had a really good rapport with the teacher as opposed to the others. There are extenuating circumstances in a student that sometimes make learning difficult. I think if the teacher is aware of that, he can be a bit more patient, she can be a bit more patient, and just progress the students at their pace in small increments. ...

In Salman's view, caring teachers issued no threats, made situations simple and "created an atmosphere of healthy competition". In addition, Samman said the teachers he found to be caring took steps to facilitate students' understanding of mathematical concepts by elaborately explaining new ideas and sincerely "covering the whole topic". Finally, Samman observed that another quality of the teachers that positively influenced him was that they exuded confidence and made their students believe that they were capable of understanding any topics in mathematics.

### 4.6.2 Teacher-student relationship

When asked to explain the influence their relationship with their mathematics teachers had on their attitudes to mathematics, every participant stated that the nature of the

relationship between him or her and the teacher influenced the way he or she related to their study of mathematics. According to Hayley, she still remembers the name of the teacher she had in year 10 after more than forty years because of the relationship that the teacher had with her. She expressed her feelings in these words.

> "Do you know ..., I can't even remember the names of the other teachers? I can't remember the name of the one I had first in the third form. ... Oh yes, I can, and she was really, really boring, and she didn't take any notice of me, and I didn't have any connection with her at all. ... The one that stands out is the one I had a relationship with. Only the teacher that I named had, the one in the fourth form, only she did that, only she had a relationship with me about that, and it made me to think that if I had her for a long time, I might have been able to achieve.

According to Savron, the teachers that had a good relationship with him, knew his level in mathematics, understood any difficulties he had and were able to help him. Savron said this encouraged him to work hard and do well in mathematics so that he would not disappoint the teachers and be seen not to be reciprocating their goodwill.

John stated that if he had a good relationship with the teacher, he had the freedom to engage in more exploration and could take more risks in solving problems. As he put it, a good relationship with the teacher helped him "to learn maths better because" he "found it easier to make mistakes in front of them" as he "didn't like making mistakes in front of strangers".

Asked if the way her mathematics teachers related to her influenced the way she related to the subject, Chelsey responded in the following way.

> Absolutely, absolutely. Everything is about relationship and I really believe that because of the relationship that I had with my teachers and the relationship they were willing to build with me, I was willing to have different positive experiences with mathematics, some not so negative and it really depended on o-h, the chemistry that you have with your teacher in the class, that's what I believe.

Many participants reported that they did not enjoy the classes of mathematics teachers that were too strict and serious. Wiseman said; "Mrs Gweek, she was a battle-axe. She was scary. We didn't learn an awful lot from her".

Granette posited;

> I think maybe if the teacher was like or had been a bit more approachable and, yes, I think, if they had been a bit more approachable, it would have been easy to, because, I had got to if it is hard for you, go for help, that would mean even after classes when the teacher is still in the staff room you

> knock on the staff room door and ask for help but not with this one. There was something about this teacher that made it difficult for me to approach him

Pressed if she made any extra efforts to seek the teacher's attention before reaching the conclusion above, Granette replied; "I guess the vibe I got from him was basically negative. So I found it hard to approach him".

From the accounts of these respondents, it appears that there is a positive correlation between their attitudes to mathematics and their teacher's relationship with them. Participants that had a good relationship with their mathematics teachers appeared to have had a positive attitude to mathematics. The ones that had no relationship with their teachers appeared to have had a negative attitude to mathematics.

### 4.6.3 Instructional practices

Participants reported that the instructional approaches employed by their teachers had an influence on their engagement with, achievement in, and their attitudes to mathematics. Samman reported that he enjoyed the classes of teachers who were authoritative but who allowed students to freely express themselves and show their unique individual features. Participants, whose early mathematical experiences were based on the memorisation of facts, appeared to have done well in primary school. However, in secondary school, as the topics expanded and increased in complexity, they appeared to have encountered great difficulties in mathematics. Hayley described her experience with mathematics in primary school as based on memorisation. She said, "things about rote learning", they were "ingrained into us". This is the way Hayley expressed her experience about transitioning from primary to secondary mathematics.

> It was a different style of learning; probably, a bit more interactive, and it was much more about concepts, so I didn't have the skills to manage that and my rote learning skills were no longer that useful. ...

Similarly, Chelsey stated;

> I think, back then, it was very much about rote learning. That was the way I feel because that was the only way I learnt. I didn't learn any other way. It was all from my memory. We used to put everything to memory. That's how we learnt. I don't remember them showing me different strategies on how to get to that one equation. I believe it was very much rote learning.

Duke said he related well to the structure of rote learning. As a result, he said when he went to high school, he regarded the concept-based approach to learning mathematics bereft of structure and irrelevant to the way he learnt mathematics. As a result, he said he drifted away from learning the subject.

In addition, participants found monotonous teaching practices where the teacher always taught from the front of the room and stuck to the same methods and tools as being unmotivating. Granette expressed her impression thus;

> ... What he tried to explain was what he wrote on the board, and you know what it is like. They wrote and then they rubbed off, and they wrote and rubbed off. So, whether you understood it or not; and sometimes even if you asked, the explanation still left you waiting for more explanation. You didn't want to hold the class back, because, maybe, others understood it, so it was always easier to just keep quiet.

Continuing on the same teaching approach, Duke articulated his experience in the following way.

> You know, it was sort of like, write that up. There was very little questioning time, very little, you know oh, I don't understand that, because, obviously they had to get through what they needed to get through. Everyone sat down there individually, looking at the board, listening to Sir or Miss, which was it and do this or that! Even though you didn't understand it, you didn't put your hand up. ... We just sat there, wrote down and copied, that was the answer there, something like that. Sometimes, there wasn't a formula, how you get there. So it was just rote learning, copy that, write that down, that is the answer that type of thing, it was just prue (sic), nothing else. If you try to suggest; maybe we try it this way, the teacher would say, no, no, no, seriously, do it that way; nothing else. It was that sort of thing.

Some participants also asserted that in secondary school, mathematics classes became overly teacher dominated and teacher directed. Comparing instructional practices in primary and secondary schools, Chelsey said in secondary school the teaching

> Became very teacher directed, ...and not so much time for group direction. The teaching styles in secondary and primary were quite different, very different. It was very much what you saw on the board or in the box that was what you got. Motivate yourself to do it on your own, kind of thing. You know, so that was how it very much felt, that way, very teacher directed.

Commenting on the positioning of the teacher, Chelsey had this to say;

> Yes, always at the front of the room, always at the front of the room. Never, never, ever, and they only ever walk down the aisle, walk in amongst the class, when you were sitting a test, to make sure you weren't looking at your partner, but they never walked down and looked at your work or anything

> like that. It was always at the front, either standing, writing on the board or sitting at the desk waiting for you to bring your work up to be marked. I remember one teacher who put his feet up on the desk a lot and said, open your book and this is what we are going to do in mathematics today. Get out your books, get out your calculators, and get out your this and your that.

From the foregoing, it seems there is some relational between the teacher's instructional style and students' engagement with, and attitude toward mathematics.

### 4.6.4 Teacher expectations

Do teacher expectations influence students' attitudes to mathematics? Participants were asked to comment on the influence of their teachers' expectations on their performance in, and attitudes to mathematics. Participants that reported having teachers that placed specific expectations on them regarding their performance in mathematics described such expectations as "empowering" because they viewed their teachers' expectations as being realistic. John regarded the expectations of his teachers as a "motivation". As he stated it;

> They expected more from me than what they would expect out of the rest of the class. That did put some pressure on me a little bit, as it would anyone, to live up to expectation; but as I said, I've always used expectations as a motivation rather than a burden.

John also described a scheme where at the beginning of every academic year, the teacher gave each student a sheet of paper and asked them to write on the paper the grade they intended to get in mathematics for that year. Once agreed this constituted a goal towards which the teacher and student worked for that year. If the student attained the goal before the end of the year, it was revised upward. John claimed understanding the target set for him by the teacher increased his motivation and determination to work to attain that target.

Boyce also said that the teacher's expectation was a positive influence on his achievement in mathematics. He had the same teacher for the last three or four years of secondary school. The teacher therefore knew him well and understood the level of his performance. This is how he narrated the import of the teacher's expectation on him.

> He certainly expected me to perform at higher grade mathematics level. He was the sort of teacher who was always encouraging and wanting you to do better but... wasn't down on you if you didn't achieve. He would very much say, look, I'll try to help you and make you get to the goal.

According to Boyce, the teacher's expectation engendered in him a self-driven determination and motivation to do well in mathematics. Savron also found his teachers' expectations valuable in helping him to achieve to his potential in mathematics. He stated his impressions as follows.

> Yes, I think they were good in the way that they expected you to perform to the level that they knew you could perform to, because, as I said before, I think maths is pretty specific to yourself; so that was the good thing in it, because then, you kind of knew where you should be; so like in some subjects, I wouldn't be at an excellence level, so they are not going to place that expectation on me because they knew what I could achieve if I tried hard.

Wiseman said the structure of his class conveyed the clear message that they were expected to attain a high level of achievement in all their subjects. Wiseman was in the professional class. Students in that class comprised the best academic students in the school. In addition, according to Wiseman, the student leaders of the school came from that class and they were expected to go to university. Wiseman asserted that these explicit expectations encouraged him to work hard to attain a high level of achievement in mathematics.

## 4.7 School connected influences

Most participants in this study stated that they attended schools whose leaders gave clear messages about the importance of academic achievement and they all said that they were proud of their schools. They also said that their schools had clear incentive schemes in place that were known to all students. All participants also said that they were placed in classes based on their academic performance and that this influenced the way they learnt mathematics. Many expressed pride in the reputation of the schools they attended and reported satisfaction with being associated with their schools.

### 4.7.1 School incentive schemes

Boyce spoke of his school as encouraging students to exert the required effort on their studies and achieve to their potential in their subjects. In addition, he talks of a goal structure that existed in his school where students were set specific achievement targets

for an academic year. If students attained those targets, they were given days off at the end of the year. This is how Boyce captured this school incentive scheme.

> What I liked about the school is that it always had these goals and that if you could achieve your goals, then you got this extra time off at the end of the year. They were certainly encouraging you to achieve, but to achieve to your potential. They didn't set unrealistic goals, and so, I think it was a very positive system.

Samman's school also had a similar incentive scheme where a student who attained a high level of achievement during the year in his or her examinations was awarded top grades and excluded from partaking in the end of year examinations. Samman claimed the existence of this scheme gave him great motivation to work hard during the year to earn top grades in his subjects so that he could enjoy extra days of holidays at the end of the year.

Overt messages from school leaders that emphasized student achievement as a prime objective of the school were found to be motivators for students to work hard in their mathematics and achieve to their best potential in their subjects. Duke observed that the message he got from his principal during his inaugural address to the students inspired him to work hard to do well in his subjects. Duke narrated that their principal stressed that students who were good in sports also needed academic success because sports could only be played for a limited time. In Duke's view, this speech had made him reflect on his studies and elicited a commitment from him to do well in his subjects.

Participants in this research study believe that the messages they got from their schools regarding achievement had influences on them and their commitment to achieve to their best potentials. In Savron's words;

> I think because there was an expectation for everyone to achieve, you kind of felt that if you didn't do your work, like in maths or whatever, then, you'll kind of be letting yourself down and you'll look bad in the school because the school had such a high level of expectation of the students.

### 4.7.2 School reputation and climate

Participants said they were proud of the schools they attended and indicated that they would be happy to be associated with those schools. Wiseman said his school was a very reputable school in New Zealand. He added the following.

> It was a great school. It was a school that had the tradition of the Kings or Christ's, that sort of thing, but the difference is that they were private, but it was a state school. ... People came to school by buses. Some of the kids came from more than 30 miles away. The school was well known. I mean, there are many top business people in New Zealand that went to that school, top business people in New Zealand. ... It was a school that was as good as any other school in New Zealand.

He then listed prominent business and company executives, educational, and political leaders, who attended that school.

In the same way, Hayley said of her school,

> It was regarded as a good school, but for a whole lot of reasons. It was good academically but it was regarded as being good for other reasons as well.

Many other participants happily mentioned the names of the schools they attended and spoke highly of the enabling environments they provided that encouraged and promoted student achievement.

### 4.7.3 Class assignment practices

School practices that allocated the same teacher to a class for 2 or more years were found favourable for participants that had these experiences. According to these participants, having the same teacher for several years created certainty and improved students' confidence in the teachers. Participants who had this experience claimed that over time, the teachers came to know them better, understood their learning style, and tailored instructional materials and strategies to their needs.

Furthermore, school practices that streamed students seemed to have conflicting influences on students' attitudes to mathematics. For Wiseman, it was a very positive experience because he was in the top stream class. He developed supportive working relationships with his peers that were beneficial for them. However, for Hayley and Duke, their experiences with regards to their mathematics proficiency were less than ideal. Hayley got into the top stream class because of her performance in other subjects. For the fact that she was in the top stream class, she was expected to perform at a top level in mathematics. However, she knew that her mathematics aptitude was below that of her peers. This caused her anxiety and frustration that resulted in her dropping mathematics at the end of her second year in secondary school. Duke was in a class of

below average students; the distractions and taunts from his peers prevented him from asking questions in class and working to improve his knowledge of mathematics.

## 4.8 Student related influences

Are there unique individual characteristics that influenced participants' aptitude and attitude to mathematics? To examine this question, participants were asked to describe how they reacted when they encountered difficulties in mathematics and who they saw as responsbible for their results.

### 4.8.1 Student learning motivation and attribution orientations

Participants who declared they had a positive attitude to mathematics appear to have individual attributes that encouraged motivation and a determination for success in mathematics. Wiseman said his drive for success was an intrinsic attribute. He saw himself as being an inquisitive person who was eager to learn anything that was new to him. Therefore any new things in mathematics or any other subjects were concepts that he was ready and enthusiastically willing to learn.

Boyce also regarded his focus on mathematical success as being "more self-driven than externally driven". According to him, he understood the importance of success in mathematics to his career objectives. He said he wanted to go to university to study medicine. He was aware he needed to do well in mathematics to be eligible for medical school. Consequently, when Boyce began to experience difficulties in some aspects of mathematics in secondary school, he opted to do extra mathematics classes, and he did this for three years, in order to ensure he did well in mathematics.

Similarly, Samman wanted to do well in mathematics. He started out as one of the best mathematics students in his primary school. In addition, he was informed of his parents' desire for him to do something in the sciences at university. These combinations of his desire to maintain his top performance in mathematics and the knowledge of his parents' expectations enabled Samman to work hard to maintain his top performance in mathematics through his years in secondary school.

The participants who stated having positive attitudes to mathematics also said they had good mathematics teachers and attributed their success to their own determination to succeed and to the support they received from their teachers.

On the contrary, participants who indicated they had a negative attitude to mathematics, said they tried to avoid mathematics, were inattentive in the mathematics class, and "switched off", when they experienced difficulties in mathematics. These participants also observed that their mathematics teachers were 'boring', and they attributed their lack of success in mathematics predominantly to their teachers.

### 4.8.2 Peer influences

To determine the influence of peers on participants' attitudes to mathematics, they were asked to characterise their classmates' influences on their attitudes to mathematics. Some of the respondents gave the following opinions.

Boyce said;

> I was in a ... mixed class with boys and girls. ... Certainly among the boys, it was a competitive group of boys who wanted to do well. One of them was actually a maths teacher's son who got 100% all the time which irritated all of us. He was particularly good at it. So it was an encouraging peer group in terms of maths. Although some of us, some of my peers, like me, were doing extra maths, we all wanted to do well. We all understood the importance of doing well in maths.

Wiseman related the influence of peers on him in this way.

> I just think they were all good students. We all wanted to learn and we all probably helped each other. ... For example, in my years 12 and 13, I was going out with a girl whose older brother was a physicist and was known very well in the community. She had been a girl with impeccable notes. I borrowed her notes and copied them out.... So, we did homework together. I guess I was influenced by her in the sense that her older brother at university was showing her how to do things and succeed and she in turn was showing me. And, I was seeing what was necessary to pass. So I guess, that was the peer support, peer influence. We had a couple of good mates with whom we did homework. ... I guess we did have an influence there.

Some participants reported that peers gave them support and helped to explain difficult concepts to them, sometimes, better than the teacher. Of the participants that took part in this study, 8 out of the 11 of them stated that their experiences in mathematics may

have been influenced by their interaction with their peers. However, this influence did not necessary change some of their attitudes to, and performance in, mathematics.

While the attitudes to mathematics of many of the participants in this study were positively influenced by peers, there were some participants whose attitude to mathematics was negatively influenced by peers. Duke was in a class stream where he was uncomfortable to ask the teacher for help because an attempt to do so was greeted with jeers from his peers. As he stated it;

> Even though you didn't understand it, you didn't put your hand up because you felt silly because you know; you needed to have understood it. So it was an environment like that which ... wasn't comfortable; because I never said, how do you do that sir, we didn't do that, we didn't question. ... So I failed.

To clarify the statement above, Duke was asked to give the reasons he was uncomfortable to ask questions in the class. He responded to this inquiry in the following words.

> The other kids would go, put your hands down, and dude... things like that. It was a class like that, that sort of thing.

Chelsey had a similar experience and she regarded it 'as a pride thing', where teenagers do not want their peers to perceive them as being dull in mathematics. Here is an extract from the account of her experience.

> I used to try and put my hand up and get the teacher's attention, and say sir, I don't understand this; and I guess when you do that, everybody makes fun of you. I'm sure the teacher is happy to help, but the peer pressure comes on you, and then ...straight away, the block comes down. You don't want to be seen as weak or you don't want to be seen as dumb or incompetent, or you know, you don't understand it, and it's very much that kind of environment.

Chelsey also reported that she sometimes found it difficult to ask questions in class because she was afraid of being perceived by her peers as being weak in mathematics. Granette felt the same way and she put it down to ego that is associated with the teenage years

In addition, Hayley cites competition between peers on who will be first in the class as preventing her peers from giving her assistance in mathematics. As a boarder and a student in the top stream class with many good mathematics students, according to her, it would have been assumed that the positive disposition of many of her peers to mathematics would have affected her positively in some way. However, the influence on her was the reverse. She stated the reason was that as a boarder, she had no group she

studied mathematics with after school; they were left to do their individual studies. To further explore the influence of peers on her attitude to mathematics, the following conversation took place between Hayley and I.

Researcher:

> Since you had many good mathematics students in your class according to your earlier statements, did they not influence your attitude to mathematics in a positive way?

Hayley:

> No, not really, maybe, they made me less confident, because they were really good. They didn't help me or something like that.

Researcher:

> Why was that? Was there competition between ...?

Hayley:

> Yes, always, all through my schooling. There was one year when I came second and it was because of my maths and the whole class went u....h! Like that when it was announced.

Hayley declared she found her weakness in mathematics humiliating because she was unable to match her peers' performance in the subject.

In summary, it appears that supportive peers may have had positive influences on participants' attitudes to mathematics. However, derisive, distractive and uncooperative peers may have had a negative influence on participants' attitudes to mathematics.

## 4.9 Parents related influences

This section focused on the influences of parents' value for education and career aspirations for their children on participants' performance and attitudes to mathematics. It also explored the influences of parents' education and parents' expectations on participants' achievement and attitudes to mathematics.

### 4.9.1 Parents' value for mathematics and career aspirations for children

To establish if the value parents place on mathematics and on their perceived importance of mathematics to their children's career options have any influence on children's attitudes to mathematics, participants were asked to comment on their parents' attitudes to mathematics. The responses obtained from participants appeared to show a correlation between parents' value and attitudes to mathematics and their children's mathematical trajectory. Simply put, it seemed that parents who valued mathematics communicated its importance to their children and provided the children with the support they needed to be successful in it. The converse also appeared to have been true. This is borne out in the responses of the participants in this research.

Hayley hails from a well educated family background. She said:

> I was brought up in a family where literacy and things concerned with literacy were much more valued. ... Education and books were highly valued but emphasis was placed probably more on literacy than numeracy. I had basic numeracy experience, much like everyone. I knew how to add and subtract and I could count easily before I went to school. So my numeracy experiences were fine but they weren't exceptional. They probably weren't as good as my literacy experiences.

Hayley stated that in line with family priority, when she went to secondary school, her mother got her a tutor for English. However, according to her, "it was never suggested or never discussed that I get any help in mathematics". To explore this point further, the following conversation took place between Hayley and I.

Researcher:

> Now, thinking of your mathematics, did you ever think or was it ever suggested that you might need some assistance in mathematics?

Hayley:

> No, it didn't occur to me ... that such a thing existed and I think it was a family attitude as much as anything else. We didn't have a mathematician in the family, except the step-father, but in the blood family, we didn't have them. We'd always for generations been a family of artists, musicians and writers, people like that. We didn't have maths people.

Researcher:

> Okay, could you recall, whether when you were in secondary school, you already had in mind the career you were going to pursue?

Hayley:

> It was always assumed by my mother, and by other members of the family that I was going to pursue something that had to do with English or Library Service or something like that; just assumed. It was never, ever; and it was quite a narrow field; that was all in it, or something like the Diplomatic Service. There was never any suggestion whatsoever, that I might pursue something in the sciences, or maths or psychology, or anything like that, it was just very narrowy, narrowed down to English; and it was generally things like Diplomatic Service, Library Service, and Teaching.

Similarly, according to Duke, his parents did not see mathematics as playing an important part in his future. His parents saw English and the ability to communicate as the most important skills to acquire. In Duke's words, his parents thought;

> The most important thing if you want to get somewhere in life wasn't mathematics ... but was to be able to communicate and write, and read; reading, writing and listening, all those skills; those were high priority; sorry, but, mathematics was down there.

As Chelsey puts it; "schooling wasn't a big thing in my family. My father didn't see the value of it". Talking about her experiences with mathematics at home, she stated;

> It wasn't something that we were equipped with at a young age. It wasn't something that my parents sort of encouraged us to sort out pairs of socks, or you know, anything that had to do with maths, we weren't encouraged to do and we didn't have a lot of exposure to it.

In addition, Chelsey reported that when she performed well in some sections of mathematics and joyfully went home to inform her parents of what she had attained, she received no support or praises from her parents to help booster her motivation to do well in mathematics. She described the effect of lack of support from her parents on her mathematics effort in this way.

> I would go home and share it with my folks ... with my mum and my dad. But again, it just never, there was never a real interest from them, ... never a response, I guess, the response I was hoping I would get, to say ..., this is what I had achieved. I couldn't do it before, but now I can. So, I really looked to school. ... School for me was more of an escape from what was going on at home, and school became a really great place for me to be at, because I found that I was seeking encouragement and affirmation and that was where I was getting it from.

The experiences represented above were characteristic of participants in this study who stated that they had a negative attitude to mathematics. These experiences suggest there

may be a connection between parents' value for mathematics and participants' attitudes to mathematics.

On the other hand, participants that declared they have a positive attitude to mathematics reported that in their homes, education was valued and books were available. They also asserted that they received ongoing help and support from their parents or older siblings, when necessary. In addition, many observed that they were plainly told by their parents that mathematics was a very important subject that they needed to be good at.

When asked if they could recall the way their parents felt towards mathematics, the participants with positive attitudes to mathematics gave the following responses.

Savron:

> My dad definitely thought it was very important. He was adamant that you needed to learn maths to do well in life.

Samman said,

> My father was a teacher and he was interested in puzzles and used to give us puzzles when we were kids. Many of these puzzles involved logic and numbers. ... My father was interested in science and science field.

Boyce responded thus:

> They always highly valued maths as being taught right through from being young. They said one of the important things you need to learn is maths. That was a very strong message that I got from my parents".

From the foregoing, it seems there was a relationship between parents' value and attitude to mathematics and participants' attitudes to mathematics. It is also likely that participants' attitudes to mathematics were influenced by the overt messages they received from their parents about the importance of mathematics and its relevance to their career aspirations.

### 4.9.2 Parents' education

Parental education appears to have been a positive influence on participants' attitudes to mathematics. All but one of the participants in this research who hailed from a home where one or both parents were educated to university level indicated they had a

positive attitude toward mathematics. Samman's parents were both teachers. He avers that his father gave them puzzles as kids and states that he and his siblings were very successful in mathematics in both primary and secondary schools. Dave's father was also a teacher but he received his early mathematics instruction mainly from his older sibling who was 5 years older than him. Boyce father was an engineer and he passed the message to his children at a very early age that mathematics was an important subject that they needed to master and do well in to enhance their career prospects. Savron's father was an engineer too and according to Savron, his father made it clear to him that mathematics was an important subject that he needed to master if he was to do well in life.

From the data, it was found that parents' education appeared to have had a positive influence on participants' mathematics potential. Many of the participants with educated parents reported receiving direct mathematical instruction from their parents. They also stated that they received overt communication about the importance of mathematics from their parents. Furthermore, many of these participants said they were given numeracy and cognitively stimulating materials by their parents. The only participant from an educated background who did not do well in mathematics attributed it to the inclinations of her parents toward the arts, and decades of family leaning towards the arts, music and literature.

The participants, who hail from homes where parents had no education or had education up to junior secondary school level, displayed a negative attitude toward mathematics. Chelsey said the first time she could recall having any interaction with her father about mathematics was when she was in her third or fourth year in primary school.

In a similar way, Duke reckons that lack of early exposure to mathematics was not helpful to his mathematics aptitude. According to him,

> Mum and dad didn't have the numeracy skills. ... Mum only went to school until she turned 13. ... So she didn't go on to college. She didn't go to high school. Same with dad; so they didn't get those opportunities to go and experience numeracy or mathematics in those days; so very little, my parents had very little influence on me because they didn't have the skills.

In this study, it was found that low parental education seemed to have a negative connection with participants' attitudes to mathematics. According to these participants; their parents did not have the skills to help them with their homework if they had difficulties. With regards to Duke, he said his parents did not show interest in his school

work. As a result, he did not put in the effort necessary to improve on his mathematics knowledge.

### 4.9.3 Parents' expectations

To investigate the role of parental expectation on participants' mathematics performance and attitudes, participants were asked to describe the impact of their parents' expectations on their mathematics attitudes. An overview of the responses received from participants is displayed below.

For Wiseman, whose father was an accountant and a farmer, the expectations of his parents were communicated to him at a very early age. He said this continually inspired him to work to fulfil his parents' expectations. In addition, he had been identified at an early age as a gifted child which justified his parents' expectation that he would go to university. In his words:

> My mother wanted me to go to the university from an early age. I was going to be the first one, because back then, my brothers had done apprenticeships and my sister had and my other sister had gone to teachers college, which wasn't university required. So I was going to be the first one in the family to go to the university and I was told that, just because I was the youngest.

Wiseman added that the knowledge of his mother's expectation presented him with a challenge and a goal that he strove to attain throughout his years in school. Similarly, Samman indicated that his parents expected him to do well, "to get a good result, above average"; and that "they would be disappointed" if he did not get a satisfactory result. Samman added;

> I wanted them to be proud and it was within the culture of our family, relatives, friends, and neighbours. Everyone was expected to do his or her best.

Savron said,

> My parents put a lot of emphasis on maths, so you kind of felt bad if you didn't do your work, like in maths or whatever.

Dave was good in mathematics but he characterised his parents' expectations on him as being unclear. According to him, this did not encourage him to do better than he did in mathematics at high school. He saw himself as a person that higher parental

expectations would have goaded to do better. He described his parents' expectation of his mathematics performance as follows.

> It was the attitude of just do your best, do your best son. That's all you can do and nothing more. Do your best. There was no pressure. That was good, that was good. There wasn't that objective, which I think would have been good to succeed. ... If you are from an environment where dad says, listen you need to do this, but you need to do your best, but your best, I know you are capable of more than this. If they just take an interest in your work and say, what did you get; I know you had a test, what did you get? Wow, that's pretty good. I know you can do better, because I know what you are capable of, that kind of thing. That would have accentuated me to just go all out, but because I felt that I didn't have to drive myself, it was because there was no emphasis to drive myself.

For Dave, clear parental expectation coupled with affirmation for his achievements and specification of the level of performance expected from him might have encouraged him to aspire for higher levels of performance.

John whose father was a mathematics teacher observed that parental expectation played a huge part in his mathematics performance through his years in school. However, he added that:

> The way they placed the expectation on me was positive and was very friendly, and was, you know, it was put to me in love. ... So, it strengthened me. It empowered me to do better. It was a motivation rather than an obligation.

Boyce understood his parents' expectations and he worked hard to satisfy these expectations. He declared that he fulfilled his parents' expectations, therefore the pressure he felt to achieve "was more internally driven than externally driven".

From the foregoing, it is probable that parental expectation may have influenced some participants' attitudes to mathematics. Participants who understood their parents' expectations saw them as goals and challenges that they needed to strive to attain and overcome.

### 4.10 Family related influences on attitudes to mathematics

Family related influences may impinge on students' mathematical achievement and attitudes. Findings regarding this theme are set out below.

### 4.10.1 Influences of preschool numeracy and mathematics exposure

To explore the part played by early exposure to numeracy and other cognitively stimulating resources on participants' later mathematical competence, participants were asked to describe their preschool numeracy and mathematical experiences. Four participants declared they did not attend preschool or kindergarten before going to primary school. Two out of these four participants received some numeracy and mathematical exposure from their parents prior to going to primary school. Nonetheless, all the participants performed satisfactorily in mathematics through their primary school years. However, toward the end of primary school, three of these four participants started to feel inadequate in mathematics and started to realise that their skills in mathematics were weaker than their skills in other subjects.

On the contrary, the seven participants who attended preschool or kindergarten before going to primary school performed very well in mathematics all through their years in primary school. Six of them were very successful in elementary mathematics and looked forward with confidence to doing mathematics in high school. Hayley was very successful in elementary mathematics, but had begun to realise, towards the end of primary school, that her skills in mathematics were not as good as her skills in other subjects. She expressed her thoughts in these words.

> ... I sailed through my primary school years thinking that I was really onto it, really smart, because all my other results were really good, as I was top of the class, but there was always that little anxiety that there was a whole area of my learning that wasn't up to scratch.

She said this unease transformed into mathematics anxiety later on and she reported dropping mathematics altogether at the end of her second year in high school.

While lack of preschool attendance and early exposure to numeracy resources and mathematics do not seem to have had detrimental effects on mathematics performance in early elementary school, it appears to have had negative consequences on participants' coping ability at intermediate level, equivalent to years 7 and 8 in New Zealand. The respondents in this study that attended preschool and had early exposure to numeracy instruction and other mentally stimulating mathematical resources appear to have performed well in mathematics in elementary, intermediate and secondary schools.

### 4.10.2 Influences of family size

Participants in this research study were from families with at least 4 children. Three participants came from families where there were 7, 8 and 10 children. In the family with seven children, one of the participant's older siblings was a mathematics teacher and others have degrees in science and business. In the families with 8 and 10 children, Duke for example, talks of his mum always nursing children and his father working late into the night. Consequently, he concluded that his parents did not influence him in any way to learn mathematics. The same experience is true for Chelsey. She comes from a family of 11 children. She also reports that her parents did not show interest in her performance in mathematics. Notwithstanding these two exceptions, it is unclear if, when, and in what way the size of the family influenced participants' competence and attitudes to mathematics.

As noted in preceding sections, many participants had siblings that were several years older than them. For Dave, Savron, and Wiseman, their older siblings provided them with assistance in mathematics in the absence of their parents. They regarded the presence of older siblings as an asset. Wiseman said his older brother was like a father figure to him. This older brother was 18 years older than him and had left home by the time he was born. Savron said his older brother who is now a mathematics teacher gave him assistance with his homework whenever their father was not at home. Dave stated her older sister shared with him the things she learnt at school. He did not understand what her sister was teaching him at that point, but those numeracy rhymes and ideas became meaningful when he commenced school.

## 4.11 Chapter conclusion

This chapter presented findings from the data collected for this study. Many participants reported that their attitudes to mathematics were influenced by their success or failure in it. Other reasons participants suggested for their attitudes to mathematics such as, the value parents had for mathematics, parents' career aspirations for their children, parents' level of education, and parental expectations, were also reported. Furthermore, the influence that participants' own motivation and drive for success had on their attitudes to mathematics, were noted. Teachers occupy an important place in the learning of mathematics. Consequently, the influence that the unique attributes of

teachers, relationship with students, expectations and instructional practices had on participants' attitudes to mathematics were also highlighted. Finally, the way that school practices regarding achievement incentives, expectations, and student classification practices, influenced participants' achievements and consequently, their attitudes to mathematics, were also noted. The next chapter will attempt to situate these findings in relation to existing literature in this field. This will include a critical discussion of participants' responses.

## CHAPTER 5 DISCUSSION OF FINDINGS



### 5.1 Introduction

This chapter discusses the findings of this study in terms of related literature. The categories and themes are set out with regard to their perceived order of importance and controllability. Mathematics success or failure is measured at school. The teacher is an important agent in the construction and transmission of mathematical knowledge. Consequently, the chapter progresses from examining the role of the teacher, school, and individual in the learning continuum, to the role of the home. The intent is not to suggest that the role of the home in the learning of its members is insignificant; but to rather underscore the fact that factors relating to the home that impinge on mathematical performance are not directly controllable by the school.

## 5.2 Reasons for attitudes: success or failure

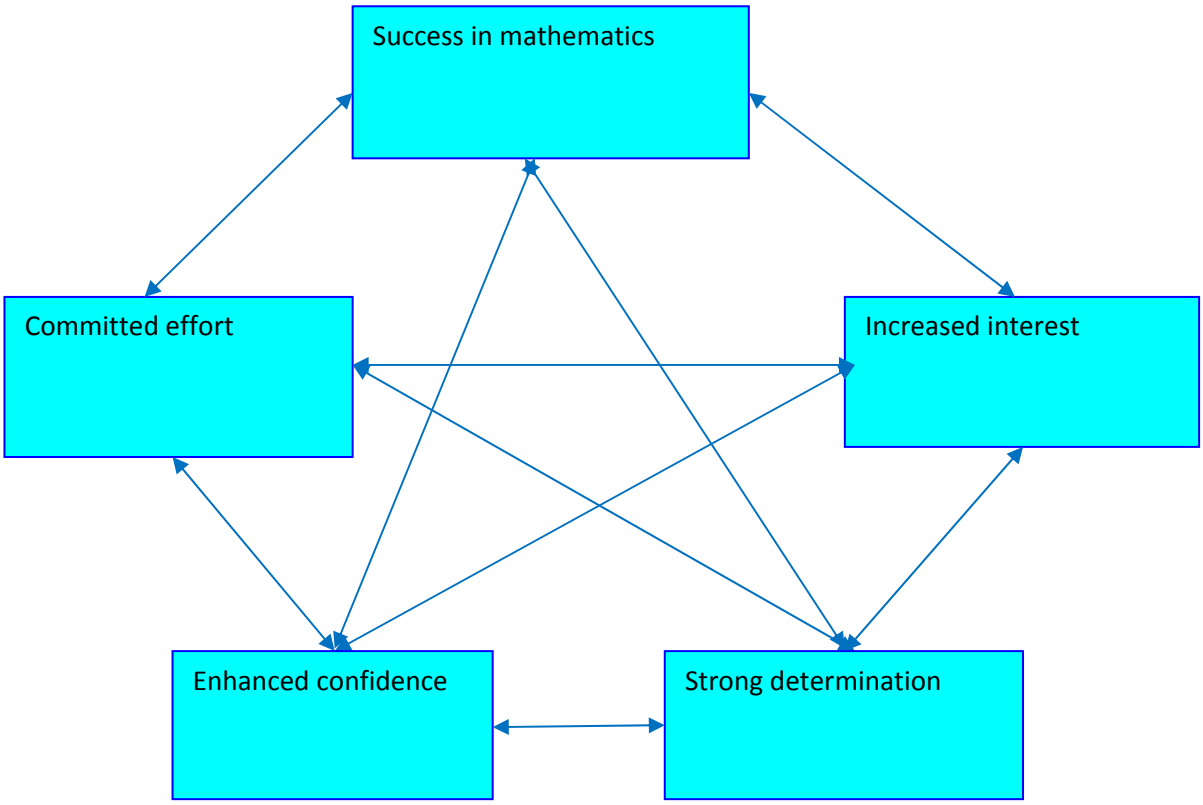
As indicated in sections 4.4 in the preceding chapter, participants described their attitudes to mathematics as being positive, neutral or negative. The reasons cited participants for their attitudes to mathematics revolved around their perceived success or failure in the subject. Participants who claimed they had a positive attitude to mathematics mainly attributed their attitude to their success in the subject. Participants that were successful through their years in primary and intermediate schools were also successful in secondary school. Some of them experienced falling grades as they spent more time in secondary school and as mathematics became broad and difficult. However, their prior success gave them confidence, motivation, and determination to devise strategies and exert extra effort to counter and overcome the challenges they encountered. These participants described the influence of mathematical success on them as giving them motivation to work hard, enhancing their confidence, increasing their interest in the subject, and furnishing them with increased determination to study the subject.

These findings of attribution patterns seem to fit with the findings of studies conducted by House, (2002); Houser and Frymier, (2009); and Nokelainen, Tirri, and Merenti-Välimäki, (2007); whose studies underscored the importance of success in the enhancement of self-efficacy beliefs. One participant, John, asserted that his early success in mathematics contributed to his ability to work hard and work independently on mathematical tasks because he wanted to maintain the level of success he had achieved in earlier years. His performance provided a standard that his peers aspired to attain. To ensure he did not slacken off, he said he had to work on his mathematics daily when he got home from school to ensure he remained up-to-date and ahead of his group in the curriculum. Another participant, Boyce, said that success in earlier years gave him the confidence that he would be successful in future years if he maintained his focus and commitment to hard-work. As a consequence, when he encountered difficulties in the latter years of secondary school, he was able to devise strategies and take remedial classes to improve his performance in the subject. According to Yates (2002), success in mathematics enhances a student's optimism regarding their performance in, and study of, the subject. This encourages students to try harder when they face difficult problems, convinced that they would find the solutions to the problems if they endured and explored different ways of getting to the solution. Several

other studies have made similar findings (E.g., Brown, Anfara Jr, & Roney, 2004; Reusser, 2000; Stevens, Olivarez Jr, Lan, & Tallent-Runnels, 2004).

Two participants stated that success in mathematics enabled them to be able to conceptualise, interpret, apply, and relate mathematical concepts to their other subjects and to concrete objects in their everyday lives. They talked about using measurement, trigonometric and geometric concepts when playing sports, like imagining the dimensions of a football post and the angle through which a ball could be shot to score a goal or the length a golf ball could be hit to make par. This approach to learning mathematics requires intentionality and conscientiousness and it engenders commitment, effort and determination. Therefore, participants who believed in their mathematics abilities and who persevered in the face of difficulties and took action to find solutions to their problems seemed to have been the people that were successful in mathematics. Studies by Singh, Grainville, and Dika (2002); Stevenson and Newman, (1986); Yates, (2002), also found that success in mathematics enhances students motivation, persistence on tasks, and outlook on future mathematics potential. Figure 1 summarises the multi-relational influence that mathematics success had on some characteristics of the participants in this study. The arrows are not an indication of causality but of the mutuality of influence. Success in mathematics may lead to greater interest, better determination, enhanced motivation, and the exertion of more effort by the student. In the same way, the presence of these factors in a student may lead to the student becoming successful in mathematics. While these conclusions may appear simplistic, there is an awareness of many other factors that can impinge on success in mathematics. The model below is at this juncture, ignoring these other variables.

**Figure 1. Multi-relational influences of success on some participants**




Concerning section 4.5 of the preceding chapter, failure in mathematics appeared to have predisposed effects on participants contrary to the ones described above. The participants that said they had a negative attitude to mathematics all observed they did not find the experience of studying mathematics pleasant. According to their descriptions, lack of success in mathematics led to lack of confidence when approaching mathematics problems, a general tendency to be indifferent about doing mathematics, attempts to avoid doing mathematics, and a general feeling of fear and anxiety when doing mathematics problems. Some participants said they were unengaged and distracted in the mathematics class, and many considered the time they spent in the mathematics class as a waste of their time

Ashcraft and Moore, (2009) related the symptoms above to those of students who suffer from mathematics anxiety; and suggested that when students feel they will not be successful in mathematics, they do not commit time and effort to trying to complete tasks and improving their knowledge of the subject. Reusser, (2000), and Vispoel & Austin, (1995), claim that such students lose confidence in their mathematics self-

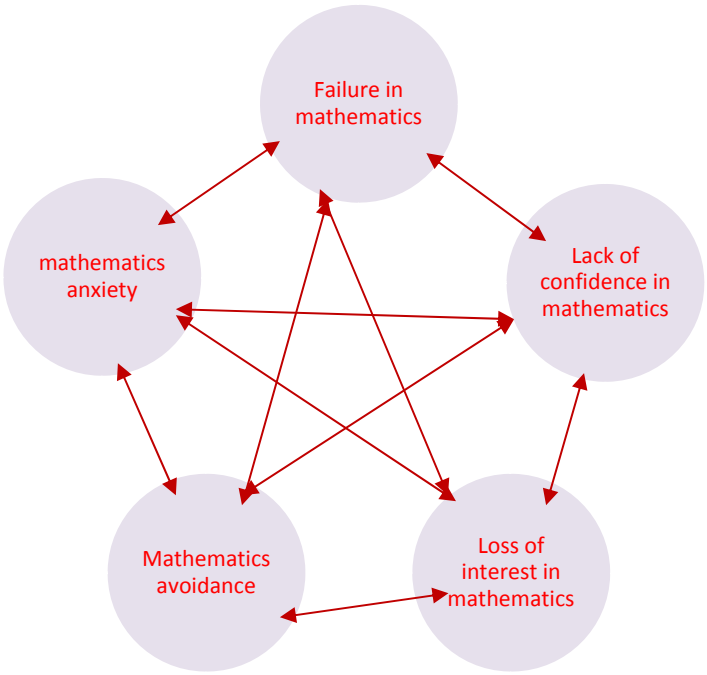
efficacy and become pessimistic about being successful in mathematics. The effect of these factors on some participants in this study was that they experienced declining fortunes in their outcomes in mathematics. One of my participants said her mind got 'blocked' when she had to 'deal with too much mathematics', and another said when she found mathematics problems difficult, she "just switched off" and became unconcerned about understanding the concepts she was learning. Another found it humiliating that she was not as good in mathematics as she was in her other subjects. However, due to her diffidence and anxiety about mathematics, she was unable to think of doing remedial classes to improve on her performance. Rather, the solution she contrived was to avoid mathematics. This solution appeared salient as she rationalised she would not take a course at tertiary level that would involve mathematics. She subsequently found this assumption to be incorrect. It appears that participants who described themselves as being unsuccessful in mathematics experienced low confidence, reduced mathematical self-belief, waning interest in mathematics, mathematics anxiety, and mathematics avoidance.

There were however two participants who described themselves as being neutral in their attitudes to mathematics but who were eager to pursue tertiary studies. These participants sought assistance from their peers and worked hard individually to ensure they secured the minimum grade they required to qualify for the courses they wanted to study. It is conceivable that this third category may encompass many learners. However, the majority of the participants in this study seemed to have placed themselves toward the extremes of the success-failure continuum, including the two participants just cited. Consequently, the emphasis in this analysis has focused on the narrative orientation of the respondents in this study.

Figure 2 below attempts to capture the influence of failure in mathematics on some participants. As the diagram suggests, failure in mathematics may have led to lack of confidence in the subject or vice versa. At the same time, lack of confidence may have led to loss of interest in the subject or the other way round. The same applies to the effects of failure and mathematics avoidance and mathematics anxiety and lack of success in mathematics. Again, the diagram does not intend to emphasize causality. The intent is to highlight the potentiality of failure in mathematics leading to these outcomes and at the same time, the possibility of the presence of these variables in a student leading to failure in mathematics; hence the cyclical nature of the diagram. As

subsequently discussed, there are a multitude of other factors that may influence students' attitudes to mathematics.

**Figure 2. Multi-relational influences of Failure on some participants**




## 5.3 Influences relating to the teacher

The teacher plays a critical role in the construction, nurture, and transmission of mathematical knowledge. In this section, participants claimed they were influenced by their teachers' unique attributes, their teaching styles, and their expectation of students' performance. These factors, through which participants' knowledge, attainment, and attitudes to mathematics were influenced by the activities of teachers, are herein explored.

### 5.3.1 Teachers' characteristics

Participants in this study appear to be in agreement with Noddings (2003) that teachers play an important role in influencing students' achievement and attitudes to mathematics. Participants suggested that they were influenced by teachers' personal attributes such as calmness, communication clarity, and respect for students.

Participants also appreciated teachers that exhibited enthusiasm toward mathematics, who were pleasant and easy to work with, and who had a positive and encouraging approach to teaching mathematics. Schornick (2010), in a study of high school mathematics in the United States found that students shared similar sentiments. She reported that students expressed concern that many secondary school mathematics teachers were unfriendly, did not show interest in the teaching of mathematics, and did not make students know about the importance of mathematics to their university studies. Many students reported teachers giving out worksheets to them without ensuring that they understood what to do or could do it.

Participants valued teachers who treated them with civility. They said that rudeness and uncomplimentary remarks made them to desist from listening to the teacher and the topic he/she was teaching. Pomeroy (1999) in a study of students that had been excluded from school found that secondary school students were particularly offended by teachers who shouted at them, called them names, openly disgraced them, and publicly told them to keep quiet. Teven and McCroskey (1996) added that teachers send a message of care by their mien, look, position in the class and behaviour toward the students. Noddings (2003) observed that "teachers must be aware of and reflective about what they are conveying to students through their manners. ... The teacher sets an example with her (sic) whole self - her intellect, her responsiveness, her humour, her curiosity, ... her care" (p.4).

Many participants were concerned with the amount of care they were shown by their mathematics teachers. They understood teacher care to mean that the teacher knew their names, knew and understood their mathematics level and could give them information on the things they needed to do to improve their knowledge and performance in mathematics. Some participants regarded patience as constituting an important feature of teacher care. They appreciated teachers who gave them individual time and explained concepts individually to them, as many times as possible, if necessary, to ensure they understood a topic, before the teacher proceeded to a new topic.

The teacher's listening ability was a vital feature of care that participants emphasised. They appreciated the chance to be listened to and to have the opportunity to respond to teacher queries before the teacher came to any conclusions. For others, teacher care

meant that the teacher took interest in them as human beings and showed concern in their lives and the things affecting them that may impinge on their ability to learn mathematics. These points agree with the findings of Averill (2009). In a study of the effect of teacher care on year 10 students, Averill (2009) found teacher interest in students to be an important motivating factor for learning and classroom engagement for people of Maori and Pacific Islands' extraction and for low socioeconomic European students in New Zealand.

Teacher accessibility was also an important aspect of care to which some participants referred. Participants appreciated mathematics teachers that were prepared to answer their questions at all times; this included being free to go to the teachers and ask for help during school hours and even after official school hours (Muller, 2001). Two participants fondly remembered their mathematics teachers who offered them extra tuition after school hours and helped them to attain the level of achievement they desired and that enabled them to pursue their career aspirations.

Some participants cited equity as constituting a significant attribute of teacher care that appealed to them. Mathematics teachers were seen to show more interest and spend more time with students that showed a lot of interest in mathematics and give little time to those who were not very interested in the subject. Similar findings were made by Hawk et al. (2002), who, in a synthesis of three research studies, found that preferential treatment undermined Maori and Pasifika students' confidence in their teachers. Some participants urged that mathematics teachers should endeavour to give the same amount of time and attention to students struggling in mathematics as they give to students who are good in mathematics.

Participants in this study also mentioned the importance of a cordial relationship with the teacher as impacting on the way they related to mathematics. One participant said he felt free to take more risks and make mistakes if he had a good relationship with the teacher because he did not like making mistakes if he was not very familiar with the person he was dealing with. Another participant added that he listened very well to the teacher if the relationship between them was cordial. Van Petegem et al. (2008), who have conducted studies on the impact of teacher-student relationship on student well-being, suggested that a cordial teacher-student relationship improves student well-being,

contributes to classroom engagement and improves the learning atmosphere in the classroom. Birch and Ladd (1997) also found that a good teacher-student relationship makes school adjustment easier and creates a positive attitude towards school. Furthermore, Daniel and Arapostathis (2005), found that a good teacher-student relationship improves students' trust in their teachers, motivates them to do more work, improves students' self-efficacy, and enhances students' achievements. Furthermore, Crosnoe, Johnson, and Elder Jr, (2004) in their study of the effect of teacher-student relationship on different races in America found that a strong teacher-student relationship was particularly beneficial for Latino girls' achievement and helped to reduce behavioural problems for white girls.

Furthermore, Urdan and Schoenfelder (2006), who explored the effects of classroom practices on student motivation, observed that teacher-student relationship is particularly important for students from unstable home backgrounds or who are experiencing rejection by their peers. These students may see the teacher as the only responsible adult they can confide in. Therefore, an unfriendly relationship with the teacher might push such students to disengage from school (Birch & Ladd, 1997).

**Interpretation**

Students should be aware that the conclusions they make of teachers' actions represent their individual understanding of those actions and it is possible for different people to perceive the same actions differently (Hudley & Daoud, 2007). For example, a teacher may tell a class, based on the students' performance in an achievement standard; that they should focus on attaining a merit level in the achievement standard. Some students may interpret this statement to mean the teacher has a low expectation of them. Other students may understand this statement to mean the teacher is confident they are capable of getting a merit grade and use it as a motivational tool to strive toward getting a merit grade in that standard (Averill, 2009).

Students must also understand that just as they have expectations of the teacher, the teacher has expectations of them too (Frymier & Houser, 2009; Muller, 2001). If they are not fulfilling their obligations, it is likely to alter the teacher's perception of them and affect their relationship with the teacher.

In addition, students should be aware that learning will not take place if it is done solely by the teacher. A student that does not come to the mathematics class and who fails to be attentive and do the work when in class should not come years later to blame lack of success on the mathematics teacher (Eccles, & Wigfield, 2002). Furthermore, teachers have a specified time within which to deliver a unit of work (Elliot, Hufton, Willis, & Illushin, 2005). It may come to a point when the teacher has no option than to make progress if the interests of other students in the class are not to be negatively affected by the teacher's attempt to wait for every student to properly understand every topic before progress is made (Urdan & Schoenfelder, 2006).

### 5.3.2 Instructional practices

Participants in this study appeared to have responded differently to the teaching styles employed by their teachers. Some participants said they had the same teacher for more than one year, so they seemed to have been accustomed to and happy with the instructional styles of these teachers. Participants that had mathematics teachers that used the same methods of teaching regarded the style to which they were exposed as the only approach of teaching mathematics. They seemed satisfied with it and depending on their mathematics potential, went about their learning in the best way possible.

Participants expressed pleasure with teachers that comprehensively covered the syllabus so that they had no surprises when they went for their examinations. One participant gave an instance of a teacher who after delivering the lesson wrote many questions and answers on the board for students to copy. Students were then expected to practise these questions at home and use the knowledge gained from them to do more questions from their textbooks. This participant was happy with this approach and did well in it. Another participant, however, was unsatisfied with this approach. She cited it as one of the things that diminished her interest in mathematics as according to her, all the mathematics teachers made students do was to copy notes without waiting to ensure that the students had understood the concepts. To this participant, the act of copying notes was a cover-up for the teacher's inability to properly explain concepts to the students' understanding. This finding agrees with those of other researchers who favour the variation of teaching style and resources to cater for the diversified interests and

learning approaches of different students (E.g., Evertson, Emmer, & Brophy, 1980; Gagnon & Bottge, 2006; Ludke et al., (2009); Meece, et al., 2006; Opdenakker & Damme, 2006; Robitzsch, Trautwein, & Kunter, 2009; Wayne & Youngs, 2003; Wentzel, 2002). Furthermore, Pianta, Belsky, Vandergrift, Houts, & Morrison (2008) found that the quantity and quality of mathematical experiences to which students were exposed had beneficial effects for their achievement in the subject at the elementary level (E.g., Nye, Konstanpoous, & Hedges, 2004).

Many participants expressed satisfaction with teachers who exercised control but allowed students to express themselves and employ differing strategies to solve problems. However, mathematics teachers that were autocratic, who limited interaction in the classroom, and restricted student exploration and innovation, were classified by many participants to be 'boring'. These findings are similar to those of Urdan and Schoenfelder (2006), who found that teachers that adopt relational practices (authoritative as distinct from authoritarian or autocratic teachers) help students to adopt a mastery goal orientation to learning (E.g., Norwood, 1994). These teachers give students work that is suitable for their level and relevant to their interest, provide feedback that applauds the progress attained rather than peer comparison, and differentiates learning in the classroom. Similarly, Opdenakker and Van Damme (2006) classified this teaching style as a 'learner-centred' teaching approach. They added that teachers adopting this approach encourage student participation, always have resources for differentiation available, deal promptly with problem students, interact with fellow teachers teaching the same class, and promote the well-being of students. Furthermore, they stated that student-centred teaching improves the classroom climate and enhances the teacher-student relationships (E.g., Averill, 2009; Lüdtke et al., 2009).

Teaching styles that emphasized the memorisation of algorithms and facts were found by participants to have been useful in elementary school but inadequate in secondary school. Some participants relied so much on working from memory that they could not use different strategies to solve problems. These participants stressed that they could not recall their mathematics teachers explaining different ways of solving a problem to them. Norwood (1994) found teaching strategies that encourage memorisation (which she called an instrumental approach) to be good for students that display anxiety toward mathematics. This problem solving approach is highly structured and students have to

stick to clearly defined set of guidelines to arrive at a solution. She says this approach encourages extrinsic motivation. The down side of this approach is that students may lack confidence in their mathematics ability, they may be risk averse, and may refrain from attempting new or complex mathematics problems. These are attributes that some participants in this study displayed. Other studies have made similar findings (E.g., Hudley, 1997; Murphy & Alexander, 2000; Shen, 2002; Turner et al., 2002; Wentzel, 1999; Wentzel & Wigfield, 1998).

On the contrary, Norwood (1994) said the concept-based approach (which she called relational approach) to teaching mathematics promotes intrinsic motivation. The relational approach encourages individualised learning, group work, the use of different strategies and resources to aid learning, and supports exploration to solve problems Sherman and Thomas (1986) conducted a study in which two groups of students with identical pre-test scores were taught the same unit using a relational or collaborative approach for one group and an individual or instrumental approach for the other group. They found that the group that was taught the unit using the relational approach performed better than the group taught individually when both groups were given a summative test.

Notwithstanding the analysis above, anecdotal evidence suggests that some concepts in mathematics have to be learnt and committed to memory. For example, when dividing fractions, the usual algorithm assumes that the first fraction has to be multiplied by the reciprocal of the second fraction. The student can obtain this result by using a calculator. However, in the absence of a calculator, the student may learn and remember this rule, or employ other approaches to doing fractions, if a problem of this nature is to be successfully solved. The constructivist learning theory is salient, but students cannot be innovative if they have nothing stored in their memory. Committing basic mathematical algorithms and rules to memory facilitates the speed with which some problems can be solved and helps students know the right formulas to use for a question when students are provided with a formula sheet. Practice-to-mastery remains an important way of fully understanding and applying mathematical algorithms (E.g., Covington, 2000). By using the same formulas repeatedly, students become familiar with them and can recall them with ease. Therefore, memorisation may be a consequence of familiarity with concepts rather than attempts at rote learning.

### 5.3.3 Teachers' expectations

Some participants found teachers' expectations empowering, motivating, providing a target, and conveying an interest on student well-being and achievement. Teacher expectations were expressed in terms of concrete achievement targets that participants were expected to strive for. This materialised in the courses teachers recommended for students and in the grades they were asked to aspire for at the beginning of the year or at the commencement of a module/achievement standard. Where these practices were in operation, teachers' expectations were seen by participants to be realistic as they concluded that teachers knew each student's level and capability in the subject and in different standards. This finding is corroborated by the findings of Covington (2000), who stated that teacher expectations may be self-efficacy enhancing when they are customised to reflect the students' mathematical skills, learning ability, and readiness to exert the effort required to realise these expectations.

Therefore, according to some participants, if the teacher suggested to them to enter for a particular mathematics standard or to aim for a specified grade in a standard, they saw it as an expression of confidence by the teacher on their ability to pursue that course or attain the recommended grade in the specified standard. This provided participants who had this experience with the self-belief and determination to strive to attain the teacher's expectation as they regarded lack of effort to equal letting themselves down and disappointing the teacher. This finding appears to be supported by a study conducted by Alvidrez and Weinstein (1999). The study was a longitudinal study spanning 25 years on early teacher assessment of pre-school children's intelligence and their performance in secondary school. They found that judgements made by teachers were relatively correct 14 years later, with these expectations being more accurate for children from low socioeconomic backgrounds and less accurate for children from high socioeconomic backgrounds. Hinnant, O'Brien, and Ghazarian (2009) added that teachers' assessment of boys' mathematics performance in year one was predictive of their mathematics performance in year 5; with an overestimation of their performance in comparison to their actual test result producing an enhanced later performance, while an under-assessment of their performance compared to their actual test score resulting in a reduced performance in later years. They further concluded that boys from minority background experienced low performance when their ability was underestimated and

showed greater achievement when their ability was over appraised. In addition, they suggested that these results appear to be permanent. Jussim and Harber (2005) agreed that teacher expectations may forecast student achievement because teacher expectations appear to be relatively accurate. However, they said that there is insufficient evidence to suggest that teacher expectancies accumulate and perpetuate in the long term.

Teachers' expectations to aim for a grade were also seen by participants as providing them a goal to aim for. This provided them with a focus, a direction, and a challenge. Many worked hard to realise these goals. If the goals were not realised, they had the confidence that they did their best to attempt to reach the target. Setting mutually agreed goals for achievement enhanced beneficial interaction between the teacher and the student and contributed to a relationship of trust between them (E.g.,Averill, 2009; Darling-Hammond, 2000). It also conveyed the teacher's interest in the student as an individual and in the student's achievement. Once a goal was agreed, it placed a duty on the teacher to work with the student to ensure that the goal was attained. Teacher expectations in this case became tools that conferred mutual obligations on the teacher and the student to collaboratively strive to enhance students' outcomes.

Three participants observed that mathematics teachers appeared to be more interested in students who performed well in mathematics than the students who did not do well in mathematics. They saw mathematics teachers as placing expectations on students who did well in mathematics and working with them to ensure they did even better while neglecting those who did not display an aptitude for mathematics. Some of the participants who were not good in mathematics saw this behaviour as a negative expectancy. According to one participant, students who were not good in mathematics accepted this negative expectancy and were resigned to let it be. Weinstein, Gregory and Strambler (2004) in a United States study reported that when African-American students along with other minority groups were aware of negative expectancies about their test performance, their result was influenced by that expectation. Similarly, Steele and Aronson (1995) concluded that the fear that African-Americans were adjudged to underperform in standardised tests compared to other ethnic groups, induced anxiety in them when confronted with these tests. Accordingly, they acted to validate the perception attached to their performance. Similarly, Rubie-Davies, Hattie, and Hamilton

(2006) in a study of teachers' expectations about the reading achievement of 540 primary school students in Auckland, New Zealand, found teachers expectancies to be relatively correct for European and Maori students but overestimated for Pasifica students. They also found that teachers' expectancies were influenced by children's ethnic background and other stereotypical factors, such as, socioeconomic status and children's classroom behaviour.

Teachers' expectations are based on teachers' perceptions of students' abilities, student prior performance, and students' performance in diagnostic and summative assessments. A communication of those expectations may influence students' achievement and impact on their attitudes to mathematics. Many participants in this study associated lack of teacher expectations with lack of care or even regarded it as a negative expectancy.

## 5.4 Influences of school practices

Some participants stated that they may have been influenced to work hard in their subjects and achieve to the best of their abilities by incentive schemes operative in their schools, the expression of overt expectations by their school leaders, pride they felt for their schools, and by classroom placement practices existent in their schools. All participants got a perception that school leaders were interested in their achievement and that school policies and practices were geared toward enhancing their academic performance. However, different participants had differing experiences with some of their school practices.

### 5.4.1 Incentive schemes

Participants that attended schools that had generally known and advertised incentive schemes were positively influenced by these schemes. One of the schemes in operation in some of the schools attended by participants is the incentive of additional days of holidays at the end of the year based on students' performances in their subjects during the year. To be eligible for days off at the end of the year, students ought to have earned grades of 90% and above in their different subjects. This scheme was limited to students in years 9 to 11 and was cited by two participants who did their secondary education outside New Zealand. These participants said they were motivated by the prospect of

having extra days off at the end of the year to work hard in their subjects during the year. In addition, it conferred an aura of competence on awardees of this scheme as they were marked out as the top achieving students in those year levels. Therefore, once a student had received this award in one year, there was an expectation that the student would continue to work hard to maintain the level of achievement that brought him/her the award in the previous year. A failure to maintain the same level of performance would convey the impression that the student had slackened off, was not sufficiently bright as the previous year's results showed, or was not capable of the current year's level of work. As a consequence, the scheme provided a fillip for those who had won the award to continue to work hard in order to maintain and improve on the performance that brought them the award.

Celebrations of students' achievements in sports or academic subjects and competitions were cited by some participants as providing incentives to strive to do their best in their studies and other endeavours. One participant mentioned that when students were called out in the assembly and honoured, he found it encouraging and it made him to aim to have the opportunity to be publically recognised someday. In this study, incentive schemes that were open and known to all students were found to motivate students that were interested in achievement and that wanted to work to achieve to the best of their ability (E.g., Pariso, 1991).

### 5.4.2 School culture and climate

This study's participants were generally proud of the schools they attended. They saw the reputation of their schools as motivating them to work hard to do well in their studies because in their final examinations, they did not want to perform poorer than their erstwhile school friends who attended schools that were less reputable than their schools. Pariso (1991), the principal of a school in Florida, amongst other things, cited his school's reputation as enhancing students' motivation, self-belief, and academic achievement. Similarly, Fowler and Walberg (1991) concluded; "students who are dissatisfied, who do not participate in school activities, who are chronically absent and who do not identify with the school will achieve less, whether on achievement tests or on post schooling outcomes" (P. 200).

The findings of this study are also buttressed by those of Sherblom, Marshall, and Sherblom, (2006) who claim that students show connectedness to schools that create a climate and culture of student achievement. They said in such schools, there is collaboration and communication between school leaders and staff, staff and students, and staff and parents. In effective schools, stakeholders know their roles and students know, accept, and are involved in realising the most important reason for the school's existence, which is to foster student learning and achievement.

Participants also appeared to have been influenced to work for success by the declared expectations of their school leaders. One participant said he reassessed his value for education and his priorities after he heard his school principal tell all students in the assembly that success in their studies was the most important priority they needed to possess, cultivate, and pursue. This principal applauded students who were good in sports but added that to complement their sporting talent, they needed to record concrete achievement in their subjects as sports could be played for a limited time and people still needed to pursue some revenue earning activities after a career in sports. In this context, messages of affirmation and inspiration from school leaders became motivating influences and provided references for re-evaluation of students' activities and priorities

### 5.4.3 Class assignment practices

School practices that assigned the same mathematics teacher to a group of students for multiple years were cited as beneficial by some participants. Participants expressed satisfaction with this practice because it gave them time to understand the teacher and the teacher understood their learning style and tried to adjust the lessons to suit the learning style of the students. Being familiar with the students also meant the teacher could work with individual students more realistically and set goals that better reflected each student's ability and preparedness to achieve in a standard (E.g., Opdenakker & Van Damme, 2006; Covington, 2000). It also enhanced parent-teacher interaction and liaison, enabling teachers to know the children's parents better and deciding the best advice to give to parents for the enhancement of their children's outcomes. The disadvantage of this system is that students that did not like a teacher's approach and teaching style would be stuck with the same teacher for more than one year and this could have very adverse motivational effects on students with concomitant

consequences for their achievement in, and attitude to mathematics (E.g., Averill, 2009).

In this studies, most participants attended schools where students were streamed or placed in classes based on their performances in mathematics and English. This created classes with an aggregation of the best students at one year level being placed in the same class. Classes were therefore a reflection of students' academic ability. Some participants expressed satisfaction with the experiences they had in their classes while other participants were not too pleased with their experiences.

Students in the top stream class in schools that practiced streaming saw themselves as the cream of the students. The top classes very often got the best teachers, resources, and there was an expectation that the students should obtain top grades in their examinations. These students became epitomes of the academic reputation of the school. As it very often happened, student leaders were selected from the top stream class. One of the participants in this study, Wiseman, said their top stream class was called the professional class. There were explicit expectations on students in this class. They were all expected to become professionals. This meant they were expected to go to the university and pursue studies in the professions, popularly considered medicine, engineering, accountancy, or something in the sciences. In addition, Wiseman said that students in this class were expected to be model students in upholding school rules and regulations as exemplified by their dress, attitude and classroom behaviour. He stated further that he was in the same class with the same peers for seven years. The implication was that the students knew themselves well, formed very close-knit study groups and friendships, and supported themselves to succeed in their studies (E.g., Gamoran, 1992, 1987). Wiseman added that he has maintained a close relationship with many of the people he studied with more than 40 years ago because they spent many years together in the same class.

The finding above agree with those of Lamb and Fullarton (2002), who stated that streaming/tracking practices produce significantly high achievement rewards for students in top streams and minimal outcomes for students in low streams. Liu, Wang, and Parkins, (2005) also reached a similar conclusion. They cited statistics that showed streaming had improved secondary school completion rate in Singapore. They added that the negative reputational effects of being in a lower stream class were temporary.

They also concluded that the ability self-concept of all students declined with the passage of time, with that of students in high-ability streams falling much more than that of students in lower-ability streams. On the contrary, Slavin (1990), found that overall, streaming has negligible effects on student achievement. However, he stated that when controls were instituted for student ability level, socioeconomic status and other individual variables, placement in a high stream class increased achievement while placement in a low stream class diminished achievement.

Considering the experience of Hayley, one participant who was in a top stream class, not all students in the top stream class reap the same level of benefit in all subjects, from being with peers considered to be high-ability students. As students were streamed based on the aggregate of their test results, Hayley got into the top stream class with her excellent performance in other subjects making up for her weaknesses in mathematics. Students in this class were subjected to the same information and pace of instruction with the supposition that they were bright students and as a result, they were good in all subjects. In addition, the top stream classes were often given work in mathematics and some other subjects, at levels higher than their chronological age. Additionally, support services and structures established to assist students in lower stream classes were not often extended to students in the top streams. Consequently, students whose ability in mathematics was below that of their year level, struggled to cope with work that was even beyond that year level. The effect was that these students became disenchanted, struggled to perform in mathematics, and developed a negative attitude toward the subject. As noted by Hayley who had this experience, her weakness in mathematics affected her confidence in the subject, caused her anxiety whenever she confronted mathematics problems, and led her to drop mathematics at the end of her second year in high school. One of the disadvantages of streaming as shown by this experience is that the assumption that all students in the same stream should work at approximately the same level in all subjects may be inaccurate.

Two other participants in this study, Duke and Chelsey, who were in lower stream classes said that they had negative experiences as a result of having peers in their streams who were not interested in studying mathematics similar to findings by Ding and Lehrer (2007). These participants stated that many students in their classes came to the mathematics class because they were required to be present in class during the

period. Secondly, due to the stream they were placed, they claimed that many of their peers considered themselves to be incapable of being successful in mathematics. Consequently, these students did everything to avoid learning the subject in tune with findings made by Berends (1995) and Boaler, William, and Brown, (2000). Lastly, Duke observed that many of these students, including him, had concluded that they were not going to do anything in future that would involve mathematics. As a result, they did not find it relevant to study mathematics for any reason. The upshot was that these students were disruptive whenever they had mathematics. They did not only hamper their own learning of mathematics, but they made it difficult for the teacher to teach the class and they took active steps to prevent other students who were interested in learning mathematics from doing so. They accomplished this distractive scheme by jeering other students whenever they attempted to ask questions. Participants who had these experiences said they were humiliated because whenever they attempted to ask the teacher a question, they were shouted down, called dullards and told to put their hands down. The actions of these disruptive peers affected these participants' ability to engage with the learning of mathematics. Many researchers have found that negative peer pressure prevents students from developing achievement enhancing attributes and forming beliefs, qualities and behaviours that promote competence and a positive attitude to mathematic (E.g., Carbonaro, 2005; Stewart, 2008).

## 5.5 Influences of individual characteristics

As will be subsequently discussed, early exposure to numeracy and mathematical activities appear insufficient to guarantee high performance in mathematics as students move to higher grades. Beyond the elementary grades, it seems that the students own motivation for success, learnt coping strategies, ability to persist on learning tasks, and their self-efficacy beliefs, all play an important role in helping students to work to attain a level of performance consistent with their parents' expectations. Studies by different researchers have also made such conclusions (E.g., Middleton & Spanias, 1999; Murphy & Alexander, 2000; Van Petegem, Aelterman, Van Keer, & Rosseel, 2008). Participants in this study that were consistent high achievers in mathematics stated that they were intrinsically motivated to succeed. Intrinsic motivation has variously been defined as engaging in a task for the love of it, learning for the love of knowledge, and

discovering new facts for the sake of keeping oneself informed (Middleton & Spanias, 1999; Mcleod, 1988). In this regard, one participant, Wiseman, stated that he was an enthusiastic learner and an avid reader. He enjoyed learning about topics new to him. Therefore, any new topics in mathematics presented opportunities for him to engage in new discoveries.

Two other participants said they were intrinsically motivated to do well in mathematics because they enjoyed the subject and had a strong motivation to do well in their studies. The views expressed by these participants fit with research on the issue of intrinsic motivation. Writing on this topic, Middleton and Spanias (1999) stated that intrinsically motivated students were more willing to experiment with new concepts, problem solving strategies, and spend a longer time on tasks in order to reach a solution. They were also more likely to attempt a range of different questions; examine their understanding of the concepts in which they were engaged, and were more likely to complete tasks in the absence of an external incentive (E.g., Houser & Frymier, 2009; House, 2002). Accordingly, two participants in this study said they internalised the mathematical concepts they learnt and made the concepts real by applying them to maximising their performance in sports. They said they related the things they learnt in mathematics to the best way to hit a golf ball, or the most efficient way to shoot a free kick in football from outside the 18-yard box and optimise the probability of scoring a goal. To study mathematics in this way, the student may have to be strongly interested, committed, and determined about doing well in the subject. Studies by Berliner (2004); and Ross, Rolheiser, and Hogaboam-Gray (2002), also found that intrinsically motivated students have individual achievement goals and possess an internal drive for success.

Intrinsic motivation is also thought to enhance a students' self-confidence toward mathematics (Middleton & Spanias, 1999; Schiefele, & Csikszentmihalyi, 1995; Van Petegem et al., 2008). One participant said he was confident in his mathematics ability. He liked the subject and enjoyed the way it made him think. Consequently, he was satisfied to go home and work on his mathematics in the evenings after school. Similarly, Grootenboer and Hemmings (2007), and Gonzalez and Wolters (2006), stated that students will engage in tasks if they have the assurance that they will be successful in them. Participants in this study indicated that the higher the level of the achievement they experienced in a task the higher their self-efficacy beliefs on the activity and the higher will be their achievement in it. Furthermore, Middleton and Spanias (1999)

suggested that students that possess the conviction they would be successful in mathematics will develop a positive attitude toward the subject.

Schiefele and Csikszentmihalyi (1995) identified motivation and ability as factors that enhance students' mathematical experiences and achievement. They found that interest and intrinsic motivation in mathematics foretold the quality of the experiences students had in their mathematics classes. While interest contributed somewhat to achievement, they suggested that mathematical ability was much more connected with achievement. The participants who asserted they had good experiences in mathematics also said they were very interested in the subject. One participant said he took extra mathematics classes to booster his performance and another said he did more work with his teachers in years 12 and 13 to ensure he was on track to achieving to his target.

Another feature of individual characteristics that appeared to have abetted some participants' achievement and attitudes to mathematics was external motivation for success. One of the participants in this study was determined to go to medical school and he knew he had to do well in mathematics to realise this objective. Consequently, he devoted extra time to mathematics in order to earn the grades he needed. Another participant was determined to maintain his status as one of the best mathematics students in his school. In addition, he was aware of his father's wish for him to aspire to pursue tertiary studies in the sciences. As a result, he said he had reasons to work hard to maintain a high performance in mathematics. Similarly, a third participant said he was identified early as a gifted student. At secondary school, he was placed in the top class. Members of this class were expected to work to attain university entrance. Furthermore, he had been informed at a young age by his parents, that being the youngest child of the family, he would be expected to be the first member of the family that went to university. These goals offered strong incentives for him to strive to maintain a high level of achievement in mathematics. The findings above are supported by studies by Middleton and Spanias, (1999), on the effect of attitudes and external motivation on student success.

Furthermore, Wilkins and Ma (2003) stated that students' career aspirations influence the attitudes they hold toward mathematics. They found that learners that intend to pursue tertiary studies that involved a strong mathematics requirement, would show more devotion to mathematics. In this study, participants that exhibited high self-efficacy toward mathematics were able to approach their difficulties with the confidence

that if they worked hard they would be able to overcome them. However, participants that exhibited low confidence in their mathematics ability easily abandoned looking for a solution to their problems when they encountered difficulties in the subject.

Middleton and Spanias (1999) posit that motivational beliefs are uniquely applied by students by the time they get to the latter years of secondary school. At this stage, intrinsic motivation combines with goal mastery to work toward the achievement of some extrinsic achievement objectives. Wiseman and Boyce, two participants in this study described above may have been unconcerned by career motives in their early secondary school years. However, as they approached the final years of secondary school, they became more conscious of their career aspirations and of career suggestions they had been given by their parents. Once these goals were adopted as targets they needed to attain, they were individually motivated to reach these goals. Consequently, they individually initiated actions that facilitated the attainment of these objectives. For one participant, this required taking extra mathematics classes after school, with his mathematics teachers for 3 years and committing several hours to practicing past examination papers. For another, it entailed working with his mathematics teachers in the last two years of secondary school to maintain the level of mathematical achievement he was accustomed to achieving and that he needed to qualify for university entrance.

Attribution styles (reasons given by participants for success or failure) (Gresham, 2009; Nokelainen, Tirri, & Merenti-Välimäki, 2007)) appeared to have been important influences on participants' attitudes to mathematics in this study. Participants who expressed interest in, and claimed they had a positive attitude to mathematics, seemed to believe in their ability in mathematics. Two participants stated that mathematics was easy for them. Two others said that they were the best mathematics students in their schools. These participants attributed their success in mathematics to ability and effort. Several studies have found that students that see the reasons for their success in mathematics as being ability and effort, variables that can be controlled and altered by the individual, attain success in mathematics (E.g. Dweck & Master, 2008; Eccles & Wigfield, 2002; Murphy & Alexander, 2000; Wentzel, 1999; Shen, 2002; Wentzel & Wigfield, 1998).

On the contrary, participants who said they did not have a positive attitude to mathematics and who were not successful in the subject mainly attributed their lack of

success in the subject to lacking confidence in their mathematics abilities. They also saw the reasons for their lack of success in mathematics as being the teacher's inability to explain, the teacher often proceeding too quickly from one topic to another, and the teacher not spending time with them individually to explain concepts to them. Two participants stated that they were placed in classes comprised of disruptive peers whose actions hindered their ability to engage with the learning of mathematics. Dweck and Master (2008), state that learners that blame external sources for their lack of success often see ability as inborn and uncontrollable. These types of learners are likely to attribute their success to luck and not effort. Bandalos, Yates, and Thorndike-Christ (1995), added that learners that ascribe their performance to external factors often display low confidence in mathematics and are susceptible to test anxiety. Consequently, participants that displayed these attribution patterns were prone to avoid doing work in mathematics, lacked the courage to persist on mathematical tasks, and did not usually attempt new or complex mathematics activities (E.g., Covington, 2000; Singh, Granville, & Dika, 2002).

However, it must be observed that it is uncertain if participants' attribution styles in mathematics were predisposed by their performance in the subject or their attribution styles influenced their performance in the subject. However, considering that most of these participants were competent performers in other subjects, it appears that the latter reason accounts for their pattern of attribution in mathematics. In addition, attribution patterns appeared to have been subject-specific and gender neutral. Participants seemed to have separated self-efficacy beliefs in mathematics from their ability concepts in other subjects.

## 5.6 Influences of peers

Participants stated that they were influenced by peers in terms of their achievement and attitudes toward mathematics. However, the nature of the influence appeared to be both positive and negative. Some participants indicated that they socialised with peers who shared their attitudes to mathematics. Other participants said that they associated with peers that shared varying attitudes to mathematics. Participants in this category who were good in mathematics enhanced their mathematics potential by collaborative mathematical work with like-minded peers. They also served as tutors to peers in their circle of friends that were weak in mathematics, but their attitudes to mathematics were

not negatively influenced by the attitudes of the weaker peers with whom they associated. It seems that academically inclined participants confined themselves to classmates that shared their academic orientation. This view agrees with Chen, Chang, and He (2003), who argued that common interests and aspirations form the basis for the constitution of peer groups. They suggested further that social groups have unwritten rules and group members may not entertain people who are likely to engage in activities that detracted from the image the group desired to portray.

One participant said he belonged to a group of boys who were geared by academic performance. Though some members of the group performed better than other members, they worked together and supported each other to improve the weaker members' performance in mathematics. Two other participants shared similar experiences. They stated that they shared resources with their peers, did mathematics problems with them, and explained concepts and received instruction from their peers.

Continuing on the value of peers, another participant, Granette, said that she sometimes found the explanations of her peers clearer than those of her teachers. This is understandable as communication may be a generational variable and peers' choice of words and style may appeal more to their peers than the words used by a teacher who may be years apart from a student. Generally, participants who claimed they had a positive attitude to mathematics reported that they had peers that were supportive, encouraging, and that positively influenced their attitudes to mathematics. A study by Whitmore (2005) on the effect of peers, found that there is a positive spill-over effect for a student in a class with competent mathematics students. The influence of peers is likely to encourage that student towards improved achievement in, and cultivation of a positive attitude to mathematics.

This point is, however, contradicted by the experience of Hayley, one of the participants in this study. Hayley was in the top stream class with many competent mathematics students. According to her, many of her classmates were excellent mathematics students who later went on to pursue careers in engineering, physics, medicine and other science fields. However, because results were publicly announced at the end of the term and students strove to outperform their peers, there was little sharing and collaborative learning groups among the students. Consequently, a student like Hayley who was weak

in mathematics said she found her weakness in the subject humiliating, and this further eroded her confidence in it. However, Hoxby (2002) and McEwan (2003), who carried out separate studies on peer effects, found that if other influences on student achievement are controlled, the influence of peers on achievement is minimal and affects different students to different degrees.

Two other participants stated they had peers that negatively influenced their attitudes to mathematics. These participants were in classes where most of the students in the class showed a bad attitude to mathematics. In addition to being disruptive, these participants said they could not ask questions in class because of the intimidating behaviour of their peers. They had peers that called them names, humiliated them and asked them to put down their hands whenever they tried to ask their teachers questions during the mathematics class. The uncooperative, disrespectful, and inconsiderate behaviour of peers appears to have negatively impacted on these participants ability to engage in the mathematics class. Consequently, they said they developed a negative attitude toward the subject. These findings concur with those of related studies conducted by Brown and Evans (2002); Chen, Chang and He (2003); Hoxby (2000), and McEwan (2003).

## 5.7 Influences relating to parents

Parents may play a pivotal role in their children's learning. In this study, the value parents attached to mathematics and their career wishes for their children, coupled with parents' level of education and their expectations for their children's success, appeared to have influenced participants' achievement in and attitudes to mathematics. These themes are given further consideration in the pages that follow.

### 5.7.1 Parents' value for education and career aspirations for children

In this study, the esteem with which parents held mathematical knowledge, irrespective of their level of education, seemed to have been an influence on the attitudes of many participants to mathematic. When parents valued the knowledge of mathematics and communicated that message to participants in this study, they appeared to have held the

learning of mathematics equally in high regard. Participants who received overt messages about the importance of mathematics observed they had to learn the subject because their parents clearly told them that it was an important subject that they needed to learn if they were to be successful people. These conclusions are in concord with the findings of writers in this area (E.g., Eccles, 2005; Peressini, 1998; Porfeli, Wang, Audette, McColl, & Algozzine, 2009; Reusser, 2000; Rogers, Theule, Ryan, Adams, & Keating, 2009; Schunn, & Reder, 2001). Trivette and Anderson (1995) concluded that one way parents show that they value mathematics is the effort they make to provide their children with relevant mathematical learning materials and a convenient learning environment. They stress that it is through the home that children learn the 'hidden curriculum' that they must master if they are to be successful learners. Furthermore, Davis-Kean (2005) suggests that a quality and comfortable home environment abets healthy growth and promotes the development of good mathematical skills.

Eccles, Adler, and Kaczala, (1982) and Haveman and Wolfe, (1995) found that the attitudes modelled by parents have influences on children's choices. Participants who were told by their parents that mathematical knowledge was one of the least skills they needed to do well in life, did not regard mathematics knowledge highly. Consequently, they did not commit time and effort to the studying of mathematics. As shown in my findings, children will focus their attention on the areas of their parents' priorities. In addition, if parents tell their children that they (the parents) were very poor and hopeless in mathematics and that the children did not necessary require a good knowledge of mathematics to pursue successful careers (which is true in many cases), the children are not going to take mathematics knowledge seriously. Sirin (2005); Wiggan (2007); and Wilkins and Ma (2003), in separate studies also found that children will model the preferences of their parents and lean toward careers of their parents' interest.

Indeed, they can give a ready alibi; 'our family is not good at mathematics. We've never been a family of mathematicians. Therefore, don't attempt an impossible task by trying to make a mathematician out of me". Yates (2009) classifies attitudes like these as 'learned helplessness in mathematics'. These types of attitude erode the confidence of the learner, prevent him or her from approaching mathematics with rationality and calm, and limit the amount of time and resources the learner commits to the learning of mathematics. It is in many ways an acceptance of failure before the student has actually

engaged in the learning task (E.g., Porfeli, Wang, Audette, McColl, & Algozzine, 2009; Wilkins & Ma, 2003; Wong, 1992).

Similarly, if parents believe that mathematics does not comprise part of their career goals for their children, they will not devote time and resources to enhance their children's mastery of mathematical knowledge and skills. In this study, a participant stated that it did not occur to her that she should seek remedial help in mathematics despite the evidence that her performance in mathematics was below her performance in English. However, her mother got her a private tutor to enhance her performance in English, a subject in which she was already doing well. She attributed the reason for this to her parents' interest that she did well in the area of their priority and in the line of career they intended for her. Hayley's parents assumed she would do something in the arts; consequently, they were prepared and eager to encourage her to gain the skills necessary for her to be successful in this area.

In relation to the findings above, Haveman and Wolfe (1995) also found that parental resource allocation and 'commitment to learning' is influenced by parents' beliefs. Consequently, if parents believe that mathematical knowledge is important and relevant to their children's future career aspirations, they will do the utmost within their capability to expose their children to rich and diverse mathematical experiences. In addition, they will provide their children with ongoing support and encouragement to acquire the mathematical knowledge they deem necessary.

Parental socialisation orientations also influence the development of children's own motivation for mathematical achievement (Eccles, Adler, & Kaczala, 1982; Stevenson, & Stigler, 1992). If children see their parents involved in mathematics related activities, they will observe and imbibe these practices as cultural norms. When parents inquire from their children the topics they covered in mathematics every time they return from school, they will be conveying messages of interest and concern to the children. Trivette and Anderson, (1995), found that the parents of high performing students communicate with their children about their school work always and give them advice and different tactics for solving problems. By asking the children about their school work, parents make it easy for their children to communicate with them and inform them of any difficulties they may be having in mathematics. This point was underscored by a participant who stated that an involvement and encouragement about his performance

from his parents would have spurred him to reach greater heights in his mathematics achievement.

The same emphasis was made by another participant who, each time she made progress in her mathematics class, she eagerly reported her achievement to her parents. However, when the parents did not appear to be concerned about her mathematical performance, she felt disappointed and discouraged. The foregoing analysis underscores the importance of parents making their children aware that they value mathematics. Regular communication with, and inquiry from their children, about their school work and any homework tasks or activities they might have been assigned, are important statements of parental interest in their children's academic and mathematical progress. In this regard, Vispoel and Austin (1995), and Yates (2009) also found that emotional support from parents, displayed by way of interest in students' school work and activities, abets students' engagement and achievement. Finally, they should provide assistance to their children with any difficulties they may have in mathematics by giving them advice and offering problem solving strategies if they are capable of doing so or alternatively, looking for and suggesting sources of help, to the best of their abilities, as some participants in this study, benefitted immensely from parental assistance.

### 5.7.2 Parents' education

In this study, all but one of the participants with educated parents claimed they had a positive attitude to mathematics. This finding is in agreement with the findings of other studies in this field (E.g., Cooper, Crosnoe, Suizzo & Pituch, 2010; Crane, 1996; Eamon, 2002; Trivette & Anderson, 1995; Tsui, 2005) that found children of educated parents often have a high regard for education.. Educated parents appear to understand and appreciate the importance of mathematics as a subject. As a consequence, they communicate the importance of acquiring a good knowledge of mathematics to their children (Epstein, 1995). Participants in this study with university educated parents claimed they were exposed to mathematical and other cognitively stimulating resources from a very early age. In addition, some participants said they received ongoing support and assistance with their mathematics homework from their parents or older siblings.

According to Davis-Kean (2005), parents' education determines their beliefs and attitudes and these have impacts on their children. Numerous studies have considered

the connection between education and income and concluded that in many countries, people with high levels of education have higher incomes than less educated people in many areas of work (Crane, 1996; Eamon, 2002; Eccles, 2005; Haveman & Wolfe, 1995; Schiller et al., 2002; Tsui, 2005). This enables them to be able to procure for their children the materials they require to develop the mathematical knowledge they desire. In addition, educated parents have gone through the school system. They may therefore be aware of the resources and sources of assistance their children may need to be successful in mathematics (Porfeli et al., 2009). They are also able to provide advice on problem solving strategies and in some cases, instruct and help their children to master different curriculum areas (Tsui, 2005). Consequently, educated parents may impart to their children social and cultural capital that are suited to the development of mathematical competence (Boehm & Schlottman, 1999).

In this study, two of the participants had parents who were teachers and two had parents that were engineers. These four participants reported different ways that their parents supported the development of their mathematics skills. One participant said his father told him from a very early age that mathematics was a very important subject that he must strive to master. Therefore, as a student in the boarding school, when he started finding aspects of mathematics difficult, he had no hesitation to take remedial classes in order to maintain and improve on his mathematics performance. Another participant stated that his father was his best mathematics teacher. He asserted that his father understood his learning style and he was happy to return home and receive further instruction and help with any difficulties he may have in mathematics. These experiences were also common with participants who had parents or older siblings that were capable of giving them assistance with their mathematics work.

These views concur with those of Lareau and Horvat (1999), and Lee and Bowen (2006), who said educated parents possess the social networks and cultural endowments that enable them to more effectively work for the academic success of their children. They say educated parents are more likely to be involved with their children's education both at home and at the school level. They attend school meetings, may be engaged in flexible jobs that allow them to volunteer for school activities, and are more likely, as a result of these contacts, to learn new skills and sources of assistance that will help them to promote the academic success of their children. On the contrary, uneducated parents are more reluctant to be involved with their children's schools because they do not understand the role they should play in their children's learning. They may also be

reluctant to be involved with their children's schools because they lack the confidence to interact with their children's teachers (Feuerstein, 2000). Some parents, from negative school experiences, do not feel they belong to, and are uncomfortable with the school environment (Ozturk & Singh, 2006). Consequently, they lack knowledge of the resources available, the nature of the difficulties their children may have in mathematics, the type of assistance their children may require, and the existing sources of help suitable for their children's difficulties (Coleman, 1988; DiMaggio, 1982). These were the experiences of Duke and Chelsey, two participants in this study, who said their parents took no active interest in their school progress, took no steps to enhance their mathematical knowledge either because they lacked the skills to assist them, had little regard for mathematical knowledge, or had less value for education in general.

Davies-Kean (2005) added that educated parents pass on genes to their children that endow them with good learning traits. This is thought to be more significant when children have mothers that are educated. Educated mothers particularly affect their children's learning ability by creating an enabling learning environment in the home and establishing a communication pattern that enhances children's cognitive development. McEwan (2003), in a study of Chilean year 9 students, found that the mean level of mothers' education predicted the mathematics achievement of students in a class. Furthermore, Maloney (2004), in a New Zealand study, reported that the number of children expected to attend university increases with the level of the parents' education. In this study, participants that had university educated parents indicated it was expected they would attend university.

Schiller, Khmelkov, and Wang, (2002), found that educated parents provide better learning spaces for their children because they have more income to buy better houses. In addition, many educated parents are able to afford private education for their children and tailor their children to more rewarding careers. The ones that are unable to afford private education use their knowledge of the school system to get their children into gifted programs or suggest that their children be placed in the classes of highly reputable teachers in the public school system. In these scenarios, the children's learning potentials will be enhanced, including the possibility to acquire good mathematics skills and as a result, form positive attitudes to mathematics.

Finally, parents may attempt to help their children in ways the children deem unacceptable. Dave, one of the participants in this study whose father was a teacher narrated the difficulties he had with fractions when he was in school. He traced it to an experience he had with his father. His father was attempting to teach him fractions. However, his father's instructional approach was too forceful for him. The upshot was that he developed a negative attitude towards that topic that lasted well into his secondary school years. This is how Dave presented this experience in response to a question on areas of mathematics he did not like in secondary school.

> I found fraction ... an area I had to work a little bit more at. I don't know what it was, but there was something there; I think I know what it was. It had something to do with home. It had something to do with my dad. It was something I had asked him and he tried to teach me but he taught me in a manner that was very...; and I didn't respond to it. I shut down and then all through those years, it became very grey. A block came in but ... just one day the penny dropped. Yes, that was an area I had a lot of trouble with.

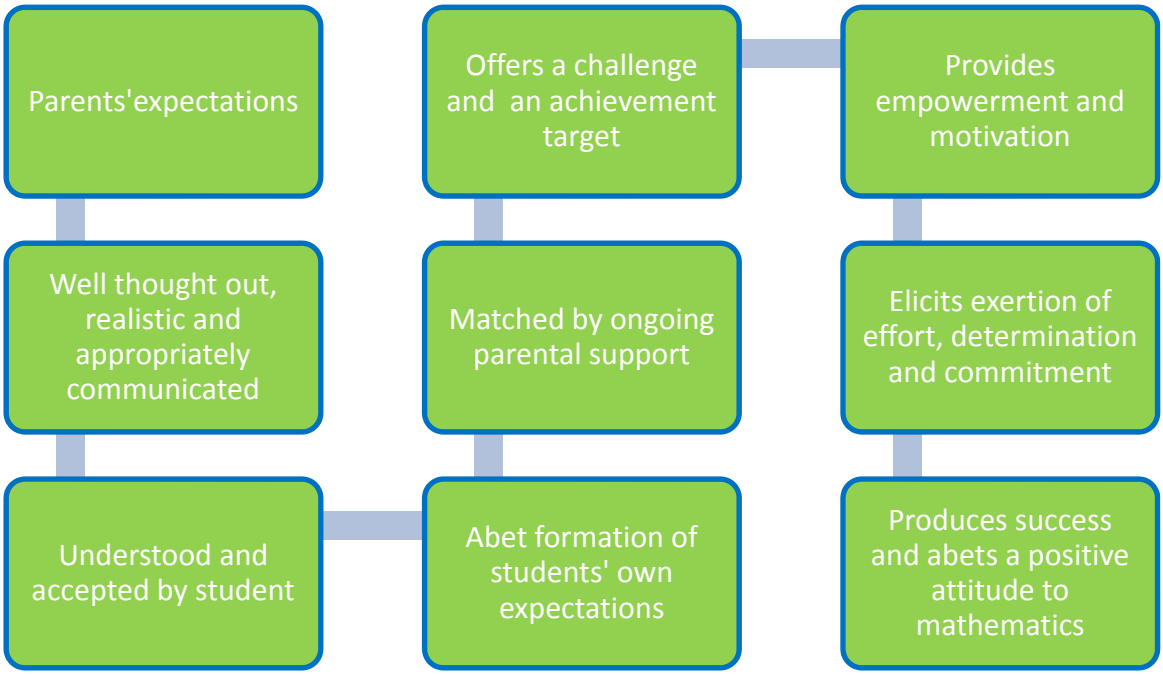
The point is that educated parents in trying to help their children may adopt an instructional tone, style, and mannerism that may be at variance with the ones to which the children are accustomed (Eg., Stinson, 2006; Visser, 1987). Consequently, parents' instructional practices instead of facilitating children's learning may become obstacles to the learning of the mathematical concepts they intended to teach (E.g., Peressini, 1998).

### 5.7.3 Parents' expectations

Parents expectations appear to be correlated with student achievement in and attitudes to mathematics in this study. Participants asserted that they found their parents' expectations motivating, empowering, and focusing. In addition, some asserted that their parents' expectations provided a base on which they built their own expectations. High but realistic expectations offered participants a challenge and a target that they strove to attain. Parents that communicated their expectations to their children were found to have been involved in their learning. They were also found to have provided ongoing support and encouragement to ensure their children achieved to the level of their expectations. Various studies on the influence of parental expectations on children's learning and mathematics competence support the views expressed above. (E.g., Davis-Kean, 2005; Goldenberg, Gallimore, Reese, & Garnier, 2001; Gonzalez, &

Wolters, 2006; Ji & Koblinsky, 2009; Lee & Bowen, 2006; Maloney, 2004; Marx & Roman, 2002; Muller, 1998; Neuenschwander et al., 2007; Pomerantz & Eaton, 2001; Stevenson, & Stigler, 1992; Sy & Schulenberg, 2005). Figure 3 below attempts to suggest a process through which parents' expectations may influence children's mathematical success. Parental expectations that were wisely constructed, communicated, and accepted by participants appeared to have acted as goals that they strove to attain. Ongoing support and encouragement by parents also led affected participants to form their own goals from their parents' expectations. This had an empowering influence on them as they worked willingly and enthusiastically towards the attainment of these expectations that they had adopted as their own expectations. It is understood that the model displayed in figure 3 may differ for different individuals and the steps may be interchangeable. Therefore it should be noted that the emphasis is not on causality but influence of expectations.

**Figure 3. Influences of Parental Expectations**




The findings of this study relating to participants' aspiration to go to university and their parents' expectations are also borne out by a longitudinal study carried out in Christchurch by Maloney. Maloney (2004) found that the expectations of parents were a good predictor of children's achievement. Parents' expectations for their children to go

to university marched increasingly with the expectations of their children between the ages of 13 and 16. He also found that parental expectations for children's performance were higher for the children that attended private schools than those that attended public schools. In addition, expectations to go to university decreased by 6.7% between the ages of 13 and 16 for children from welfare benefit receiving families while it increased by 6.9% for children from non-welfare benefit receiving backgrounds.

In this study, it appears that parental expectations influenced participants' achievement and attitudes to mathematics. Expectations seemed to be important when they were realistic, communicated, understood, and adopted by participants as achievement targets.

## 5.8 Influences of family features and practices

Family features such as the size of the family and parents attitudes to kindergarten attendance were also explored. The conclusions emanating from participants' narratives are discussed below.

### 5.8.1 Family size

Family features, such the number of children in the family, appeared to have had ambivalent effects on participants' achievement and attitudes to mathematics in this study. Participants in this study came from families with a minimum of 4 children. This would be considered a large family by current standards in New Zealand. However, only two participants, who hailed from families of 8 and 11 children, appeared to have alluded to the size of the family as a possible reason for their difficulties with mathematics. One of these participants, Duke, stated that his parents only had basic education and did not possess the skills to teach him mathematics. He also said that his parents told him that communication and listening were more important skills for him to acquire than mathematics. It appears therefore that Duke's attitude to mathematics may have been influenced by other factors than the size of the family. The other participant who came from a large family, Chelsey, also said that education was not given priority in her family, probably due to the size of the family, or as she reminisced, lack of parental interest in her mathematics performance. As a result, it appears too that her difficulties with mathematics may have been influenced by other variables than the size of the family.

Many of my other participants benefited from having older siblings who helped them with their work in mathematics in the absence of their parents. However, many researchers have suggested that a large number of children in a family may have detrimental influences on achievement for several reasons; first, the amount of quality time the parents have to spend with each child will be reduced; second, the financial resources that parents have to spread among the children may be limited; and third, parents' emotional support and intellectual interaction with their children may be reduced (Aldous, 2006; Crane, 1996; Pong, 1997; Tsui, 2005).

From the findings of this study, there is a strong counterargument to the two preceding points. In a family with many children, the first children are often several years older than the last ones. For example, one of the participants in this study, Wiseman, said his first brother was 18 years older than himself. Therefore, by the time he was born, his oldest brother had left school and was no longer reliant on parental resources. This participant also added that one of his older sisters was his mathematics instructor when he was young. Another participant alluded to his older sister returning home to share with him whatever she learnt at school. In addition, books and other cognitively stimulating resources that were bought for the first children, if well maintained, could be passed down to the younger ones. Therefore, family size did not appear to constitute a barrier to learning mathematics in this study. Other factors, such as, parents' level of education, their value for mathematical knowledge, and their earning capacity, amongst others, appeared to have influenced the learning practices they adopted in their families.

### 5.8.2 Preschool numeracy exposure

Kindergarten or preschool attendance and exposure to numeracy and other cognitively stimulating materials appeared to have enhanced participants' performance in mathematics in the first years of primary school in this study. This appears to reflect the findings of other studies in this area (E.g., Lee & Ginsburg 2010; Lee, Ginsburg & Boyd, 2008; LeFevre et al., 2009). Participants who did not attend kindergarten appear to have done well in mathematics in the first years of elementary school too. This could be due to the fact that in early years, assessment in primary school is mainly subjective, based on teacher's assessment of students' ability. This assessment could be influenced by students' likability and behaviour, familiarity of teachers with pupils' parents, and

parents' involvement in school activities (Alvidrez & Weinstein, 1999). In later years of primary school, participants in this study who had attended preschool or kindergarten continued to do well while those who did not attend preschool or kindergarten said they started to experience difficulties in mathematics. It appears that participants who attended kindergarten adjusted more easily to the changing demands of mathematics after the first four years of primary school than those who did not attend kindergarten. The only participant who did not attend kindergarten but performed well in mathematics through primary and secondary school stated that he was exposed to mathematical experiences at home before he went to school. In addition, he said that he hailed from a home where the knowledge of mathematics was valued, actively encouraged, and supported.

The findings of this study are in agreement with previous studies on this topic. Duncan et al. (2007) submitted that the degree of readiness displayed by students at school commencement predicted the level of their future achievement. They included factors such as possessing a basic knowledge of mathematical concepts, being able to listen to and follow instructions, and being able to work independently and work with other kids, as comprising important attributes that contribute to later achievement. They also suggested that the presence of early mathematical skills forecasted future reading skills, but early reading skills did not foretell later mathematical skills. Jordan, Glutting, and Ramineni, (2010) also found that children that possessed an awareness of number sense prior to commencing school recorded good achievement in mathematics in their second and fourth years of primary school. Lee and Ginsburg (2010) stressed that the benefit of kindergarten attendance is that children enhance their awareness of number sense, develop good attention skills, learn to work independently and learn to work with other children.

Lee, Ginsburg and Boyd (2008) added that children learn many mathematically related concepts naturally in the process of growing up. Therefore to harness this mathematical talent, they suggest that children should be exposed to mathematical concepts and activities from a very young age (E.g., Greenes, Ginsburg, & Balfanz, 2004; Geary 2000). Furthermore, Lee and Ginsburg (2010) found that exposure to mathematical activities at kindergarten years is particularly important for children from low socioeconomic backgrounds if they are to acquire satisfactory mathematical skills in later years.

The evidence from this study suggests that while kindergarten attendance assists children's learning of mathematical concepts, this can be mediated by parental practices and individual attributes of the child. Participants who did not attend kindergarten did as well as those who did in the first four years of elementary school mathematics. It is unclear if the benefits of preschool and kindergarten attendance persisted after this time. However, continued high performance in mathematics appeared to have relied on school experiences, parental expectations, the availability of ongoing home support, and the students' own learning motivation. The last point was discussed in the succeeding section. The conclusion above may have been different if a larger and more diverse sample was studied.

## 5.9 Chapter conclusion

In this chapter, I have discussed the influences of success and failure on students' attitudes to mathematics. It was discussed that teachers may influence students' mathematical performance and attitudes through their individual attributes, teaching styles, and expectations. Schools were also arguably, thought to influence students through their practices. Students own motivation for learning may impact on their mathematical performance and attitude to the subject. Finally, it was suggested that parents value for mathematics may influence the way they orientate their children towards the study of the subject. However, some researchers have found little evidence to support this position.

## CHAPTER 6 CONCLUSION



### 6.1 Introduction

The primary research question of this study was; what are some of the factors that influence students' attitudes to mathematics? In pursuit of evidence to help answer this question, eleven participants were drawn from various workplaces to express their views on the factors that influenced their attitudes to mathematics. It was thought that using a semi-structured interview method would afford participants the chance to freely express themselves. At the same time, it gave me the privilege to further explore interesting points that emanated from participants' responses. At the end of the conversations with participants, some findings emerged, which were discussed in the last chapter. The implications of these findings, the benefits of the study and its limitations, from my perspective, are set out below. My personal reflection of the study process and suggestions for future research are also included in the latter part of this chapter.

### 6.2 Implications of findings

The findings of this study have several implications for the different parties interested in education. Some of these implications are enumerated below.

### 6.2.1 Schools

Schools play an important role in the lives of young people as students spend at least, a quarter of their day at school. It is therefore essential that schools ensure that the young people in their sphere of influence receive messages while at school, that are consistent, positive, motivational, and exemplary. This study has shown that messages delivered by some school leaders during assemblies and other forums, may have the potential of inspiring some young people to cultivate a desire and determination for academic success. It is apparent also that a school's reputation may have implications for student connectedness to school (E.g., Brown & Evans, 2002; Pariso, 1991; Shin, Lee, & Kim, 2009). As discussed in chapter 5, students who show a strong connection to school will achieve well and show a commitment to their studies, and will speak well of the school outside its environs (E.g., Fowler & Walberg 1991; Sherblom, Marshall, & Sherblom, 2006). Consequently, school leaders must use every opportunity to promote and impress on their students, the good things about the school, and the image of the school that the leadership desires and is committed to fostering.

Incentive schemes appear to act as extrinsic motivators towards the latter years of students' educational experiences (E.g., Covington, 2000; Opdenakker & Van Damme, 2006). It may help senior students to be reminded at the beginning of the year, and at regular intervals, of academic rewards, such as scholarships, and non-academic incentives that are available to deserving students. Student achievements in sports, subject competitions and other events should be regularly celebrated as these may provide stimuli for some students to work hard to have the opportunity of being publically recognised someday.

Classroom placement practices that stream students based on ability should be regularly revised to ensure that all students are benefitting maximally in all their subjects (E.g., Gamoran, 1987, 1992). Flexibility in streaming arrangements are required to ensure that a student who has weaknesses in mathematics for example, is not compelled to do accelerant mathematics because he/she is in the advanced learning class; a situation that may have arisen due to the students sterling performance in other subjects. School leaders must therefore ensure that support services and structures that are in place for low ability students are also made available to high ability students as some of these students may have weaknesses in some subjects that may demand remedial work if they are to achieve to their true academic potential.

### 6.2.2 Teachers

The findings have a number of implications for teachers too. Teachers must be aware that they communicate in the classroom not just through their words, but also through their facial expressions, their gazes, their actions, display of anger, and even their silence. They should therefore exercise utmost care to ensure they are sending the messages they intend to send to students through their deportment in the classroom.

Seven of the participants in this study stated that their attitudes to mathematics may have been influenced by their relationship with their teachers. It is therefore important that teachers cultivate a cordial relationship with their students; learn students' names; show students that they care by taking an interest in the students as individuals, and provide them with timely feedback and feed forward information that may encourage the students to work to achieve to their potential in mathematics. Teacher accessibility was stated by many participants as an important feature of teacher care. Therefore, it might enhance the notion of teacher care for students to be aware of the times the teacher is available for consultation.

Teachers should also endeavour to understand their students learning styles, mathematics level, and goals, and try to tailor their instructional practices to meet their students' needs. In addition, teachers should expose their students to quality and diverse mathematical experiences, and place reasonable expectations on them to achieve to their potentials in mathematics.

Setting individual achievement goals for students in mathematics is another feature that many participants in this study found motivating. Teachers should therefore at the beginning of the year, try to get each student in their mathematics classes to set an individual achievement goal or target for the year. This could be repeated for each unit of study. For example, based on a students' previous history of achievement, a teacher may agree with a student to aim for a merit endorsed certificate in level 1 mathematics at the end of the year. This type of target may provide an incentive for the student to work hard to attain this goal.

### 6.2.3 Students

My findings have some obvious implications for students. Students as learners should understand that they have an obligation to be engaged and committed to their learning. As such, they should have an individual objective for learning mathematics and should have achievement targets that they intend to attain (E.g., Murphy & Alexander, 2000; Van Petegem et al., 2008). It would be helpful for students to regularly assess their motivational orientations and the reasons they give for success and failure as these may have impact on their commitment to their work, the nature of mathematical tasks they do, and the time they spend on these tasks (E.g., Dweck & Master, 2008; Mcleod, 1988; Middleton & Spanias, 1999).

Peers may also exert differing influences on students' achievements and attitudes to mathematics. Working together with others reinforces students' knowledge of concepts they had been taught (E.g., Chen, Chang, & He, 2003). It would therefore be expedient for students to learn to work cooperatively with their peers. Student's should choose to work with students who share their achievement aspirations and goals as they would be complementing each others' ability instead of distracting one peer from making the progress he/she may desire (E.g., Calvo′-Armengol, Patacchini, & Zenou, 2009; Whitmore, 2005; Zimmerman, 2003).

### 6.2.4 Parents

The implications of the findings for parents are many and significant. Children spend the first few years of their existence with their parents. The cognitive mathematical experiences to which they are exposed in those early years may have enduring consequences for their future educational achievement in general, and their attainment in mathematics, in particular (E.g., Porfeli et al., 2009; Rogers, 2001; Walker, 2006). Ideally, parents should consider making deliberate efforts to expose their children to rich mathematical experiences when they are young (E.g., Greenes et al., 2004; Jordan, Kaplan, Ramineni, & Locuniak, 2009; Lee et al., 2008)

Parents also have to be aware of the messages they pass to their children about their mathematical beliefs and attitudes, and their value for mathematics, as these may influence their children's mathematical beliefs and attitudes (E.g., Wiggan, 2007; Sirin, 2005; Wilkins & Ma, 2003). Notwithstanding their experiences in mathematics and

their attitudes to the subject, parents may steer their children toward developing a positive attitude to the subject by appropriately supporting their children, and encouraging them by words and action, to work toward attaining mathematical competence. Parental support may entail the provision of suitable mathematical resources to their children, consultation with their children's teachers to find the type of help their children need and the sources of help that may be available, and the provision of a conducive learning environment for their kids (E.g., Davis-Kean, 2005; Dietz & Haurin, 2003; Eamon, 2002; Essen et al., 1978; Tsui, 2005;).

Lastly, parents should have achievement expectations for their children and they should communicate these expectations to them. In addition, they should inform the children of their career aspirations for them. Parental expectations and aspirations may provide an achievement target and an attainment motivation, or may help the children to develop their own achievement goals or career objectives.

## 6.3 Benefits of study

This study has been beneficial for several reasons. For me, the study underscored the importance of affective (the feeling, thinking, belief, attitudes, and so on, that students bring to mathematics) variables in relation to mathematics achievement in New Zealand. The study affirmed my belief that a clear understanding of students' mathematical predispositions may enable teachers tailor instruction to meet students' learning needs. With regards to parents, and in line with previous studies on the subject, this study found that parental value for education influences children's academic achievement (E.g., Anderson & Minke, 2007; Fan & Chen, 2001, Lee & Bowen, 2006; Rogers et al., 2009; Seginer, 2006). This study has gone further to show that parents' value for mathematical knowledge appears to influence students' performance in and attitudes to mathematics through the nature of the resources and support parents commit to their children's mathematical competence.

This study supported what other studies have found that success and failure are major influences on students' attitudes to mathematics. The import of this finding is that stakeholders in education have to set the foundation for students to be successful in the subject from the beginning of their educational life. This will enhance students' self-

confidence in mathematics and endow them with the determination to work for success and develop positive attitudes toward the study of the subject.

In this study influences on attitudes to mathematics have been explored from different perspectives. The views expressed in the findings were derived from the submissions of participants who had real experiences with different teachers in different schools from different regions of New Zealand and from other countries. Participants in this study have all had tertiary training of one form or the other. They all sounded credible and seemed to have recalled their mathematical experiences with clarity and conviction. These experiences are likely to reflect and exemplify the experiences of many current learners in New Zealand. Participants stated that they were motivated by messages they received from their parents and from their school leaders. Other participants said they benefited from having peers who had aspirations and who were determined to succeed academically. However, 2 participants mentioned that their progress in mathematics was affected by being put in classes where they could not work to improve their mathematical knowledge. This happened because the pace of mathematics instruction in those classes was either too fast for them or they had peers who were not interested in mathematics and these peers took active steps to disrupt other students' learning of the subject. Furthermore, participants' experiences were grouped into different topics so that different interested parties can easily find points relevant to them by going directly to their area of interest.

Contrary to many studies that report the detrimental effects of family size on children learning, this study found that family size does not appear to have a major influence on achievement and attitudes to mathematics. It appears that variables such as a teachers and school practices and experiences, and the students motivation for success, seem to be more potent influences on a student's mathematics competence and attitude than family size.

This study also attempted to establish and emphasise that mathematical success depends on the combined efforts of the teacher and school, the student, and the parents. Maximum mathematical attainment may only occur, all things being equal, if the different parties in the learning process understand, accept, and discharge their various responsibilities satisfactorily. As a consequence, it is hoped that where one of the stakeholders fails in the discharge of its responsibility, the other parties must recognise and compensate for this failure if the student is to attain optimum mathematical success.

## 6.4 Limitations of study

In a qualitative study, the researcher depends on the respondents to answer interview questions honestly and in as much detail as possible. Firstly, it is entirely possible that respondents' answers were influenced by the wording of the questions. Secondly, in this study, I chose to interview participants who were at least 20 years old and who had studied mathematics to at least, secondary school level. In addition, there was no upper age limit imposed on eligibility. This meant I had a respondent who was 60 years old and another respondent who was 21 years old. Thus, some of these participants have left school for just 4 years, while two participants left secondary school just over 40 years ago. Consequently, it is probable that the ability of some respondents to recall the things that transpired many years ago could have been impaired by the lapse of time. It is also possible that participants' experiences after school and their present understanding of what mathematical learning should be may have impacted on their interpretation of what their learning experiences were. Additionally, because respondents went to school many years apart, the learning experiences, teaching styles, and learning resources available at the times they went to school may have been different. For example, participants who went to school in the 1960s and 1970s may not have used calculators and computers. They may not have contacted their teachers by email and accessed learning resources on the internet. On the contrary, participants who went to school in the late 1990s and 2000s may have used different types of calculators and internet resources to support their learning. In addition, parents' and teachers' expectations and career emphasis for different decades may have been different because of changing technology and career demands. This may make it difficult to compare the mathematical experiences of the different participants as we may be comparing experiences that may not be similar. It is very likely though, that there might be similar areas of common experiences between learners of mathematics from different decades.

Furthermore, the findings and analysis herein presented were based on eleven interviews. This is a very small sample. As a result, conclusions may not generally be applicable to other people, places, and situations. In this particular study, participants appear to be middle class people. It is very likely that choosing participants from different socio-economic groups would produce an outcome somewhat different from the one presented in this study.

Finally, as the researcher, I have tried to remove myself from the experiences of the respondents. However, the questions that elicited these responses were coined by me. Furthermore, the presentation and analysis of the findings were done using my diction and writing style. It is therefore probable that my choice of words may have given meaning and emphasis to participants' narratives in a way or to a degree that they may not have intended.

## 6.5 Personal reflection

At the commencement of this endeavour, I only had a faint idea of the depth of the task I had undertaken, although I had many personal assumptions. I was initially uncertain if there was enough literature to make the study credible, substantial, relevant and worthwhile. As the study progressed, I became amazed by the avalanche of previous studies that had been conducted by different scholars on various aspects of the topic I surveyed. The upshot was that my interest and commitment to the topic deepened and my conviction of its validity and esteem of its relevance, affirmed.

The experience of writing this thesis has enriched my appreciation of knowledge and the difficulties many learners face in mathematics. It brought to my memory an event that happened many years ago while I was in an examination hall. The examiner gave out the papers. The examination started and all examinees turned their scripts and proceeded with their work. However, the young man sitting beside me to the right, examined the paper, lowered his head on the desk, and remained still. Several minutes after the examination started, his head was still down. I alerted the examiner to see if the guy was fine. The examiner came. The young man raised his head and was sobbing. He narrated how he had done the same mathematics paper for 6 years and how mathematics had prevented him from fulfilling his dreams of going to university. This learner appeared like someone who wanted to learn. He had dreams. He wanted to go to university, but he was unable to surpass the obstacle mathematics constituted to him.

As I finished the analysis of my findings, I wondered what happened to that young man. I never saw him after that experience because he left the examination venue before I came out. As I recalled that experience, it brought many questions to my mind. Is it possible that there are people incapable of learning mathematics? Are dyscalculia and acalculia valid concepts to investigate? At what stage of the learning cycle do people

develop the mathematical self-efficacy that would assist them to strive for mathematical success? These questions and many more have created in me a longing to investigate in more detail, the particular experiences that make people successful learners of mathematics.

I have enjoyed the opportunity to explore this topic. My hope for the future is to investigate one of the areas I have encountered in this thesis. It will be satisfying to me if by reading this thesis, people become familiar with the factors that influence students' attitudes to mathematics and do what they can to help students form positive attitudes to mathematics. If by having positive attitudes toward mathematics, students improve their mathematical competence and attainment, one of the most important goals for which I undertook the writing of this thesis would have been achieved.

## 6.6 Suggestions for future research

I did not investigate the impact of culture on achievement in mathematics. Therefore, the impact of cultural socialisations on mathematical competence and achievement is an area that could be explored in future studies.

The findings indicated that participants' perceptions of teachers' personal attributes impacted on the way they related to their teachers and the subject. The influences of teachers' personal characteristics and relationship with students, and connection to mathematics achievement, are areas that could also be investigated in future studies.

Teachers were cited by participants as being major influences on their attitudes to mathematics. Therefore, issues pertaining to teaching styles, teacher qualifications, and teacher experience, are areas that could be studied in future. In addition, the extent to which the reputation of a school influences the achievement of its students in mathematics is an area that could also be explored in future studies.

The comparison of students' attitudes to mathematics and their attitudes to other subjects such as, science, social studies, physical education and health, and so on, and reasons for any differences in attitudes, are also topics that could be examined in future studies.

There are studies on the benefits of homeownership on students' achievement but there is no one that has focused specifically on mathematics achievement. Therefore, the

impact of homeownership on mathematics achievement in New Zealand is another area that could be investigated in future studies, although homeownership in New Zealand may differ from region to region.

Some researchers have recommended that mathematics should formally be introduced to children at kindergarten to harness the different mathematical concepts children learn in the process of development. The effect of early mathematical experiences on future mathematics competence is another area that could further be studied in New Zealand.

Finally, while students may encounter different mathematics teachers throughout their schooling life, their parents largely remain a constant part of their existence. Therefore, the role that parental support plays in mathematics achievement in New Zealand is a topic that could be studied in future.

## 6.7 Final remarks

Mathematics is an important subject that is compulsory in New Zealand in the first 11 years of education. Many tertiary courses require a certain level of mathematical knowledge for acceptance. Students who desire to pursue careers in science or business are expected to have a good knowledge of mathematics. It is therefore important that mathematical knowledge is highlighted and promoted to learners from a very early age. While many adults have no hesitation declaring their incompetence in mathematics, no adults proclaim with glee their inability to read.

The last point is exemplified by a recent experience I had. A colleague, who is a graduate student, asked me what the title of my thesis was. When I told her that the title of my thesis was ‘influences on attitudes to mathematics’, she responded! “When I hear that word, mathematics, I feel very uneasy”. One of the reasons I chose this topic is to show the effect of these types of attitude on learners of mathematics and to emphasize the importance of cultivating a positive attitude towards the study of the subject. In this study, it was shown that teachers’ activities may affect students’ performance and attitudes to mathematics. As well, the messages students receive from school leaders may influence their approach to their learning. It was also highlighted that learners’ individual attributes and learning motivation may influence their mathematical achievement and attitudes. Finally, parental practices, parents’ education, and parents’ expectations, were also shown to probably influence students’ achievement and

attitudes to mathematics. It is hoped that by reading this thesis and being aware of the influences that impinge on people's attitudes to mathematics, stakeholders will take corrective actions that would help learners encounter positive experiences in mathematics and make them to become successful mathematics students.

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## APPENDIX 1
## INDICATIVE INTERVIEW QUESTIONS

1. Could you briefly describe for me your attitude towards the subject mathematics? I mean, is it a subject you liked, disliked? Did you look forward to the maths period?
2. Now, let's come to look at this question stage by stage, could you describe your first encounter with maths? Could you describe your numerical strength when you started school (I mean elementary school)?
3. Could you describe any type of books on basic numeracy or arithmetic that you may have encountered before you started primary school? (It may be at home, kindergarten or other preschool environment)
4. Could you describe the attitude of other members of your family towards mathematics? Did you have other siblings or close relatives or anyone with whom you could do maths when you were in school? Could you please, explain your answers?
5. Could you recall the attitude of your parents towards mathematics? Do you remember any stories they told you about their maths experience? Did they actively try to help you with your maths, such as by teaching you themselves, helping you to get external help or giving you encouragement to try to discover the answers to problems yourself?
6. Let's briefly think back to your primary school days, are there any memories that stand out for you regarding mathematics or arithmetic?
7. What were your feelings about mathematics when you were in primary school? Could you recall if your attitude towards maths changed depending on the topic, teacher, students sitting close to you, or resources being used by the teacher?
8. What influence did assessment results have on your attitude to mathematics, specific topics, or your teachers? I mean, did you like to do a topic if you understood it and passed the test on it or did you have more determination to understand a topic when you did not do well in its assessment? And does your performance affect the way you related to mathematics?
9. Did you have to do homework when you were in primary school? If yes how often did you have homework in a week?

10. If you had homework, where you able to do them every time? If you had difficulties with any questions, did you have someone to go to for assistance?
11. When you were in primary school, do you recall if you understood the best way you learnt maths? Did this learning style change as you went higher in grade?
12. Could you recall your most favourite topic in maths when you were in primary school? Would you like to explain to me why this topic was your most favourite topic?
13. Now let's turn over to your secondary school years, when you left primary school, would you let me know if you looked forward to studying mathematics at secondary school? If so, why was this so? If not, why?
14. Could you tell me about your experiences with mathematics in secondary school? What aspects of mathematics did you like during your secondary school days? If you like, you may think about your relationship with maths at the different year levels. Would you like sharing with me the reason(s) you liked these areas?
15. Would you like to share with me too, areas of mathematics you did not like and the reasons you did not like these areas, topics, etc?
16. Did your friends' or classmates' attitude to maths affect the way you related to the subject? If so, would you like to describe how?
17. Among your peers, was it 'cool' to be good at maths? Would you like to explain to me if the perception of students who were good or not good at maths affected the way you related to the subject?
18. Did you understand your learning style while you were in secondary school and do you recall if you had teachers who taught to your learning style?
19. In your years at high school, could you describe any different teaching styles your teachers used? How did they influence your attitude towards mathematics?
20. Could you tell me about the resources used by your teachers? How did they influence your attitude to mathematics?
22. Let's look at tests or examinations, when you did or did not do well in tests or examinations, to what or whom did you attribute the blame?

23. Here I am looking at individual characteristics, when you did well in a test or did not do well in a test, did you have the motivation and determination to maintain your performance and improve on it? Let's look at each situation separately.

24. Can you think about and would you like sharing with me a stand out experience, event, person, teacher, classmate, or other school friend, that influenced your attitude to mathematics in a significant way? Why is this experience unique?

25. In summary, what can you say are the main factors that influenced your attitude to mathematics, either positively or negatively?

**APPENDIX 2**

# Participant Information Sheet

**Date Information Sheet Produced: October 20, 2010**

**Project Title: Influences on attitudes to mathematics**

**An Invitation**

Dear _____

My name is Samuel Aruwa. I am a teacher studying towards a Master's degree at the Auckland University of Technology. I am interested in exploring the experiences that affected the way you related to mathematics. I would like to ask you questions to help you recall important experiences that influenced your attitude to mathematics. Your participation in this study is voluntary and you are free to withdraw from this research any time until you have read your interview transcript and given final consent to use your data.

**What is the purpose of this research?**

The aim of this study is to explore attitudes to mathematics and help policy makers design strategies to help students relate well to mathematics in the future.

**How was I identified and why am I being invited to participate in this research?**

You responded to my request for participants at your workplace, by emailing me to show your interest in the study. You have been invited to participate because you are over 20 years old, you have studied mathematics at high school, and you either live or work in one of the areas from which I decided to recruit participants for this research.

**What will happen in this research?**

I will talk with you to explore your experiences with mathematics. I will interview at least 9 other people. At the end of the interviews, the information that I wish to use will be transcribed and returned to you for checking and any changes you may wish to make. I will then analyse the data to draw conclusions about influences on people's attitudes to mathematics.

**What are the discomforts and risks?**

I do not anticipate any risks to you for participating in this research. However, in the course of the interview, you may recall particular events or people that were not very pleasant to your experience. Should this happen, you do not need to answer any questions if you are not happy to do so.

**What are the benefits?** The main benefits of this research for me are;

A. Your experience may help me determine the factors that influence people's attitudes to mathematics

B. Your experience may help bring about conclusions that may help policy-makers design policies that will help students form positive attitudes towards mathematics

C. Your experience will help me to write my thesis to complete my master's degree.

**How will my privacy be protected?**

Any personal information you give will be treated with utmost confidentiality and will only be seen by me and my supervisor, and your name will not be mentioned in the thesis.

**What are the costs of participating in this research?**

The only cost to you for taking part in this research is your time. I expect interviews to last less than an hour. If there is a need to continue, this will be by mutual agreement.

**What opportunity do I have to consider this invitation?**

I will appreciate if you can inform me by phone or email of your decision regarding this invitation within a week.

**How do I agree to participate in this research?**

If you agree to participate in this research, please sign the attached consent form and give it to me before the interview.

**Will I receive feedback on the results of this research?**

If you wish to get feedback about the research, I will provide you with an electronic summary of the findings at the end of my data analysis.

**What do I do if I have concerns about this research?**

**APPENDIX 3**

**Consent Form**

Project title: Influences on attitudes to mathematics

Project Supervisor: Dr. Andy Begg

Researcher: Oniovosa Samuel Aruwa

- ○ I have read and understood the information provided about this research project in the Information Sheet dated October 20, 2010.
- ○ I have had an opportunity to ask questions and to have them answered.
- ○ I understand that notes will be taken during the interviews and that they will also be audio-taped and transcribed. In addition, I understand that my transcribed interview will be returned to me so that I may make any changes or correction.
- ○ I understand that I may withdraw myself or any information that I have provided for this project at any time prior to the time I agree for my data to be used to write the research, without being disadvantaged in any way.
- ○ If I withdraw, I understand that all relevant information including tapes and transcripts, or parts thereof, will be destroyed.
- ○ I understand that my name will not be mentioned in the thesis and that any opinions I express will not be directly associated with me, in order to protect my identity
- ○ I agree to take part in this research.
- ○ I wish to receive an electronic copy of the summary report from the research (please tick one):

  Yes ○ No ○

Participant's signature ……..

Participant's name ……

Participant's Contact Details (if appropriate):Date:

**Approved by the Auckland University of Technology Ethics Committee on March 1, 2011 AUTEC Reference number: 10/277**

Note: The Participant should retain a copy of this form