Grade 10 – 12 Learners' attitude towards mathematics and how the attitudes affect performance

By

Vusumuzi Ndlovu

Student number: 754787

Protocol number: 2016ECE052M

A research report submitted to the school of Education, University of Witwatersrand, in partial fulfilment for the requirements for the degree of Master of Education by coursework and research report.

Johannesburg, March 2017

Supervisor: Dr Patrick Barmby

Abstract

The role of learner attitude in the learning of mathematics has given rise to numerous research on the subject with most research providing several empirical evidence on the relationship between learner attitude towards mathematics and their performance in the subject. The present study was designed so as to explore the influence of some attitude dimensions that learners have towards mathematics and relate these attitudes measures to the performance of the learners and also find out if some of these attitudes factors are gender related. The study was carried out in one of the Soweto schools; a total of 231 learners from Grade 10 – 12 were involved in the completion of a questionnaire, followed by interviews with 10 learners across the three grades. Therefore, a mixed method approach (quantitative and qualitative methods of collecting data) was used. The instrument used for the questionnaire was tested for reliability using Cronbach's alpha and the correlations established between the various attitudes measures and the June examination scores for the learners. This revealed some mixed results ranging from a general weak correlation between attitude and the performance of the learners in lower grades to generally high positive correlation in the higher grades, consistent with existing literature on attitude and performance. It was also found that gender played a major role in learner attitudes which was not very consistent with most existing literature on gender and attitude towards the learning of mathematics. The study also unveiled some external factors that could affect learners in the learning of mathematics including the teacher, pressure from other learners and the community in general, as well as school policy on the choice of mathematics and mathematical literacy.

Declaration

I declare that this research is my unaided work. I understand that the University of the Witwatersrand may take disciplinary action against me if there is a belief that this is not my own unaided work or that I failed to acknowledge the source of the ideas or words in my writing.

Signed ---------- (754787) Date ----------

Acknowledgements

I would like to express my sincere gratitude to my supervisor for the many hours he spent advising me on this project and also to my wife Khethiwe and family for the support.

Contents

Abstract ii
Declaration iii
Acknowledgements iv
List of Tables vii
1 Introduction 1
1.1 Background to the study 1
1.2 Research problem 2
1.3 Research questions 3
2 Literature Review 5
2.1 What are attitudes? 5
2.2 Components of attitude 6
2.3 External factors that influence attitudes. 7
2.4 Relationship between attitudes and attainment 9
2.5 Measuring attitudes 10
2.6 Conceptual Framework 10
Table 1 11
3 Methodology 12
3.1 Methods of data collection 12
3. 2 Research Instruments 12
3.3 Methods of data analysis 14
3.4 The Sample 16
3.5 Issues of validity and reliability 16
3.6 Ethical Issues 18
4 Results 19
4.1 Questionnaire results 19
4.1.2 Looking at the relationship between attitude dimensions and exam results 24
4.1.3 Looking at gender differences 26
4.1.4 Looking at differences between maths and maths lit students 26
4.2 Interview results 27
4.2.1 Enjoyable/Not enjoyable/ Frustrating/Complicated/ Difficult – Enjoyment dimension 29
4.2.2 Motivated/ not motivated / highly motivated/ confidence/ not confident- Motivation dimension 29
4.2.3 Important/ not important – Value/ important dimension 30
4.2.4 Anxiety 30
4.2.5 Social Issues 31

4.2.6 School setup 31
5 Discussion of results 32
5.1 Answering research question 1. 32
5.2 Answering research question 2 34
5.3 Answering research question 3 35
6 Conclusion 38
References 40
Appendices 47
Appendix 1 (Letter to the principal, SGB chair) 47
Appendix 2 (INFORMATION SHEET LEARNERS) 49
Appendix 3 (Learner Consent Form) 51
Appendix 4 (INFORMATION SHEET PARENTS) 52
Appendix 5 (Parent's Consent Form) 54
Appendix 6 (GDE Research Approval Letter) 55
Appendix 7 (University Clearance Letter) 57
Appendix 8 (Questionnaire items) 58
Appendix 9 (Interview questions) 62

List of Tables

Relating questionnaires to the components of attitude .....Table 1

Dimensions of attitudes emerging from the exploratory factor analysis ....Table 2

Correlation of attitude dimensions wit maths exam Grade 10.....Table 3

Correlation of attitude dimensions with maths lit exam Grade 10 .....Table 4

Correlation of attitude dimensions with maths exam Grade 11.....Table 5

Correlation of attitude dimensions with maths lit exam Grade 11.....Table 6

Correlation of attitude dimensions with maths exam Grade 12.....Table 7

Correlation of attitude dimensions with maths lit exam Grade 12 .....Table 8

Results of independent t - test comparing attitudes of male and females .....Table 9

Results of the independent t – test comparing attitudes of mathematics and mathematical lit learners ..... Table 10

Themes identified from the interviews.....Table 11

1 Introduction

1.1 Background to the study

In South Africa mathematics has been found to be one of the most important core subjects in the curriculum, with the subject being compulsory for every learner in the education system from grades 1 – 9. From grades 10 – 12 in the Further Education and Training (herein FET) phase, the learners can choose either mathematics or mathematical literacy. The significance of the subject is emphasised by the fact that mathematics and mathematical literacy, as policy dictates, is timetabled daily in the school education system in South Africa (Department of Basic Education, 2011) (herein DBE). The importance of this subject could also be justified by the fact that the use of mathematics is in the everyday life of people (Mohamed & Waheed, 2011). It is for this reason that competence in mathematics is essential in society as it is a tool that could be used to overcome barriers in the daily lives of people (Mensah, Okyere, & Kuranchie, 2013) and that mathematics is used in many fields (Zakaria, Chin, & Daud, 2010). Furthermore, as one of the aims of policy statements states, its purpose is "equipping learners, irrespective of their socio – economic background, race, gender, physical ability or intellectual ability, with the skills and values necessary for self – fulfilment, and meaningful participation in society as citizens of a free country" (Department of Basic Education, 2011, p. 4). Notwithstanding its importance and the significance of the subject, many learners still obtain poor marks in mathematics. Students have been obtaining the lowest achievement pass rate in mathematics as compared to other subjects since 2012, with a percentage achievement of 49,1% in the 2015 Matric examination (Department of Basic Education, 2015). The depressing performances by matric learners in mathematics are a cause of concern and it calls for research into the factors that affect performance of learners in mathematics.

As noted above, the achievement in mathematics nationally is the lowest amongst all subjects, and also South Africa ranks amongst the lowest in mathematics achievement in the world as evidenced by the four-year report in the Trends in International Mathematics and Science Study (TIMSS) for 2011 (Mullis, Martin, Foy, & Arora, 2012). It is also observed that there is a growing number of learners who choose mathematical literacy at FET phase as more learners sit for mathematical literacy as compared to mathematics at matric level (DBE, 2015). Having noted the trends in the achievement of learning in mathematics in South Africa, and also the

fewer number of studies in learner attitudes towards mathematics, this is the basis of why this study is being undertaken.

There have been a number of studies that have been carried out in different countries to find out more about attributes that influence learner performances in mathematics. One of the attributes towards learner performance that has been widely studied is learners' attitudes towards mathematics. Learners' attitudes towards mathematics have been a factor that has been studied persistently to find out if there is a relationship between learner achievement and attitudes (Jennison & Beswick, 2014; Aiken, 1972; Mohamed & Waheed, 2011). Although there have been many studies on students' attitudes towards mathematics around the world, there have been very few studies carried out in South Africa. Most of the studies that have been carried out worldwide noted that attitudes in mathematics play a significant role in the teaching and learning of mathematics (Farooq & Shah, 2008; Majeed, Darmawan, & Lynch, 2013; Mcleod, 1994; Neale, 1969; Zan & Di Martino, 2007). The present study will therefore investigate the effects of attitudes towards the learning of mathematics in the South African context.

1.2 Research problem

Attitudes are part of our everyday life as one has a particular liking or dislike, love, fear or appreciation towards a certain object (Hannula, 2002). It has been argued that attitudes are part of human identity (Mohamed & Waheed, 2011). Mathematics as an object could also be loved, feared, hated or disliked, just like any other object. It then follows that the learning of a particular subject could be linked to the attitudes that one has on that subject, as it is suggested that there is "a strong interaction between cognitive and emotional aspect" (Zan & Di Martino, 2007, p. 3). It therefore follows that the emotional aspect (part of attitude) could come into play in the learning of mathematics (cognitive). Poor performance in mathematics could therefore be partly attributed to learners' attitude towards mathematics (Bayanga & Wadesango, 2014; Farooq & Shah, 2008; Hannula, 2002; Mahanta, 2014; Mohamed & Waheed, 2011). In my teaching experience, I have observed that most learners that I teach have had a negative attitude towards mathematics as they always say negative comments about the learning of the subject. I have also observed that they tend to perform badly in mathematics examinations. This study aims to find out the attitudes exhibited by learners towards mathematics and whether these attitudes have a bearing on the achievement of these learners. The main purpose of this study is to identify factors that influence the attitudes that learners have towards mathematics. One

has to take cognisance of the fact that South Africa is a male dominated society. Although South Africa boasts a constitution that has an emphasis on equality and women make up a greater percentage than men, the unemployment of women is higher than that of men (Kehler, 2001). It is further observed that black women in particular face difficulties as compared to men in education and job opportunities (Hames, 2006). This male domination is also seen in management as studies show that the general feeling is that men would make better managers as compared to women (Booysen & Nkomo, 2010) and also that in the appointment of principals there was a preference to men as opposed to women (Moorosi, 2010). In addition to these factors it is observed that although schools in South African have a larger enrolment of girls as compared to boys and also they have been more girls writing mathematics at matric than boys as from 2012 to 2014, the percentage of boys getting more than 30 % in mathematics from 2012 (boys 59,7% - girls 49,25%) to 2015 (54, 9 % boys – girls 44,2%) is far higher for boys than that for girls (Department of Basic Education, 2016). Taking this into account, and focusing on education and mathematics in particular, one has to find out if boys and girls exhibit the same attitudes towards mathematics. If one can identify the factors that affect attitudes, it will help teachers to be equipped with this knowledge as they will be able to recognise these factors and deal with them accordingly. Once these can be identified, it could also mean that possibly the results of South African learners in mathematics could improve.

1.3 Research questions

In order to achieve the above purpose, this study aims to answer the following questions:

- What is the relationship between attitudes towards mathematics and learner achievement in mathematics, and what aspects of attitude have the greatest influence?
- Are attitudes towards mathematics gender biased in a particular South African school context?
- What social factors influence these learner attitudes towards mathematics?

In addition to this introductory part, the work will comprise of a literature review and methodology. In the literature review part, an examination of findings from other research findings as well as the conceptual framework that will guide this research project will be discussed. The third part of the work will elaborate on the methodology that this work will follow in carrying out the proposed research. The fourth part of the research will present the

findings of this particular study and the last part of the research will discuss the results of the findings as well as concluding and providing some recommendations from the findings.

2 Literature Review

2.1 What are attitudes?

In our everyday life as human beings our actions are usually determined by our like or dislike of a particular object. This like or dislike which is our attitude is pivotal to our human identity and actions (Mohamed & Waheed, 2011). It is noted by researchers that defining an attitude towards mathematics is not very implicit (Bragg, 2007; Grootenboer & Hemmings, 2007; Mcleod, 1992; Mcleod, 1994; Neale, 1969; Zan, Brown, Evans, & Hannula, 2006; Zan & Di Martino, 2007, 2010), however most researchers agree on a working definition of attitude towards mathematics. For the purpose of this research project a working definition of attitude is adopted. Attitude is defined as "a predisposition or a tendency to respond positively or negatively to a certain idea, object, person or situation or an attitude problem" (Mensah *et al.*, 2013, p. 133). It is further postulated that attitudes towards mathematics could be seen through one's response towards the subject and the attitudes could also be evaluated (Grootenboer & Hemmings, 2007). In other words, one could view attitudes towards mathematics as just a positive or negative outlook towards mathematics (Mcleod, 1992). A positive or negative outlook towards a subject develops as one learns that particular subject. This means that mathematics attitudes could be learned in the course of one's education. As asserted, these attitudes could also develop over time within learners in the learning of a subject, and these attitudes will have an impact on learners' effectiveness and performance (Majeed, Darmawan, & Lynch, 2013). Macleod (1992) further explains that attitudes develop in learners due to an emotional reaction to the subject and eventually this emotional reaction tends to be an automatic response to the subject. The fact that attitudes develop means that they can also change. Majeed *et al*. (2013) further elaborate that learner attitudes could develop as a result of curriculum response, teaching practice and the school organisation, and as such could change depending on whether these are conducive to the learners or not. There have been many studies across the world which have investigated learner attitudes towards mathematics and also the relationship between attitudes and the learner performances (Kislenko, Grevholm, & Lepik, 2005; Liu & Koirala, 2009; Mahanta, 2014; Mensah, Okyere, & Kuranchie, 2013; Mohamed & Waheed, 2011; Mutodi & Ngirande, 2014; Neale, 1969). These studies have identified different components of attitudes towards mathematics and also how these components affect learner performance.

2.2 Components of attitude

Attitude can also be defined as "an aggregated measure of a liking or disliking of mathematics, a tendency to engage in or avoid mathematics activities, a belief that one is good at mathematics and a belief that mathematics is useful or useless" (Ma & Kishor, 1997, p. 27). This could mean that attitudes embrace emotions, beliefs as well as behaviour related to that subject (Zan & Di Martino, 2007). It could be argued from the above definition that one's attitude will depend on how one feels about mathematics, how one perceives mathematics and also how one will behave towards the subject. This view of attitude gives rise to what some researchers call the tripartite view of attitude, namely the cognitive, affective and the behavioural components of attitudes (Barmby & Bolden, 2014). It is further pointed out that these three components are interrelated and also connected (Mensah *et al*., 2013). The cognitive domain could be defined as one's discernment or awareness of mathematics or one's belief in his or her learning of mathematics (Mensah *et al.*, 2013; Ruffell, Mason, & Allen, 1998). The affective component is one's impressions about the subject. On the affective domain, Mensah *et al.* (2013) and Ruffell *et al.* (1998) both suggest that these are feelings that are expressed towards the subject. It is further postulated that this domain could be exhibited by an individual effortlessly or deliberately (Crano & Prislin, 2006). This suggests that one could have positive or negative feelings towards mathematics that have developed over time without realizing it or one could just intentionally decide that they do not like mathematics. One of the factors of the affective component is mathematical anxiety that negatively affects the learning of mathematics (Ho, *et al.*, 2000; Iben, 1991). A study on mathematical anxiety which was carried out in three countries, that is, China, Taiwan and the United States of America, indicated that mathematics anxiety tends to inhibit learners' achievement (Ho, *et al*., 2000). The behavioural component is the way in which an individual will respond to mathematics (Mensah *et al*., 2013). This is how one will deal behaviourally with the learning of mathematics.

In response to the different components, different dimensions of attitudes that are related to the three components have been suggested by different researchers. For example, Tapia and Marsh II (2002) put forward a measure of attitudes that included self-confidence, value, enjoyment and motivation components. All these factors may play a role in how one will go about learning mathematics. Mahanta (2014) suggests that the usefulness of mathematics and how one feels when doing mathematics (enjoyment or boredom) and one's confidence in mathematics will be useful in solving mathematics problems which ultimately support the learning of mathematics. For instance, if a person feels that mathematics is important in solving day to day

problems both at home and in workplace (value), one will be motivated to learn the subject. Iben (1991) emphasises that if one believes that mathematics is useful and important then they would tend to succeed in the learning of the subject. Also the enjoyment of a subject or being confident in that particular subject could give rise to one learning the subject effectively.

Self – efficacy in the subject has also been studied as a component to find whether it has an impact on the learning of mathematics. This is a learner's belief in his or her ability to commence and accomplish a task (Liu & Koirala, 2009). This study carried out on self – efficacy revealed that learners who possessed self – efficacy did better in mathematics than those who were less confident (Liu & Koirala, 2009). Related to self – efficacy is self – concept that could likewise have a bearing on the learning of mathematics. This self – concept is seen as a learner's individual thoughts about his or her abilities towards mathematics (Mahanta, 201). This means that learners will be influenced by their confidence in doing mathematics. Bayanga and Wadesango (2014) concluded that self – concept plays a crucial role in the learning of mathematics. The same conclusion was also reached by Mahanta (2014) in which it was observed that self – concept is vital to mathematical achievement. Another component examined is intrinsic motivation. Iben (1991) suggests that intrinsic motivation tends to make learners persistent at their mathematics problems and therefore they will in turn perform better. McLeod (1994) also mentions that the emotional response towards mathematics has a bearing on how learners perform in mathematics. Those learners with positive emotions tend to do better that the ones with negative responses. Hannula (2002) also affirms that emotions towards mathematics are useful in the learning of mathematics and goes on to state that these emotions change quickly. However, Leder and Groottenboer (2005) argue that there has not been conclusive evidence on how emotions will have an effect on learning mathematics as emotions are difficult to measure.

2.3 External factors that influence attitudes.

In addition to looking at the different components that make up attitudes, we can also look at factors that influence these attitudes. Several factors that influence learners' attitudes have been investigated and articulated by different researchers. These factors range from context, gender, school years, parental involvement, friends and teachers (Adebule & Aborisade, 2014; Aiken, 1976; Bayanga & Wadesango, 2014; Flowers, 2006; Haladyna, Shaughnessy, & Shaughnessy, 1983; Kislenko, Grevholm, & Lepik, 2005.; Leder & Groottenboer, 2005; Liu & Koirala, 2009; Mahanta, 2014; McLeod, 1994; Mensah et a*l*., 2013; Mutodi & Ngirande, 2014; de Lourdes

Mata, Monteiro, & Peixoto, 2012; Frenzel, Pekrum, & Goetz, 2007; Steele & Ambady, 2006). Some of these studies have also looked at how the family background or how the society of the learner would have an effect on the attitude of the learner towards mathematics. Some studies done in South Africa showed that the home background factor and attitudes towards mathematics had one of the highest correlations (Bayanga & Wadesango, 2014; Mutodi & Ngirande, 2014). In addition, it was also discovered that in the Maldives, factors such as home background and the level of parental education had an impact on the attitudes that learners exhibited towards mathematics (Mohamed & Waheed, 2011). However, elsewhere, a study carried out in Hong Kong showed that home background such as parental expectations, educational levels of parents, size of household and parent level of support had little or no effect on learner attitudes towards mathematics (Wong, 1992). However, Wong, (1992) argues that there is a relationship between the affective domain and home background as parental involvement could give rise to how the learner will feel towards mathematics.

Another factor that has received numerous attention is gender. Studies have long since been investigating if gender plays a role in learners' attitude towards the learning of mathematics (Adebule & Aborisade, 2014; Chamdimba, 2008; Flowers, 2006; Mohamed & Waheed, 2011). Some studies report that there is no gap between genders when it comes to attitudes towards the learning of mathematics. A study carried out in Nigeria on gender comparisons of attitudes in secondary school showed that there was no significant difference in the attitudes towards mathematics (Adebule & Aborisade, 2014). There was also no significant difference found in the study carried out in the Maldives (Mohamed & Waheed, 2011), and in Pakistan, a study on grade 10 mathematics learners concluded that both male and female have the same type of attitude (Farooq & Shah, 2008). However, there have been some contrasting results from other studies where boys seemed to possess a higher level of attitudes as compared to girls in mathematics as was evidenced in research done in Malawi (Chamdimba, 2008). It was also found that girls have lower confidence levels and tend to be more anxious towards mathematics in the United States (Flowers, 2006). Tella (2007) in his research in Nigeria found out that there were gender differences in the motivation of secondary school mathematics learners where male students seemed to be more motivated as compared to their female counterparts. One of the studies carried out in Europe revealed that on average girls experienced less enjoyment and less pride and also had higher anxiety and felt more hopelessness towards mathematics as compared to boys in the learning of mathematics (Frenzel et al., 2007) It is also

suggested that if girls are subtly reminded of their gender in the learning of mathematics, this could influence their attitude towards mathematics (Steele & Ambady, 2006).

One of the most important influencing factors influencing mathematics attitudes is the teacher. The teacher is said to play a role in how learners relate to the learning of mathematics. Mensah *et al.* (2013) found in their study that the attitude of the mathematics teacher was related to the attitude of the learners that he was teaching. If a teacher exhibited negative attitude, then learners would follow that. de Lourdes Mata et al., (2012) view the teacher and peer support roles as one of the strongest relationship in cultivation of positive attitudes towards the learning of mathematics. Besides the attitude of the teacher, which is seen as responsible for the attitudes of the learners that he or she teaches, Aiken (1972) and Haladyna *et al*. (1983) expound further that the teacher's understanding of mathematics is also important in developing learners' attitudes and their level of confidence. Mji and Makgato (2006) also point out that the underachievement of learners in mathematics could be attributed to under-qualified teachers teaching this subject. They further contend that teachers should be involved in refresher courses so as to gain confidence which will in turn motivate learners in the subject as they argue that motivation comes from confidence (Mji & Makgato, 2006).

2.4 Relationship between attitudes and attainment

The different factors related to attitude will in turn have an effect on how the learners perform in mathematics. It then follows that attitude could have a correlation with mathematical achievement. Studies carried out in different countries have found different outcomes on how attitudes and mathematical achievement correlate. It is argued that learners' attitudes have a bearing on their mathematical achievement (Liu & Koirala, 2009; Mahanta, 2014; Mensah *et al.*, 2013; Nealie, 1969). These studies emphasised different factors. Liu and Koirala (2009) emphasised that self-efficacy is an important factor for mathematical attainment, whereas Mahanta (2014) looked at self-concept as an important aspect of attitude in attainment. Neale (1969) investigated motivational factors and found out that they have a bearing on performance. In yet another study carried out in Nigeria achievement in mathematics was found to be related to motivation (Tella, 2007) where highly motivated learners outperformed the less motivated. In the United States it was concluded that intrinsically motivated black students showed a general improvement in achievement in mathematics (Iben, 1991). A study carried out in Malaysia found out that using a cooperative learning approach increases student's

attitude towards mathematics in turn leading to a better performance (Zakaria, Chin, & Daud, 2010).

However, some studies carried out had some slightly different results. Marchis (2013) postulated that learners' attitudes towards mathematics are related to their problem solving skills. Wong (1992) saw the relationship between attitudes and mathematics achievement as being reciprocal. This meant that if a learner would get a lower mark in mathematics then they would develop a negative attitude and also a negative attitude would result in lower marks. It is contended that levels of intelligence could increase mathematical performance but also parents and teachers shaping learners' perceptions could also improve learner performance in the learning of mathematics (Mutodi & Ngirande, 2014).

2.5 Measuring attitudes

It is generally agreed that it is difficult to measure learner attitudes towards mathematics. This is because attitude is not directly observable (Kislenko et al., 2005). This makes it difficult to develop instruments that could accurately measure attitudes. However, by using instruments that would measure different components of attitude, some measure of success in measuring attitudes could be attained. In measuring attitudes towards mathematics, Aiken (1974) used enjoyment and value as the two scales with questionnaires targeting the two aspects. Fennema and Sherman (1976) have designed a nine scale instrument to measure attitude. Some of the aspects include confidence, anxiety, motivation, usefulness, teacher and parent interest. Tapia and Marsh II (2002) developed a four factor questionnaire that could be used to measure attitudes. Most of these studies make use of questionnaires on a Likert scale, with these questionnaires linked to different aspects of attitudes.

2.6 Conceptual Framework

This research is informed by the framework of the three components of attitudes which are the cognitive, behavioural and affective components (Barmby & Bolden, 2014). The cognitive aspect of attitude is what the individual thinks or believes about mathematics, the affective being the feelings or the emotion that an individual associates with mathematics, and the behavioural is the tendency to behave in a certain towards mathematics (Mensah, Okyere, & Kuranchie, 2013). The three components of attitude will be used in conjunction with the four factor questionnaire developed by Tapia & Marsh II, 2002 which aligns with the cognitive,

affective and behavioural components of attitude (see Table 1). These factors from the questionnaire are self – confidence, value, enjoyment and motivation.

Table 1 shows examples of items (descriptors) from the four factor questionnaire (Tapia & Marsh II, 2002) linked to the attitude components (Barmby & Bolden, 2014).

Table 1

Relating questionnaire items to the components of attitude

Item	Factor	Component
I really like mathematics	Enjoyment	Affective
Studying mathematics makes me feel nervous	Self-confidence	Affective
Mathematics is important in everyday life	Value	Cognitive
The challenge of mathematics appeals to me	Motivation	Behavioural

The results from the research will be compared to the model above.

In summary, this chapter examined findings from other research work on attitude towards the learning and teaching of mathematics. This examination looked at definitions of attitude as relating to this study as well as discussing attitudes components, discussing external factors that influence attitude, exploring literature that have looked at the relationship between attitude and attainment, a brief discussion on how attitude measures could be measured and lastly the discussion on the conceptual framework that would direct the research.

3 Methodology

My study investigated attitudes that learners have towards the learning of mathematics and also looked whether the attitudes attributed by the learners had an effect on the performance of the learners towards mathematics.

3.1 Methods of data collection

The study used a mixed method approach which is an approach "where the research mixes or combines quantitative and qualitative research techniques, methods, approaches … in a single study" (Johnson & Onwuegbuzie, 2004, p. 17). This approach involves a quantitative method which would be used to collect numbers and also a qualitative method which would collect words in the same study (Caracelli & Greene, 1993). The researcher used questionnaires and the June 2016 school mathematics exam results to obtain quantitative data, and the follow-up interviews to get qualitative data so as to get a more detailed and an in-depth understanding of the attitudes that learners exhibit towards mathematic (Creswell, 2012). Additionally, with the mixed-method approach, one could get "elaboration and enhancement" (Greene, Caracelli, & Graham, 1989, p. 259) from those methods. In this study, one could see elaboration and enhancement in the use of the questionnaire giving the researcher the different attitudes components that learners have and then the interview would shed light on why they have those attitudes. The interviews could bring about some more explanations on the attitudes therefore enhancing the results that were obtained from the questionnaires and also explaining more why a certain phenomenon is observed. Caracelli and Greene (1993) argue that using a mixed – method approach could result in measuring different overlapping aspects of the data therefore clarifying the results. In addition, with using qualitative and quantitative methods of collecting data, the researcher might get convergence of results (Greene, Caracelli, & Graham, 1989). In using a questionnaire and interview in the same study, the researcher could also find out if the same components of attitudes from the questionnaire are also mentioned in the interviews.

3. 2 Research Instruments

Since attitudes are "concerned with an individual's way of thinking, acting and behaving" (Mensah, Okyere, & Kuranchie, 2013, p. 132), they could be difficult to measure. There are a variety of approaches and instruments that one could use; these include observations, interviews, questionnaires and tests. Observations are said to involve the researcher in the site of the study to observe or see for themselves what is taking place (Bertram & Christiansen,

2014). With this approach the researcher would not depend on what the participants said or what they thought but would have observed for himself or herself, that is one got firsthand data (Bertram & Christiansen, 2014; Opie, 2004). Observations could be structured or unstructured where in the structured observation a researcher may go through a checklist to check if what he or she wants is in the list. With the unstructured observation, the researcher would be in the field and writing notes on what they are observing (Bertram & Christiansen, 2014; Opie, 2004). Since this particular research project aims at investigating attitude towards mathematics, where one needs to know how participants feel about mathematics and also what make them feel that way, it could be very difficult to observe attitude from the participants. Another way of collecting data is tests. This approach is mainly used in experiments, where a researcher would try to ascertain if a particular intervention strategy works. This involves the researcher giving a pretest to ascertain the level before intervention of the strategy, and then after the strategy giving out a posttest to check if the intervention was effective (Bertram & Christiansen, 2014). The research that I carried out involved investigating the attitudes that learners have towards mathematics only and not on how the attitudes are changed by an intervention, therefore there was no need for pretests and posttests to be employed.

For this study I chose to use a questionnaire as the main instrument to use in investigating the different attitudes that learners have towards mathematics. Questionnaires are listed questions that respondents answer, and these could be open – ended or closed questions (Betram & Christiansen, 2014; Opie, 2004). Closed questions are those questions where respondents are given a choice of responses, while open–ended questions are those where respondents are not offered a choice, with no pre – determined responses from the researcher (Opie, 2004). For my research which involved all learners in the given grades, a closed questionnaire was used. The study was carried out at my school, with the questionnaire given to all learners who do mathematics and mathematical literacy from grade 10 – 12, since my school is from grade 10 -12. The set of responses on the questionnaire that I used was the Likert-scale type with responses ranging from strongly disagree to strongly agree (Appendix 8). The Likert scale is said to be easy to use and the most common when measuring attitudes (Estrada, Batanero, & Lancaster, 2011). This questionnaire would then categorise learners as having positive or negative attitudes. With closed questions, these make it easy for a researcher to categorise the responses.

The questionnaire used was developed by Tapia and Marsh II (2002). This is a forty item questionnaire aimed at measuring different attitude factors, that is, self – confidence, value,

enjoyment and motivation. The questionnaire will provide the quantitative part of the research. The researcher will also use test results (June exams) to compare the scores for learners against their attitudes. This is part of the quantitative research as well.

3.3 Methods of data analysis

As stated earlier, closed questionnaires are easy to categorise. The information that was collected from the questionnaires could then be captured in a computer programme and analysed (Bertram & Christiansen, 2014). As the study involves investigating different dimensions of attitudes, exploratory factor analysis would be used to identify latent variables (Field, 2009). From the questionnaire using this method, one would come up with the different components of attitude, which were found to be value, enjoyment, motivation and confidence in mathematics. Another aspect of the instrument to be measured would be its reliability which would be measured using Cronbach's alpha, where a score of about 0,8 is generally considered to be reliable (Field, 2009). Although it is advised that one could get a high value of α simply because of very large number of items on the questionnaire (Field, 2009), this research study did not have too many items. For comparisons between attitudes and performance, I used correlations between the different attitude dimensions and the test results to see what attitude factors influence test performance. Bertram and Christiansen (2014) caution that in correlations it is not a case of one phenomenon bringing about a change in one another but that the two variables could see be going together. It is generally argued that in research a correlation (r) of about 0,8 is considered to be a strong positive correlation while a value of 0,3 would be weak positive correlation (Opie, 2004). In terms of gender, I then compared average measures of the different attitudes between boys and girls using independent sample t-tests (a statistical test). This test is used to compare the mean from one group with another to check if there are some statistical differences (Bertram & Christiansen, 2014; Field, 2009; Opie, 2004). In this case, the averages for boys is compared to the averages for the girls. However, problems could be faced with the questionnaire if the learners do not read through the questions but rather guess the answers which could result in wrong inferences. Besides not reading through, they could also not understand what the questions mean and end up making up answers from questions that they do not understand (Bertram & Christiansen, 2014). The questionnaire was therefore piloted at a neighbouring school to find out if learners comprehended the language. Opie (2004) advises that questionnaires need to be piloted so as check for the length and also any confusion that could be presented by the questions. After the pilot stage the researcher modified the forty

item Tapia and Marsh questionnaire by adding two more questions. This was done in cases where an item was broad and needed to be broken into two parts for easy understanding.

I also used interviews as an additional instrument for the qualitative aspect of the research. Based on the questionnaire responses, I followed up by carrying out interviews with a few chosen learners based on gender and choosing those with negative attitude towards mathematics (n=10). These interviews where spread across the grades (10 – 12). The interview comprised of questions with the aim of finding out more about their attitudes towards mathematics, including what factors influence their attitudes. The interview questions would then endeavour to answer the third research question aiming at finding out what could be some of the factors that influence learner attitudes towards mathematics. It is possible to get an in-depth or more detailed information from an interview as the researcher can ask follow up questions (Bertram & Christiansen, 2014).

The sample size for my research was quite large (n =231) hence the use of the questionnaire as the questionnaire could easily be administered to large groups (Bertram & Christiansen, 2014). This would then enable me as the researcher to find out if learners have either relatively positive or negative attitudes in each of the components. However, it could be difficult to ascertain some underlying reasons why these learners have such attitudes. It is advised by Opie (2004) that while answers as to what, where, and when can easily be found out from participants in questionnaires, it is not always easy to find out why. It is for this reason that after the questionnaire, I had a one- on- one interview sessions with a small number of learners (n = 10) to get in-depth information on their attitudes towards mathematics. An interview is a dialogue between a researcher and participant, whereby the researcher has some predetermined information that he or she wants to elicit from the participant. (Bertram & Christiansen, 2014; Opie, 2004). The researcher used a set of eight structured questions for the interviews. Although the researcher followed the structure of the laid down questions, follow-up questions were asked by the researcher to get as much detail as possible. These interviews were recorded so as to be analysed later. This was aimed at helping me as the researcher to get clarity on why they have positive or negative attitudes towards mathematics. It is suggested that through interviews, the researcher could make the questions clear as opposed to a questionnaire, therefore one is likely to get more information (Bertram & Christiansen, 2014; Opie, 2004). This was also help me answer questions that pertain to learners' attitudes and their performance, particularly whether they believe that these attitudes would have an effect on

their performance. If more clarity could be extracted from the interviews, one has to be mindful of the fact that I was going to be asking questions to some students that I teach, and as such some personal relations may come into play, or some learners may be embarrassed of being found out that they do not like mathematics (Bertram & Christiansen, 2014). It is therefore important to assure the participants that the information will not prejudice the teacher – learner relationship. It is also observed that interviews may take time to do and also to analyse (Creswell, 2012), hence the researcher used only ten learners so as have time analyzing the results.

3.4 The Sample

The sample consisted of all 231 mathematics or mathematical literacy learners in one school from grades 10 – 12 for the questionnaires on their attitudes towards mathematics. This was because the learners who do mathematics or mathematical literacy are within the school that I teach and also were willing to take part or were accessible to the researcher, therefore convenient sampling was used (Teddlie & Yu, 2007; Kitchenham & Pfleeger, 2002). For the interviews a total of 10 learners were chosen based on gender and also based on their responses from the questionnaires. Learners who had relatively negative attitudes were targeted as the researcher wanted to find out in more detail about their negative attitudes. This was therefore purposive sampling. In purposive sampling the researcher deliberately looks at participants with the desired qualities and which appears to represent the targeted learners. (Koerber & McMichael, 2008; Teddlie & Yu, 2007).

3.5 Issues of validity and reliability

Zohrabi (2013) contends that in using both qualitative and quantitative approaches a researcher aims at enhancing the validity and reliability of the data. This research used the mixed methods approach with the intention of legitimizing the validity and reliability of the research. By using interviews and questionnaires in the same study, the researcher aimed at validating the results. In interviews the researcher would complement the questionnaires by providing some in – depth information as interviews tend to probe further on the learners' attitudes as advocated by Zohrabi (2013). While the use of closed – ended questionnaires would provide quick responses that are not ambiguous, the responses could not cover all aspects on how an individual feel.

However, Onwuegbuzie and Johnson (2006) warn that in mixed methods research, both validity and reliability are not clear cut. They however contend that by using mixed methods research one is able to examine different perspectives of the study even if both qualitative and quantitative approaches would bring about validity problems in the study. In this research, the researcher was dealing with the numbers that were obtained from the questionnaire as well as the marks of learners, while with qualitative part of the data collection would be dealing with evaluating what participants say coupled with interpreting their feelings (Onwuegbuzie & Johnson, 2006).

In addition, the researcher gave peers and the research supervisor the questions that where to be on the questionnaire so that they could also ascertain their validity. It is emphasised that peer reviews are important so as improve the accuracy of the instrument to be used (Morse, Barrett, Mayan, Olsen, & Spiers, 2002). In the case of my study the validity of my instrument was important as one had to make sure that the instrument produces credible results. It is underscored that validity examines whether instruments measure what they intend to measure (Opie, 2004). The issues of validity were relevant to my research as I would have liked the responses from the learners to give categories of attitudes. To avoid misunderstanding from the learners, I also tried to simplify the English in the questions in the already prepared questionnaire if there was need so that learners are able to answer these. Questions that had been reviewed by peers where then taken to a pilot sample so as to check if learners were able to understand the language in the questionnaires. This could help to find out if the questions were clear, and also if there were some questions that people were not comfortable with (Opie, 2004). Bertram and Christiansen (2014) further emphasise that if one is piloting an instrument, then the piloting should have the same context as the place for the main study. If one intends to do a study in a township school to a group of learners who use English as a second language, then the questions should be piloted in a school which is also in a township and also has English as a second language.

In terms of reliability, the internal reliability of the instrument was measured. This was done using a statistical computer programme where Cronbach's alpha was measured. Regarding this internal reliability, it is advised that "the usual way to look at reliability is based on the data that individual items (or sets of items) would produce results consistent with the overall questionnaire" (Field, 2009, p. 674). The questionnaire items where tested and some items were excluded after the reliability test.

In addition, from the interviews, one could also assess if the interviews and the questionnaire brought out similar information or not. This could also have added credibility to my results. Given in the appendices are sample questions for the questionnaire followed by the interview questions used.

3.6 Ethical Issues

The research was carried out at a school with learners as the participants in interviews and questionnaires, and as such, ethical issues were considered during the research process. Behi and Nolan (1995) advise that in conducting the research that involves human beings, issues such as anonymity, confidentiality, respect and dignity are important considerations. In doing the research, the research had to consider these facts as well. Since learners are minors, consent forms were given to parents and also learners in the study so that they could understand the research (Appendices 2, 3, 4 and 5). An application was sought from the Gauteng Department of Education to ask for permission to do the study at the school (Appendix 6). Permission was also given by the university to carry out the study (Appendix 7).

Regarding the privacy of the learners and the institution (Behi & Nolan, 1995), they did not write their names or the name of the school on the questions but instead wrote numbers that could only be identified by the researcher so that the researcher could select learners for interviews. The researcher did not write the names of the learners on the interview recordings. The questionnaires and the interviews recordings would be kept safe as the researcher works on the project.

4 Results

As mentioned in the methodology, data was collected using the questionnaires and interviews as well as using the June results for 2016. The results are presented below starting first with the questionnaire results from the adapted Tapia and Marsh questionnaire, showing through statistical analysis the dimensions of attitudes that emerge. Secondly the results showing the reliability analysis for the dimensions are presented. This is followed by correlational comparisons of each dimension with the June examination results for the learners, then the comparing of the attitudes measures and the test results between male and female learners using the independent sample t–test. The last part of this chapter presents the interview results where particular themes emerged from the analysis of the interviews.

4.1 Questionnaire results

From the questionnaire given to the learners, quantitative results were obtained. The items on the questionnaire were based on a Likert Scale and from these four dimensions emerged.

4.1.1 Initial analysis

The aim of the initial analysis was to check for dimensions in the Tapia and Marsh questionnaire, and to check on the reliability of the emerging dimensions. Using exploratory factor analysis with rotated varimax approach, the following dimensions emerged (only loadings greater than or equal to 0.4 are included in Table 2):

Table 2

Dimensions of attitudes emerging from the exploratory factor analysis

	Dimension			
	1	2	3	4
*My mind goes blank and I am unable to think clearly when working with numbers	0.727			
*It makes me uneasy to even think of having to do a mathematics problem	0.714			
*I am always under terrible strain in maths class.	0.692			
*I hesitate to do maths problems	0.677			
*I am always confused in a maths class	0.638			
*Studying mathematics makes me feel nervous/uneasy	0.633			

*Mathematics makes me feel uncomfortable	0.599			
*I dislike mathematics	0.58	0.464		
*Mathematics makes me feel irritable	0.542			
*I am inpatient when solving maths problems	0.504			
I plan to take as much mathematics as I can during my education		0.715		
I am willing to take more than the required amount of mathematics		0.65		
I like to solve new problems in mathematics		0.573		
I think studying advanced mathematics is useful		0.556	0.412	
I am happy in my maths class that other classes		0.554		
Mathematics is very interesting to me.		0.528		0.417
The challenge of maths appeals to me		0.516		
I would prefer to write a maths assignment than write an essay		0.491		
I really like mathematics		0.469		0.406
I expect to do fairly well in my maths class.		0.443		
I believe studying of maths helps me with problem solving in other subjects.		0.417		
*I would like to avoid mathematics courses in future		0.412		
Mathematics is one of the most important subjects for people to study			0.706	
Mathematics is important in everyday life			0.688	
Mathematics helps develop the mind and teaches a person to think			0.684	
I want to develop my mathematical skills			0.65	
Mathematics is very useful and necessary subject			0.625	
A strong maths background will help me in my professional life			0.535	
High school mathematics would be important no matter what I decide			0.441	
I am able to solve mathematics problems quite easily				0.706
Mathematics does not scare me at all.				0.674
I have a lot of self- confidence when it comes to mathematics.				0.67
I feel I am good at solving problems				0.597

I am comfortable answering maths problems in class	0.574
I learn mathematics easily	0.563
*Mathematics is one of the most feared subjects	0.434
I get a great deal of satisfaction out of solving a mathematical problem	0.433

* These items were reverse coded.

From the above analysis, the breakdown is seen as follows. There were four dimensions regarding anxiety about mathematics (dimension 1 - 10 items), motivation/enjoyment of mathematics (dimension 2 - 13 items), importance/value of mathematics (dimension 3 - 8 items) and confidence in mathematics (dimension 4 - 10 items). The 10 items of anxiety referred to mathematics as causing strain, making the mind go blank, feelings of uneasiness, uncomfortable, impatient, irritable, nervous and confused. The 13 items on motivation/ enjoyment of mathematics referred to mathematics as interesting, appealing, liking to solve problems and being happy in the mathematics class. The 8 items of importance/value in mathematics referred to mathematics as important, as background for professional life, necessary, and to be developed further. The 10 items on the last dimension referred to doing mathematics fairly well, not being scarred of mathematics, learning mathematics easily, being good at solving mathematical problems and getting a great deal of satisfaction when doing mathematics.

Examining the items included in each dimension, the dimensions were identified as follows:

Dimension 1: Anxiety about mathematics
Dimension 2: Motivation/enjoyment in mathematics
Dimension 3: Importance/value of mathematics
Dimension 4: Confidence in mathematics

These dimensions correspond to the original dimensions identified by Tapia and Marsh.

Following the identification of dimensions, reliability analysis was carried out for each group of items. For items that appeared on more than one dimension, they were only included with the dimension for which they had the higher loading value in the factor analysis. Also, if it

was found that the reliability was improved with the exclusion of other certain items, then these were removed as shown below:

Dimension 1: Anxiety about mathematics:

*My mind goes blank and I am unable to think clearly when working with numbers
*It makes me uneasy to even think of having to do a mathematics problem
*I am always under terrible strain in maths class.
*I hesitate to do maths problems
*I am always confused in a maths class
*Studying mathematics makes me feel nervous/uneasy
*Mathematics makes me feel uncomfortable
*I dislike mathematics
*Mathematics makes me feel irritable
~~*I am impatient when solving maths problems~~

Resulting Cronbach alpha reliability for anxiety dimension = 0.88.

Dimension 2: Motivation/enjoyment in mathematics:

I plan to take as much mathematics as I can during my education
I am willing to take more than the required amount of mathematics
I like to solve new problems in mathematics
I think studying advanced mathematics is useful
I am happy in my maths class that other classes
Mathematics is very interesting to me.
~~The challenge of maths appeals to me~~
I would prefer to write a maths assignment than write an essay
I really like mathematics
I expect to do fairly well in my maths class.
I believe studying of maths helps me with problem solving in other subjects.
*I would like to avoid mathematics courses in future

Resulting Cronbach alpha reliability for motivation/enjoyment dimension = 0.86.

Dimension 3: Importance/value of mathematics:

Mathematics is one of the most important subjects for people to study
Mathematics is important in everyday life
Mathematics helps develop the mind and teaches a person to think
I want to develop my mathematical skills
Mathematics is very useful and necessary subject
A strong maths background will help me in my professional life
High school mathematics would be important no matter what I decide

Resulting Cronbach alpha reliability for importance/value dimension = 0.79.

Dimension 4: Confidence in mathematics:

I am able to solve mathematics problems quite easily
Mathematics does not scare me at all.
I have a lot of self- confidence when it comes to mathematics.
I feel I am good at solving problems
I am comfortable answering maths problems in class
I learn mathematics easily
~~*Mathematics is one of the most feared subjects~~
I get a great deal of satisfaction out of solving a mathematical problem

Resulting Cronbach alpha reliability for confidence dimension = 0.85.

Based on the above grouping of items, average measures of attitude for each dimension were calculated for each learner.

In order to answer the first question of the research, the correlations between the June test results and the dimensions of attitudes were measured. This was done for both maths and math literacy learners.

4.1.2 Looking at the relationship between attitude dimensions and exam results

Looking at the correlation values for the grade 10 to 12 maths and maths literacy students (**Tables 3 to 8**):

Table 3

Correlation of the attitude dimensions with maths exam results (Grade 10)

Dimension	Correlation with June exam results
Anxiety about mathematics	0.34
Motivation/enjoyment in mathematics	0.05
Importance/value of mathematics	0.22
Confidence in mathematics	0.08

Table 4

Correlation of the attitude dimensions with maths lit exam results (Grade 10)

Dimension	Correlation with June exam results
Anxiety about mathematics	-0.35*
Motivation/enjoyment in mathematics	-0.37*
Importance/value of mathematics	-0.07
Confidence in mathematics	-0.19

Table 5

Correlation of the attitude dimensions with maths exam results (Grade 11)

Dimension	Correlation with June exam results
Anxiety about mathematics	0.27
Motivation/enjoyment in mathematics	0.22
Importance/value of mathematics	0.22
Confidence in mathematics	0.28

Table 6

Correlation of the attitude dimensions with maths lit exam results (Grade 11)

Dimension	Correlation with June exam results
Anxiety about mathematics	0.38*
Motivation/enjoyment in mathematics	0.22
Importance/value of mathematics	0.36*
Confidence in mathematics	0.27

Table 7

Correlation of the attitude dimensions with maths exam results (Grade 12)

Dimension	Correlation with June exam results
Anxiety about mathematics	0.43*
Motivation/enjoyment in mathematics	0.52*
Importance/value of mathematics	0.47*
Confidence in mathematics	0.60*

Table 8

Correlation of the attitude dimensions with maths lit exam results (Grade 12)

Dimension	Correlation with June exam results
Anxiety about mathematics	0.34*
Motivation/enjoyment in mathematics	0.12
Importance/value of mathematics	0.17
Confidence in mathematics	0.35*

Quite mixed results were obtained for the correlations between the attitude measures and the June exam results. It looks like for Grade 10, exam scores were only weakly or even negatively correlated with attitude measures. However, as we move up the grades, the positive correlations between scores and attitude measures become more significant (correlations with a * were significant at the $p = 0.05$ significance level), with the correlations between the attitude measures and the exam results for the Grade 12 maths learners being quite large (between 0.43 and 0.60).

4.1.3 Looking at gender differences

To answer the second research question, independent sample t-tests were carried out to compare the average attitude measures for the female and male learners in the sample:

Table 9

Results of the independent samples t-tests for comparing the attitudes of males and females

Variable	Females	Males	Females - Males	t-value	df	p
Anxiety about mathematics	3.0	3.2	-0.2	-1.944	229	0.053
Motivation/enjoyment in mathematics	3.2	3.6	-0.4	-3.996	229	< 0.05
Importance/value of mathematics	4.0	4.2	-0.2	-2.171	229	<0.05
Confidence in mathematics	2.8	3.3	-0.5	-4.793	229	<0.05

For three of the attitude dimensions, the difference between female and male learners was significant in favour of male learners.

4.1.4 Looking at differences between maths and maths lit students

Independent sample t-tests were also carried out to compare the average attitude measures and the average exam results for the maths and maths lit learners in the sample:

Table 10
Results of the independent samples t-tests for comparing the attitudes of maths and maths lit learners

Variable	Maths	Maths Lit	Maths–Math Lit	t-value	df	p
Anxiety about mathematics	3.2	3.0	0.1	1.197	229	0.233
Motivation/enjoyment in mathematics	3.4	3.4	0.0	0.271	229	0.786
Importance/value of mathematics	4.1	4.0	0.1	1.175	229	0.241
Confidence in mathematics	3.0	3.1	-0.1	-1.101	229	0.272

There were no significant differences in the attitude measures between these two groups of learners. The results show that the learners have almost the same attitude towards mathematics in both subjects, that is, mathematics and mathematical literacy.

4.2 Interview results

In order to answer the third question, interviews were carried out with ten learners to find out more about their attitudes. Based on the four measures of attitudes, the four lowest scoring (i.e. most negative) learners on each of the dimensions were chosen for interviews. Because some learners scored low on more than one dimension, this resulted in ten learners being chosen for interview. Each interview lasted about 8 – 12 minutes depending on the explanations from the learners and each interview was recorded. Then each interview was transcribed. From the interviews, the research looked for particular themes that were related to the attitudes that learners had towards mathematics. After listening to the interview each theme was picked from each learner and tallied.

Table 11

The results show themes identified from the interviews

Major Themes identified	**Subthemes**	**Number of interviewees identified within the theme**
Enjoyment	Enjoy mathematics	1
	Not enjoy mathematics	4
	Frustrating	4
	Complicated	1
	Difficult	8
Motivation	Highly motivated	2
	Motivated sometimes when I understand	1
	Confident	1
	Not confident	6
	Not motivated	7
Importance of mathematics	Important	6
	Not important	3
Anxiety		9
Social Issues	Gender importance (girls have a negative attitude)	9
	Teacher	3
	Pressure from the society	4
	Pressure from other learners	4
	School set up	2

The results from the themes are explained below and also relating the themes to the various dimensions of attitude.

4.2.1 Enjoyable/Not enjoyable/ Frustrating/Complicated/ Difficult – Enjoyment dimension

Learners thought that mathematics was complicated (one learner) for them as more topics are piled on top of each other and yet they do not understand the previous topic. They expressed the fact that they were frustrated (four learners) as they kept on doing one and the same problem but failing to do it. One learner lamented "I keep doing problems without getting the right solution". Some also said that they have been failing mathematics from term one to term four coupled with the fact that they just do not understand the mathematics, and as a result were very much frustrated by this. This frustration and complication has led them to hate mathematics and they do not enjoy the subject at all. Some said that there are times when they enjoy the subject and that would be the time when they understand it. On the difficulty of mathematics learners (eight) felt that they would never ever understand the subject as it was very much challenging to them. One of the learners expressed "Do not like maths, it's hard. I fail maths from term 1 to term 4 and pass other subjects, exams are always difficult. You write and get maybe 10 out of 50".

4.2.2 Motivated/ not motivated / highly motivated/ confidence/ not confident- Motivation dimension

From the ten interviewees only one learner said he felt confident when doing mathematics as he understood the subject most of the time. About six learners said they were not confident at all about mathematics as they have already told themselves that they could never do the subject. On motivation, two learners said they were motivated to study the subject as they wanted to be successful and mathematics is the gateway to success. Whether it was difficult or not they had to work hard on it. Seven learners felt that there was nothing in them when it came to maths and therefore not motivated to study the subject. Those who do mathematical literacy felt that mathematical literacy was inferior and as such even if they studied the subject their chances of making it in life was already low because of the mathematical literacy that they were doing. Some learners said they were not given a choice but had to do mathematical literacy that they

did not like and therefore not motivated enough to study the subject. Also on motivation, two learners felt that they were not motivated because teachers comment badly on learners who have failed and also that society tends to divide people on ability; those who are good in mathematics are told that they can and will achieve while struggling learners are told that mathematics is not for them. As one learner lamented "I am not being told that I can, no fairness as teachers move on when only a few people understand and those are the learners expected to understand". Some of the learners felt that they were not motivated as teachers do not change teaching methods, as one commented "I get to understand I enjoy, and if a teacher shows me something new in how to solve a problem and if maths was presented in an interesting way and with prizes I will be very interested".

4.2.3 Important/ not important – Value/ important dimension

Six learners felt mathematics was important in their lives as the subject helps them in day to day life. They cited mainly financial mathematics as they use this in everyday life. Some learners emphasised the fact that most fields that are high paying require mathematics as a base. They also expressed the idea that at higher institutions mathematics is important. As elaborate by one learner: "Most universities want maths and many other jobs- it is difficult to get to university with maths lit". However, three learners (mathematical literacy) felt the subject was not important at all as some universities look down upon the subject.

4.2.4 Anxiety

Nine learners from the interviews said they were very anxious when doing mathematics or when they are about to write a test in mathematics. The emphasis on maths and the general respect that society places on the subject puts pressure on them as the society and other learners believe that if one fails mathematics, then they are not good enough for the society, therefore making the learning of the subject strenuous. The society that they live in views mathematics as hard or difficult and anyone who can do it is generally respected and learners find it hard to cope with the expectations of the society. "I have pressure to pass maths, this is where respect lies" explained a learner. Adding on to the pressure is when they are about to write an exam; the anxiety is worse as they know that more than 50% - 90% of the paper they do not know, as explained: "When I write am always under pressure because I am afraid of failure". One of the

learners said “I am depressed; I have tried all but it does not work for me so I feel uneasy in maths”.

4.2.5 Social Issues

Ninety percent of the interviewees felt that girls were generally weak in mathematics as compared to boys. The reasons ranged from the fact that girls have many chores to do at home limiting their study time; therefore, they do not have enough practice in mathematics which needs learners to practice most of the time. Therefore, they lose interest as they would not understand most of the time. Another reason cited was that for girls from a young age the society they are in dictates that boys are there to think while girls are to be submissive and listen to their male counterparts. This gives rise to the notion that girls are good in number patterns while boys are good at solving problems in Euclidian geometry and also algebra. One learner shared the view that “Girls are good in number patterns, boys are good in geometry because of their position in society”. It is for this reason that girls tend to doubt themselves and develop negative attitude towards mathematics. Four learners also cited other learners as putting pressure on them when it came to learning mathematics, as other learners would laugh at them when they are not able to solve mathematical problems as they are perceived as stupid or not intelligent. One learner said “Girls fear maths and they do not want to try because they do not want to be laughed at”.

4.2.6 School setup

The policy by the school that some learners are forced to move from mathematics to mathematical literacy also deters some learners from working hard in mathematical literacy because they would have chosen mathematics as their subject of their choice. They would develop a tendency not to like mathematical literacy and despise it therefore getting a negative attitude towards it. “When I came to this school, because I was new, I was made to do maths lit and I do not like and am now told it is too late to change to maths” complained one learner.

5 Discussion of results

The study undertook a methodological approach to identify different components of attitudes held by learners in the learning of mathematics in grades 10 – 12 in one school in Soweto. The research started with the quantitative part of the research which involved the identification of attitudes dimensions/components from the questionnaires. The following is a discussion of the results starting with addressing the research questions and later discussing the dimensions that emerged from the study.

5.1 Answering research question 1

In order to answer the first research question, namely 'What is the relationship between attitudes towards mathematics and learner achievement in mathematics, and what aspects of attitude have the greatest influence?', correlations between the four attitudes measures and the June examination scores for the learners were calculated. This comparison was carried out grade by grade and also separately for mathematics and mathematical literacy learners as the learners did not write the same test. Starting with the grade 10s, the results showed only weak correlations between the attitudes measures and the June examination for mathematics with anxiety having the highest correlation of 0,34 (Table 3). Table 4 shows the correlation between attitudes measures and achievement in mathematical literacy. The results show that the correlations were negative for anxiety and motivation with the other attitude measures being weakly negative as well (Table 4). Therefore, for the grade 10 learners, it was concluded that the attitude measures did not correlate strongly with the exam scores. The results for grade 11 however showed that there was a general positive correlation between attitude measures and examination marks for these particular learners. Correlation values were around 0,25 for the maths learners and were closer to 0,4 for anxiety and importance for the grade 11 maths lit learners. The grade 12 figures showed a very significant correlation for mathematics with all attitude measures having quite high correlation (Table 7). For grade 12 mathematical literacy learners the correlation was also significant for anxiety in mathematics at 0,34 and confidence at 0,35, although the attitude measures were only weakly correlated with motivation/enjoyment at 0,12 and importance of mathematics at 0,17 (Table 8). For all the three grades, it was therefore concluded that that the correlations between the attitude measures and examination scores get more significant as one moves from grade 10 to grade 12. A possible reason for this observation could be that as learners move from one grade to another, they would have had

more feedback on their marks and therefore their attitudes would become more in line with their scores

When comparing the qualitative and the quantitative results there seemed to be a general agreement between the two sets of results during this research. For the interviews, learners with negative attitudes in the four dimensions were chosen. We would therefore expect the chosen learners to be anxious about mathematics, and indeed this was expressed by most of the learners during their interviews (9 out of 10), namely that mathematics makes them anxious especially when they are about to write examinations. As far as confidence is concerned, in the qualitative results, 6 learners out of the 10 expressed the fact that they were not confident at all when they do mathematics.

The correlation findings seem to agree with some literature where attitudes in mathematics seemed to have an effect on the learners' achievement. Although the comparisons between dimensions and the examination results were found to be weakly correlated especially for grade 10, there is some general agreement with some of the studies elsewhere where learners' attitudes have a bearing on their mathematical achievement (Liu & Koirala, 2009; Mahanta, 2014; Mensah *et al.*, 2013; Nealie, 1969). These studies emphasised different factors. Liu and Koirala (2009) emphasised that self-efficacy is an important factor for mathematical attainment where learners who believed in their abilities had better attainment levels as compared to learners who had a low belief in themselves. Mahanta (2014) looked at self-concept which is seen as the learner individual thoughts about the subject,and concluded that this was an important aspect of attitude in attainment. In the present study, confidence was seen as the most highly correlating factor for grade 12 learners.. Neale (1969) investigated motivational factors and found out that they have a bearing on performance. In yet another study carried out in Nigeria achievement in mathematics was found to be related to motivation (Tella, 2007). A study on mathematical anxiety carried out in three countries, that is, China, Taiwan and the United States of America, indicated that mathematics anxiety tends to inhibit learners' achievement (Ho, *et al*., 2000). The results from the present study also showed that there were learners who disliked mathematics as observed during the interviews, and these learners linked these feelings to their performance in the subject. This could mean that feelings towards the subject has a bearing on their perfomarnce as observed in other studies (Crano & Prislin, 2006; Mensah, et al., 2013; Ruffell, Mason, & Allen, 1998). However, we must be careful to note that the correlation results do not imply causality. In the interviews, the learners seemed to

imply that the poor performance brought about their negative attitudes, rather than the attitudes causing the poor attainment.

5.2 Answering research question 2

To answer the second part of the research question which aims to seek if attitudes towards mathematics are gender related, independent sample t-tests were carried out to compare the average attitude measures for the female and male learners in the sample (Table 9). The quantitative results showed that there was a significance difference in learner attitudes in favour of boys. This is in disagreement with some studies done in some parts of the world where it was found that there were no significant differences between girls and boys in attitudes towards mathematics. Theses studies were carried out in Nigeria (Adebule & Aborisade, 2014), in the Maldivies (Mohamed & Waheed, 2011) and in Pakistan by (Farooq & Shah, 2008). The qualitative results in this study provided further details, revealing that some learners believe that girls have a negative attitude towards mathematics and that girls do not believe in their abilities. This is in agreement with Chamdimba (2008) who carried out a study in Malawi and found that boys have a generally better attitude towards mathematics as compared to girls. Flowers (2006) also found out that girls tend to have a lower confidence in mathematics in some of the schools in the United States of America and also Tella (2007) found out that in some parts of Nigeria boys are motivated to do their mathematics when compared to their girl counterparts. From the dimensions measures, the results are in favour of the boys in 3 out of 4 dimensions (Table 9) where the boys seem to be influenced by confidence, enjoyment and are generally motivated. This is also consistent with some of the findings (Frenzel et al., 2007) where they found out that girls experienced less enjoyment and less pride and also feel hopeless in the learning of mathematics. However, differences in anxiety (Table 9) seems not to be significant when comparing the t – test for boys and girls and this result is in constrast with Frenzel et al., (2007) where they established that girls are likely to be more anxious when doing mathematics when compared to boys.

This could mean that attitudes are a result of the social organisation of the community. In this particular community where the study was carried out, girls are expected to do house chores and by the time they try to work on their mathematics they would be tired and possibly develop that negative attitude. This could be taken to be in agreement with Steele and Ambady (2006)

who found that if girls are stereotyped, this could have an influence on their attitudes towards the learning of mathematics. This could mean that attitudes towards mathematics are not universally the same, and there would be a change from community to community depending on their cultural beliefs. This is also seen to be consistent with the literature where different studies from the same country will not always yield the same results (Flowers, 2006). Also seen in Nigeria, Adebule and Aborisade (2014) and Tella (2007) found that different studies produced slightly different results depending on which part of Nigeria the research was carried out.

5.3 Answering research question 3

The qualitative part of the results was mainly aimed at answering the third question where the study sought to find out if there could be some external factors that could have an effect on the attitudes towards mathematics. These are some of the factors that emerged from the interviews:

1. Mathematics is difficult
2. Mathematical literacy is inferior
3. Teacher and society viewing mathematics as difficult
4. Pressure from the society to pass mathematics
5. Examination pressure
6. Teacher and society respecting those that are good in mathematics
7. School policy on forcing weak learners to do mathematical literacy
8. Gender.

The results showed that teachers and the society in general will have a bearing on how learners treat the subject. Three out the ten learners in the interviews felt that how the teacher views the subject and how he or she comments on their progress could change their attitudes depending on whether the comments are positive or negative. Some of the views expressed during the interviews such as the fact that girls are supposed to be good in number patterns and not in geometry could lead to negative attitude towards mathematics. If other learners express this view then girls would likely believe it de Lourdes Mata et al., (2012) and that peer support has a relationship with how girls will develop their attitude towards the learning of the subject. Mensah et al. (2013) concur to say that the attitude of the teacher will have an effect on the attitude of the learners. Aiken (1970) suggested that the understanding of the teacher will have

an impact on learner attitude and this was also expressed by the learners when they suggested that teachers should use different methods so as to make the subject interesting for them. The same view was expressed by Mji and Makgato (2006) when they found that a teacher's knowledge and methodology could be vital to learners performance in mathematics. The society's expectations and their views that mathematics is difficult also has an effect on learner's attitude. From the results in the present study the learners explained that parents' and society's view that those who are good in mathematics are to be respected and those who struggle are looked down upon puts a lot of pressure on them. It could therefore be argued that learners will be anxious to achieve and end up hating the subject because of the expectations from parents and the community. Bayaga & Wadesango, (2014); Mutodi & Ngirande, (2014) in their studies carried out in South Africa also acknowledge that there is a correlation between home background and attitudes towards mathematics. They also cite parents involvement as also key towards how learners will view mathematics. This could mean that as parents criticise their children for not being good in mathematics, they would in turn not like the subject. This could be seen to contrast to observations by Wong (1992) whose study in Hong Kong found that parents' involvement will not have an effect on learner attitude on learning of mathematics. However Wong (1992) asserts that parental involvement will only influence the learner's affective domain which seems to be in agreement to what the learners highlighted in the interviews.

The qualitative results also showed that some of the negative attitudes towards mathematics result from the fact that learners are forced to move from doing mathematics to mathematical literacy (2 learners). This is further compounded by the fact that mathematical literacy is seen as inferior to mathematics as 4 of the learners asserted. This could be seen to further make learners have a negative attitude towards the subject as it is seen as not very important. These interview results are in contrast to the quantitative results which showed that there was no significant difference between attitudes measures for learners in the two subjects (Table 10). It is worth noting that most of the issues raised by the learners from the interviews are seen as causing or developing in learners some attitudes towards the learning and teaching of mathematics.

Finally, we can examine how well the Tapia and Marsh questionnaire worked for identifying learners' attitudes towards mathematics in the particular context of this study. The exploratory

factor analysis carried out found that the following attitude dimensions emerged from the study (with example items):

Dimension 1: Anxiety about mathematics

My mind goes blank and I am unable to think clearly when working with numbers
It makes me uneasy to even think of having to do a mathematics problem
I am always under terrible strain in maths class.

Dimension 2: Motivation/enjoyment in mathematics

I plan to take as much mathematics as I can during my education
I am willing to take more than the required amount of mathematics
I like to solve new problems in mathematics

Dimension 3: Importance/value of mathematics

Mathematics is one of the most important subjects for people to study
Mathematics is important in everyday life
Mathematics helps develop the mind and teaches a person to think

Dimension 4: Confidence in mathematics

I am able to solve mathematics problems quite easily
Mathematics does not scare me at all.
I have a lot of self- confidence when it comes to mathematics.

There seems an agreement with previous literature as these were the same as the factors identified by Tapia and Marsh (2002). In this research, the researcher included anxiety as one of the dimensions and also grouped together motivation and enjoyment. These dimensions were then confirmed using the reliability analysis calculating Cronbach's alpha. After this analysis, one item was removed from the anxiety dimension so that the remaining items had a 0,88 score which is considered reliable on the Cronbach's score. Also eliminated was one item from the confidence dimension giving an overall score of 0,85. The identification of the dimensions of the attitudes was seen as an advantage in that it would be easy to use these when one compares each dimension to the June examination results.

Although it has been stated before that measuring of attitudes is difficult, by using the Tapia and Marsh questionnaire and attitude components, the study was able to measure the attitudes that are exhibited by the learners towards the leaning of mathematics. From the given results, it could be seen that the slightly modified Tapia and Marsh questionnaire worked quite well in the South African context revealing results that seem to be in agreement with literature from

other studies carried out in different parts of the world. From Tapia and Marsh, two factors, that is, motivation and enjoyment were combined as the researcher felt that if one enjoys what they do, he or she will be motivated in performing that particular task. Another factor of anxiety was added as the fourth factor on the Tapia and Marsh. The questionnaire seemed to work well as the different attitudes dimensions were seen to emerge from the given instrument. The use of interviews also provided further insight into the attitudes exhibited by learners and some explanations on why learners have attitudes towards mathematics. It could be argued that by using mixed methods in attitude research as in this research, one is able get more detailed results as shown from this study.

6 Conclusion

This study on attitudes revealed that there were some correlations between the attitudes of the learners towards mathematics and their performances in subject at school. The results of the research showed that for both mathematics and mathematical literacy there is a general positive correlation between student performance and their attitudes towards the subject. For all the three grades, it was therefore concluded that that the correlations between the attitude measures and examination scores get more significant as one moves from grade 10 to grade 12. The quantitative results showed that there was a significance difference in learner attitudes in favour of boys in this school. The findings also highlighted some other aspects that have an influence on attitude towards mathematics. It became evident from both the quantitative and the qualitative results that gender is one of the factors that plays a role in learner attitude towards mathematics, with girls showing less positive attitudes. Some of the factors that impacted on attitude towards mathematics were the role of the teacher in how he or she communicates with learners or how learners communicate with each other regarding mathematics, school policy on the choice of mathematics and mathematical literacy, society's views on mathematics, pressure to perform in examinations and the inferiority of mathematical literacy in the workplace.

From the results, it could be seen that the cultivation of a good learning atmosphere by the teacher could be key in trying to develop better attitude from the learners. How one communicates with learners is important, as through this communication one could develop positive attitudes in learners. It is also imperative that learners are given proper guidance in the

choice between mathematics and mathematical literacy so as to make them to make an informed decision therefore avoiding them being frustrated in the subject choice that they do not like. As a teacher one should be careful on what is said about mathematical literacy as negative comments about the subject could lead to learners not taking the subject seriously or thinking that it is for the not so gifted. Shaping the emotions of learners could also be of paramount importance, especially the girl child where it was observed that girls have low confidence in mathematics as a result of some societal beliefs. Encouragement for the girl child and not stereotyping could also help in promotion of some better attitudes towards mathematics.

The study was carried out in one school and one with only 231 learners taking part. Only 10 learners were sampled for interviews and it could be argued that one did not get sufficient information from only 10 learners to interview. As it was done in one school, one could not generalize the results. Future research could investigate the roles of gender in mixed schools and also in girls' only schools to find out if it is they have the same attitude. This could help to investigate girls' confidence, anxiety and enjoyment when in girls' only schools to compare with this in when in mixed schools. Another area of study could focus on different communities and establish if societal beliefs in mathematics differ and if there are different how do these beliefs impact on the learners from those communities. A case that has received some attention is the attitude of the teacher towards mathematics and how the teacher's attitude has an effect on learners' attitudes, but this has not received much attention in South Africa. This could also be investigated.

.

References

Adebule, S. O., & Aborisade, O. J. (2014). Gender comparison of attitude of senior secondary school towards mathematics in Ehiti state, Nigeria. *European Scientific Journal*, *10*(19), 153–160.

Aiken, L. (1976). Attitudes and other affective variables in learning mathematics. *Review of Educational Research*, *46*(2), 293–311.

Aiken, L. R. (1974). Two scales of attitude towards mathematics. *Journal for Research in Mathematics Education*, *5*(2), 67–71.

Aiken, L. (1972). Research on attitude toward mathematics. *The Arithmetic Teacher*, *19*(3). 229 -234

Barmby, P., & Bolden, D. (2014). A new approach to measuring pre-service teachers' attitudes towards mathematics. In C. Nicol, P. Liljedahl, S. Oesterle, & D. Allan (Eds.), *Proceedings of the 38th Conference of the International Group for the Psychology of Mathematics Education and the 36th Conference of the North American Chapter of the Psychology of Mathematics Education* (Vol. 2) (pp. 97-104). Vancouver, Canada: PME.

Bayanga, A., & Wadesango, N. (2014). Analysis of students attitude on mathematical achievement - Factor structure approach. *International Journal of Educational Research*, *6*(1). 41 – 50.

Behi, R., & Nolan, M. (1995). Ethical issues in research. *British Journal of Nursing*, *4*(12), 712–716.

Bertram, C., & Christiansen, I. (2014). *Understanding research: an introduction to reading research* (3rd ed.). Pretoria: Van Schaik.

Booysen, A. E., & Nkomo, S. M. (2010). Gender role stereotype and requisite management: The case of South Africa. *Gender in Management: An International Journal*, *25*(4), 285–300.

Bragg, L. (2007). Students'conflicting attitudes towards games as vehicle for learning mathematics: a methological dilemma. *Mathematics Education Research Journal*, *19*(1), 29–44.

Caracelli, V. J., & Greene, J. C. (1993). Data analysis strategies for mixed - method evaluation designs. *Educational Evaluation and Policy Analysis*, *15*(2), 195–207.

Chamdimba, P. (2008). Students' Attitude Towards Mathematics in Malawi: Can They Be Improved? *Proceedings of the 12th annual conference of the Southern African Association for Research in Mathematics, Science and Technology Education*. Durban: SAARMSTE.

Crano, W. D., & Prislin, R. (2006). Attitudes and persuasion. *Annu. Rev. Psychol.*, *57*, 345–374.

Creswell, J. (2012). *Educational Research: Planning, conducting and evaluating quantitative and qualitative research.* Boston: Pearson Education.

de Lourdes Mata, M., Monteiro, V., & Peixoto, F. (2012). Attitudes towards mathematics: Effects of individual, motivational, and social support factors. *Child Development Research*, 2(1), 1 - 10.

Department of Basic Education. (2011). *National Curriculum Statement: Curriculum and Assessment Policy Statement: Further Education and training phase Grades 10 - 12 Mathematics*. Pretoria, South Africa: Department of Basic Education.

Department of Basic Education. (2011). *National Curriculum Statement: Curriculum and Assessment Policy Statement: Further Education and training phase Grades 10 - 12 Mathematical Literacy*. Pretoria, South Africa: Department of Basic Education.

Department of Basic Education. (2015). *2015 National senior certificate examination schools subject report*. Pretoria, South Africa: Department of Basic Education.

Department of Basic Education. (2016). *2015 National Senior Certificate Examination: Examination Report*: NSC. Department of Basic Education.

Estrada, A., Batanero, C., & Lancaster, S. (2011). Teachers' attitudes towards statistics. In C. Batanero, G. Burrill, & C. Reading (Eds.), *Teaching statistics in school mathematics e Challenges for teaching and teacher education: A joint ICMI/IASE study: The 18th ICMI study* (pp. 163-174). Dordrecht, The Netherlands: Springer.

Farooq, M. ., & Shah, S. Z. U. (2008). Students attitude towards mathematics. *Pakistan Economic and Social Review*, *46*(1), 75–83.

Fennema, E., & Sherman, J. A. (1976). Fennema - Sherman mathematics attitudes scales: Instruments designed to measure attitudes towards the learning of mathematics by females and males. *Journal for Research in Mathematics Education*, *7*(5), 324–326.

Flowers, E. (2006). Differences between male and female students'confidence, anxiety and attitude towards learning Jazz improvisation. *Journal of Research in Music Education*, *54*(4), 337–349.

Frenzel, A. C., Pekrum, R., & Goetz, T. (2007). Girls and mathematics - A "hopeless"issue? A control - value approach to gender differences in emotions towards mathematics. *European Journal of Psychology of Education*, *22*(4), 497–514.

Greene, J. C., Caracelli, V. J., & Graham, W. F. (1989). Towards a conceptual framework for mixed - method evaluation designs. *Educational Evaluation and Policy Analysis*, *11*(3), 255–274.

Grootenboer, P., & Hemmings, B. (2007). Mathematics performance and the role played by affective and background factors. *Mathematics Education Research Journal*, *19*(3), 3–20.

Haladyna, T., Shaughnessy, J., & Shaughnessy, J. (1983). A casual analysis of attitude toward mathematics. *Journal for Research in Mathematics Education*, *14*(1), 19–29.

Hames, M. (2006). Rights and Realities: Limits to woman's rights and citizenship after 10 years of democracy in South Africa. *Third World Quarterly*, *27*(7), 1313–1327.

Hannula, M. S. (2002). Attitude towards mathematics: Emotions expectations and values. *Educational Studies in Mathematics*, *49*, 25–46.

Ho, H., Santurk, D., Lam, A. G., Zimmer, J. M., Hong, S., Okamoto, Y., Wang, C. (2000). The effective and cognitive dimensions of math anxiety: A cross - national study. *Journal for Research in Mathematics Education*, *31*(3), 362–379.

Iben, M. F. (1991). Attitudes and mathematics. *Comparative Education*, *27*(2), 135–151.

Jennison, M., & Beswick, K. (2010). Student attitude, student understanding and mathematics anxiety. In L. Sparrow, B. Kissane, & C. Hurst (Eds.), *Shaping the future of mathematics education* (Proceedings of the 33rd annual conference of the

Mathematics Education Research Group of Australasia, pp. 280–288). Fremantle, WA: MERGA.

Johnson, R. B., & Onwuegbuzie, A. J. (2004). Mixed methods research: A research paradigm whose time has come. *Educational Researcher, 33*(7), 14 – 26.

Kehler, J. (2001). Women and Poverty: The South African experience. *Journal of International Women's Studies., 3*(1), 41–53.

Kislenko, K, Grevholm, B., & Lepik, M. (2007). "Mathematics is important but boring": students' beliefs and attitudes towards mathematics. In C. Bergsten, B. Måsøval , & F.

Rønning (Eds.), Relating practice and research in mathematics education. *Proceedings of Norma05, Fourth Nordic Conference on Mathematics Education, Trondheim, 2nd-6th of September 2005* (pp. 349–360). Trondheim: Tapir Akademisk Forlag

Kitchenham, B., & Pfleeger, S. L. (2002). Principles of survey research Part 5: Populations and samples. *ACM SIGSOFT Engineering Notes, 27*(5), 17 – 20.

Koerber, A., & McMichael, L. (2008). Qualitative sampling methods: A premier for techincal support. *Journal of Business and Technical Communication, 22*, 454 – 473.

Leder, G., & Groottenboer, P. (2005). Affect and mathematics Education. *Mathematics Education Research Journal, 17*(2), 1–8.

Liu, X., & Koirala, H. (2009). The effect of Mathematics self - efficacy on mathematics achievement of high school students. *In Northern Educational Research Association (Nera) Annual conference* (Vol. 10, pp. 1–13). University of Connecticut.

Ma, X., & Kishor, N. (1997). Assessing the relationship between attitude toward mathematics and achievement: A meta - analysis. *Journal for Research in Mathematics Education, 28*(1), 26–47.

Mahanta, D. (2014). Impact of attitude and self - concept of the students towards mathematics upon their achievement in mathematics. *International Journal of Theoretical and Applied Sciences, 6*(1), 20–35.

Majeed, A., Darmawan, I. G., & Lynch, P. (2013). A confirmatory factor analysis of attitudes toward mathematics inventory, *15*(1), 121–135.

Marchis, J. (2013). Relation between students' attitude towards mathematics and their problem solving skills. *PedActa, 3*(2), 1–8.

McLeod, D. B. (1992). Research on affect in mathematics education: A reconceptualization. In D. A. Grouws (Ed.), *Handbook of research on mathematics teaching and learning* (pp. 575-596). New York: Macmillan Publishing Company.

Mcleod, D. B. (1994). Research on affect and mathematics learning in the JRME: 1970 to the present. *Journal for Research in Mathematics Education, 25*(6), 637–647.

Mensah, J. K., Okyere, M., & Kuranchie, A. (2013). Students attitude towards mathematics and performance: Does the teacher matter? *Journal of Education and Practise, 4*(3), 132–139.

Mji, A., & Makgato, M. (2006). Factors associated with high school learners' poor performance: a potlight on mathematics and physical science, *South African Journal of Education, 26*(2), 253–266.

Mohamed, L., & Waheed, H. (2011). Secondary students' attitude towards mathematics in a selected school of Maldives. *International Journal of Humanities and Social Science, 1*(15), 277–281.

Moorosi, P. (2010). South African female principals' career paths: Understanding the gender gap in secondary school management. *Educational Management Administration & Leadership*, *38*(5), 547-562.

Morse, J. M., Barrett, M., Mayan, M., Olsen, K., & Spiers, J. (2002). Verification Strategies for Establishing Reliability and Validity in Qualitative Research. *International Journal of Qualitative Methods*, *1*(2), 1 – 19.

Mullis, I. V. S., Martin, M. O., Foy, P., & Arora, A. (2012). *Trends in International Mathematics and Science Study 2011*. Chestnut Hill, Massachusetts: TIMMS & PIRLS Study Centre.

Mutodi, P., & Ngirande, H. (2014a). The influence of students' perception on mathematics performance. A case of a selected high school in South Africa. *Mediterranean Journal of Social Sciences*, *5*(3), 431–445.

Mutodi, P., & Ngirande, H. (2014b). The influence of students 'perception on mathematics performance. A case of a selected high school in South Africa. *Mediterranean Journal of Social Sciences*, *5*(3), 431–445.

Neale, D. C. (1969). The role of attitudes in learning mathematics. *The Arithmetic Teacher*, *16*(8), 631–640.

Onwuegbuzie, A. J., & Johnson, R. B. (2006). The validity in mixed research. *Research the Schools*, *13*(1), 48–63.

Opie, C. (2004). *Doing educational research*. London: sage Publications.

Ruffell, M., Mason, J., & Allen, B. (1998). Studying attitude to mathematics. *Education Studies in Mathematics*, *35*(1), 1–8.

Steele, J. R., & Ambady, N. (2006). "Math is Hard"The effect of gender printing on women's attitudes. *Journal of Experimental Social Psychology*, *42*(1), 428–436.

Tapia, M., & Marsh II, G. E. (2002). *Confirmatory factor analysis of the attitudes towards mathematics inventory*. Presented at the Annual Meeting of the Mid - South Educational Research Association, Chattanooga, Tennessee.

Teddlie, C., & Yu, F. (2007). Mixed Method Sampling. A typology with examples. *Journal of Mixed Methods Reseach*, *1*(1), 77 – 100.

Tella, A. (2007). The impact of motivation on student's academic achievement and learning outcomes in mathematics among secondary school students in Nigeria. *Eurasia Journal of Mathematics, Science & Technology Education*, *3*(2), 149–156.

Wong, N. (1992). The relationship among mathematics achievement, affective variables and home background. *Mathematics Education Research Journal*, *4*(3), 32–42.

Wong, N.- ying. (1992). The relationship among Mathematics Achievement, affective variables and home background. *Mathematics Education Research Journal*, *4*(3), 33–41.

Zakaria, E., Chin, L. C., & Daud, M. Y. (2010). The effects of cooperative on students'learning students'mathematics achievement and attitude towards mathematics. *Journal of Social Sciences*, *6*(2), 272–275.

Zan, R., Brown, L., Evans, J., & Hannula, M. S. (2006). Affect in mathematics education: An introduction. *Education Studies in Mathematics*, *63*(2), 113–121.

Zan, R., & Di Martino, P. (2007). Attitude toward mathematics: Overcoming the positive/negative dichotomy. *The Montana Mathematics Enthusiast*, *3*, 157–168.

Zan, R., & Di Martino, P. D. (2010). “Me and maths”: Towards definition of attitude grounded on students’narrative. *Journal of Mathematics Teacher Education*, *13*(1), 27–48.

Zohrabi, M. (2013). Mixed method research: Instruments, validity, reliability and reporting findings. *Theory and Practice in Language Studies*, *3*(2), 254–262.

Appendices

Appendix 1 (Letter to the principal, SGB chair)

LETTER TO THE PRINCIPAL, SGB Chair, etc.

DATE: 10/04/2016

Dear Principal

My name is Ndlovu Vusumuzi. I am a Masters student in the School of Education at the University of the Witwatersrand.

I am doing research on **Grade 10 -12 learners' attitudes towards mathematics and how the attitudes affect performance**.

My research involves finding out learners' attitudes towards mathematics. I will want to find out the kind of attitudes exhibited through the use of questionnaires. Learners will complete questionnaires as to ascertain the attributes of attitudes they have. From the questionnaires I will select 12 learners that I will interview to get to know about their attitudes in detail. After that I will check the marks for the end of term to investigate if the marks correspond to those with positive or negative attitudes. This will be done by checking the percentage of those with positive attitude and then check the percentage pass rate.

The reason why I have chosen your school is because I teach at the school and it will make it accessible for me to carry out the research. Furthermore, I would like to see learners improve their mathematics marks.

I am inviting your school to participate in this research by allowing me to carry out the research study at your school.

The research participants will not be advantaged or disadvantaged in any way. They will be reassured that they can withdraw their permission at any time during this project without any penalty. There are no foreseeable risks in participating in this study. The participants will not be paid for this study.

The names of the research participants and identity of the school will be kept confidential at all times and in all academic writing about the study. Your individual privacy will be maintained in all published and written data resulting from the study.

All research data will be destroyed between 3-5 years after completion of the project.

Please let me know if you require any further information. I look forward to your response as soon as is convenient.

Yours sincerely,

V. Ndlovu

NAME Vusumuzi Ndlovu

ADDRESS 701 Metropolitan 39 Alexandra Street, Beria

EMAIL ndlovu.vusumuzi@ymail.com 754787@students.wits.ac.za

TELEPHONE NUMBERS 0832816658

Appendix 2 (INFORMATION SHEET LEARNERS)

INFORMATION SHEET LEARNERS

DATE: 10/04/2016

Dear Learner,

My name is Vusumuzi Ndlovu and I am a Masters student in the School of Education at the University of the Witwatersrand.

I am doing research on **Grade 10 -12 learners' attitudes towards mathematics and how the attitudes affect performance**.

My investigation involves collecting information about how learners feel about mathematics. Learners will complete a questionnaire on their attitudes towards mathematics. It will take about 15 – 20 minutes to complete the questionnaire. I will also ask if some of you would be interviewed by me so that I can find out more about your attitudes towards maths.

Would you mind if you help me carry out my research project? I need your help completing the questionnaire, and help from some of you to agree to be interviewed. Remember, this is not a test, it is not for marks and it is voluntary, which means that you don't have to do it. Also, if you decide halfway through that you prefer to stop, this is completely your choice and will not affect you negatively in any way.

I will not be using your own name but I will make one up so no one can identify you. All information about you will be kept confidential in all my writing about the study. Also, all collected information will be stored safely and destroyed between 3-5 years after I have completed my project.

Your parents have also been given an information sheet and consent form, but at the end of the day it is your decision to join us in the study.

I look forward to working with you!

Please feel free to contact me if you have any questions.

Thank you,

SIGNATURE V. Ndlovu

NAME Vusumuzi Ndlovu

ADDRESS 701 Metropolitan 39 Alexandra Street , Beria

EMAIL Ndlovu.vusumuzi@ymail.com 754787@students.wits.ac.za

TELEPHONE NUMBERS 0832816658

Appendix 3 (Learner Consent Form)

Learner Consent Form

Please fill in the reply slip below if you agree to participate in my study called:

My name is: _____

Circle one

Permission for questionnaire/test

I agree to fill in a question and answer sheet or write a test for this study. YES/NO

Permission for interview

I agree to take part in an interview that will be audio-recorded for this study.
YES/NO

Informed Consent

I understand that:

- my name and information will be kept confidential and safe and that my name and the name of my school will not be revealed.
- I do not have to answer every question and can withdraw from the study at any time.
- I can ask not to be audiotaped, photographed and/or videotape
- all the data collected during this study will be destroyed within 3-5 years after completion of my project.

Sign_____ Date_____

Appendix 4 (INFORMATION SHEET PARENTS)

INFORMATION SHEET PARENTS

DATE: 10/04/2016

Dear Parent,

My name is Ndlovu Vusumuzi and I am a Masters student in the School of Education at the University of the Witwatersrand.

I am doing research on **Grade 10 -12 learners' attitudes towards mathematics and how the attitudes affect performance**.

My research involves finding out about how learners feel about mathematics. I will use a set of questions that the learners will complete to establish if they have a positive or negative attitude towards mathematics. I will also ask if some learners would be interviewed by me so that I can find out more about your attitudes towards maths.

The reason why I have chosen your child's class is because your child is doing mathematics and I am finding out about their attitudes in mathematics. All the mathematics learners will be requested to complete the questionnaire, and some learners will be chosen to be interviewed. Would you mind if you allow your child to complete a questionnaire and to take part in an interview?

Your child will not be advantaged or disadvantaged in any way. S/he will be reassured that s/he can withdraw her/his permission at any time during this project without any penalty. There are no foreseeable risks in participating and your child will not be paid for this study.

Your child's name and identity will be kept confidential at all times and in all academic writing about the study. His/her individual privacy will be maintained in all published and written data resulting from the study.

All research data will be destroyed between 3-5 years after completion of the project.

Please let me know if you require any further information.

Thank you very much for your help.

Yours sincerely,

SIGNATURE V. Ndlovu

NAME Vusumuzi Ndlovu

ADDRESS 701 Metropolitan 39 Alexandra Street. Beria

EMAIL Ndlovu.vusumuzi@ymail.com 754787@students.wits.ac.za

TELEPHONE NUMBERS 0832816658

Appendix 5 (Parent's Consent Form)

Parent's Consent Form

Please fill in and return the reply slip below indicating your willingness to allow your child to participate in the research project called :

Circle one

Permission for questionnaire/test

I agree that my child may fill in a question and answer sheet or write a test for this study. YES/NO

Permission for interview

I agree that my child can take part in an interview that will be audio-recorded for this study.
YES/NO

Informed Consent

I understand that:

- my child's name and information will be kept confidential and safe and that my name and the name of my school will not be revealed.
- he/she does not have to answer every question and can withdraw from the study at any time.
- he/she can ask not to be audiotaped, photographed and/or videotape
- all the data collected during this study will be destroyed within 3-5 years after completion of my project.

Sign_____ Date_____

Appendix 6 (GDE Research Approval Letter)

For administrative use only:
Reference no: D2017 / 053
enquiries: Diane Buntting 011 843 6503

GAUTENG PROVINCE
REPUBLIC OF SOUTH AFRICA

GDE RESEARCH APPROVAL LETTER

Date:	**16 May 2016**
Validity of Research Approval:	**16 May 2016 to 30 September 2016**
Name of Researcher:	**Ndlovu V.**
Address of Researcher:	**701 Metropolitan; 39 Alexander street; Berea; 2198**
Telephone / Fax Number/s:	**083 281 6658**
Email address:	**Ndlovu.vusumuzi@ymail.com; 754787@students.wits.ac.za**
Research Topic:	**Grade 10 - 12 learners' attitudes towards Mathematics and how the attitudes affect performance**
Number and type of schools:	**ONE Secondary School**
District/s/HO	**Johannesburg West**

Re: Approval in Respect of Request to Conduct Research

This letter serves to indicate that approval is hereby granted to the above-mentioned researcher to proceed with research in respect of the study indicated above. The onus rests with the researcher to negotiate appropriate and relevant time schedules with the school/s and/or offices involved. A separate copy of this letter must be presented to the Principal, SGB and the relevant District/Head Office Senior Manager confirming that permission has been granted for the research to be conducted. However participation is VOLUNTARY.

The following conditions apply to GDE research. The researcher has agreed to and may proceed with the above study subject to the conditions listed below being met. Approval may be withdrawn should any of the conditions listed below be flouted:

CONDITIONS FOR CONDUCTING RESEARCH IN GDE

1. *The District/Head Office Senior Manager/s concerned, the Principal/s and the chairperson/s of the School Governing Body (SGB.) must be presented with a copy of this letter.*

2017/05/17

Office of the Director: Education Research and Knowledge Management ER&KM)
9th Floor, 111 Commissioner Street, Johannesburg, 2001

2. *The Researcher will make every effort to obtain the goodwill and co-operation of the GDE District officials, principals, SGBs, teachers, parents and learners involved. Participation is voluntary and additional remuneration will not be paid;*
3. *Research may only be conducted after school hours so that the normal school programme is not interrupted. The Principal and/or Director must be consulted about an appropriate time when the researcher/s may carry out their research at the sites that they manage.*
4. *Research may only commence from the second week of February and must be concluded by the end of the THIRD quarter of the academic year. If incomplete, an amended Research Approval letter may be requested to conduct research in the following year.*
5. *Items 6 and 7 will not apply to any research effort being undertaken on behalf of the GDE. Such research will have been commissioned and be paid for by the Gauteng Department of Education.*
6. *It is the researcher's responsibility to obtain written consent from the SGB/s; principal/s, educator/s, parents and learners, as applicable, before commencing with research.*
7. *The researcher is responsible for supplying and utilizing his/her own research resources, such as stationery, photocopies, transport, faxes and telephones and should not depend on the goodwill of the institution/s, staff and/or the office/s visited for supplying such resources.*
8. *The names of the GDE officials, schools, principals, parents, teachers and learners that participate in the study may not appear in the research title, report or summary.*
9. *On completion of the study the researcher must supply the Director: Education Research and Knowledge Management, with electronic copies of the Research Report, Thesis, Dissertation as well as a Research Summary (on the GDE Summary template). Failure to submit your Research Report, Thesis, Dissertation and Research Summary on completion of your studies / project – a month after graduation or project completion - may result in permission being withheld from you and your Supervisor in future.*
10. *The researcher may be expected to provide short presentations on the purpose, findings and recommendations of his/her research to both GDE officials and the schools concerned;*
11. *Should the researcher have been involved with research at a school and/or a district/head office level, the Director/s and school/s concerned must also be supplied with a brief summary of the purpose, findings and recommendations of the research study.*

The Gauteng Department of Education wishes you well in this important undertaking and looks forward to examining the findings of your research study.

Kind regards

.....

Dr David Makhado

Director: Education Research and Knowledge Management

DATE: 2018/05/17

Office of the Director: Education Research and Knowledge Management ER&KM)
9th Floor, 111 Commissioner Street, Johannesburg, 2001

Appendix 7 (University Clearance Letter)

Wits School of Education

27 St Andrews Road, Parktown, Johannesburg, 2193 Private Bag 3, Wits 2050, South Africa. Tel: +27 11 717-3064 Fax: +27 11 717-3100 E-mail: enquiries@educ.wits.ac.za Website: www.wits.ac.za

30 August 2016

Student Number: 754787

Protocol Number: 2016ECE052M

Dear Vusumuzi Ndlovu

Application for Ethics Clearance: Master of Education

Thank you very much for your ethics application. The Ethics Committee in Education of the Faculty of Humanities, acting on behalf of the Senate, has considered your application for ethics clearance for your proposal entitled:

Grade 10 -12 learners' attitudes towards mathematics and how the attitudes affect performance

The committee recently met and I am pleased to inform you that **clearance was granted**.

Please use the above protocol number in all correspondence to the relevant research parties (schools, parents, learners etc.) and include it in your research report or project on the title page.

The Protocol Number above should be submitted to the Graduate Studies in Education Committee upon submission of your final research report.

All the best with your research project.

Yours sincerely,

MMabeta

Wits School of Education

011 717-3416

cc Supervisor - Dr Patrick Barmby

Appendix 8 (Questionnaire items)

Your attitude towards mathematics

Please tick one box for each statement to show your level of agreement.

Please tick one box for each statement to show your level of agreement

		Strongly agree	*Agree*	*Neither agree nor disagree*	*Disagree*	*Strongly disagree*
1	Mathematics is very useful and necessary subject	SA	A	N	D	SD
2	I want to develop my mathematical skills	SA	A	N	D	SD
3	I get a great deal of satisfaction out of solving a mathematical problem	SA	A	N	D	SD
4	Mathematics helps develop the mind and teaches a person to think	SA	A	N	D	SD
5	Mathematics is important in everyday life	SA	A	N	D	SD
6	Mathematics is one of the most important subjects for people to study	SA	A	N	D	SD
7	High school mathematics would be important no matter what I decide	SA	A	N	D	SD
8	I can think of many ways that I can use mathematics outside of school	SA	A	N	D	SD
9	Mathematics is one of the most feared subjects	SA	A	N	D	SD
10	My mind goes blank and I am unable to think clearly when working with numbers	SA	A	N	D	SD
11	Studying mathematics makes me feel nervous/uneasy	SA	A	N	D	SD

12	Mathematics makes me feel uncomfortable	SA	A	N	D	SD
13	I am always under terrible strain in maths class.	SA	A	N	D	SD
14	I dislike mathematics	SA	A	N	D	SD
15	It makes me uneasy to even think of having to do a mathematics problem	SA	A	N	D	SD
16	Mathematics does not scare me at all.	SA	A	N	D	SD
17	I am able to solve mathematics problems quite easily	SA	A	N	D	SD
18	I have a lot of self- confidence when it comes to mathematics.	SA	A	N	D	SD
19	I expect to do fairly well in my maths class.	SA	A	N	D	SD
20	I am always confused in a maths class	SA	A	N	D	SD
21	I learn mathematics easily	SA	A	N	D	SD

Please turn over the page

Please tick one box for each statement to show your level of agreement

		Strongly agree	*Agree*	*Neither agree nor disagree*	*Disagree*	*Strongly disagree*
22	I really like mathematics	SA	A	N	D	SD
23	Mathematics is dull and boring	SA	A	N	D	SD
24	I like to solve new problems in mathematics	SA	A	N	D	SD
25	Mathematics is very interesting to me.	SA	A	N	D	SD
26	I would like to avoid mathematics courses in future	SA	A	N	D	SD
27	I am happier in my maths class that other classes	SA	A	N	D	SD
28	I am willing to take more than the required amount of mathematics	SA	A	N	D	SD
29	I plan to take as much mathematics as I can during my education	SA	A	N	D	SD
30	The challenge of maths appeals to me	SA	A	N	D	SD
31	I believe studying of maths helps me with problem solving in other subjects.	SA	A	N	D	SD
32	I am comfortable answering maths problems in class	SA	A	N	D	SD

33	A strong maths background will help me in my professional life	SA	A	N	D	SD
34	I feel I am good at solving problems	SA	A	N	D	SD
35	Mathematics scares me	SA	A	N	D	SD
36	I feel a definite positive reaction towards maths	SA	A	N	D	SD
37	Mathematics makes me feel irritable	SA	A	N	D	SD
38	I am inpatient when solving maths problems	SA	A	N	D	SD
39	I hesitate to do maths problems	SA	A	N	D	SD
40	I think studying advanced mathematics is useful	SA	A	N	D	SD
41	I would prefer to write a maths assignment than write an essay	SA	A	N	D	SD
42	I learn mathematics easily	SA	A	N	D	SD

Thank you for completing this questionnaire.

Appendix 9 (Interview questions)

1. Tell me a little about your attitude towards mathematics.
2. More specifically, could you tell me about your confidence in mathematics? Why is this? What influenced your confidence?
3. Could you tell me whether you feel anxious in mathematics? Why is this? What causes this anxiety?
4. Could you tell me whether mathematics is important? Why is this? What influences your views?
5. Could you tell me whether you enjoy maths and are motivated to study it? Why is this? What influences your views?
6. What you do to help learners to have better attitudes towards mathematics? Could you explain why? Any other suggestions?
7. The results from the study suggest that female learners have less positive attitudes towards mathematics. Why do you think this might be? What could we do to improve female attitudes towards mathematics?
8. Is there anything else that you would like to say about your attitudes towards maths?