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Tracing factors that facilitate achievement in mathematics in traditionally disadvantaged secondary schools

by

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Submitted in partial fulfilment of the requirements for the degree

Philosophiae Doctor

in the Department of Mathematics and Applied Mathematics
in the Faculty of Natural and Agricultural Sciences

University of Pretoria
Pretoria

January 2009

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ABSTRACT

The purpose of this study is to advance the understanding of why some mathematics classrooms in disadvantaged communities are successful and others not. The study was conducted in Limpopo Province in the northern part of South Africa.

The central research question addressed in the study is: What factors facilitate achievement of Grade 12 mathematics learners in traditionally disadvantaged schools, particularly in Limpopo Province? The study included in an extensive literature survey in order to identify related studies in this and other countries. The analysis is based on qualitative and quantitative data gathered in schools with similar learner demographics and socioeconomic characteristics, including both high-achieving and low-achieving schools. The quantitative analysis was based on a questionnaire issued to learners whereas the qualitative analysis was based on focus group interviews with learners and individual interviews with teachers. A questionnaire issued to teachers was also included in the study.

This investigation shows that factors such as learners' and teacher' commitment and motivation, attitudes and self-concept, learners' career prospects, learners' perceptions of peers and teachers, and teachers' perceptions of learners appear to influence disadvantaged learners' decisions to persist and achieve in mathematics in spite of their difficult circumstances.

The conclusion is that there are no mysterious factors that lie at the root of the differences between high- and low-achieving schools. The application of sound teaching and learning principles fosters an environment where pupils are motivated to reach their full potential.

Keywords: mathematics, achievement, disadvantaged schools, factors facilitating performance

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ACKNOWLEDGEMENTS

I owe special thanks to God, the Almighty, the creator of humankind, for strengthening and uplifting me as I toiled.

For the development and completion of this study, I extend my sincerest gratitude to:

- **Professor Ansie Harding,** my supervisor, and **Prof Johann Engelbrecht** and **Prof Kobus Maree**, my co-supervisors. They guided me with wisdom, experience and enthusiasm. Your recommendations and suggestions were insightful and inspiring.

- My precious and loving wife **Avhashoni**, and our children, **Murangi, Munei**, and **Maanda** for their patience, support and understanding when I was absent where and when they needed me most.

- **Ms Rina Owen** from the Department of Statistics at the University of Pretoria, for her assistance in data analysis and interpretation.

- My mother, brothers and sisters for their strong moral and family values and support. Thank you immensely, you are great.

- My spiritual father, **Pastor Reuben Denga. Y**our teaching of faith, words of encouragement, and above all your prayers, were not in vain. May our great God spare you for many years.

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CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION AND BACKGROUND

A thorough understanding of mathematics is an asset if not essential for applicants interested in obtaining employment in South Africa. According to Steen (1989:19) mathematics does not only empower people with the capacity to control their lives but also provides science a firm foundation for effective theories, and also guarantees society a vigorous economy. At its most basic level mathematics is a requirement for science, computer technology and engineering courses. Seen from a social perspective, mathematical competence is an essential component in preparing numerate citizens for employment and it is needed to ensure the continued production of highly skilled persons required by industry, science and technology. Throughout the world a major difference between the advanced and the underdeveloped countries of today has been noted in their level of development in modern science and technology. There is thus a compelling need for South Africa as a developing country to keep up with new and emerging technologies. However, literature on the academic achievements and success of historically disadvantaged learners in mathematics is mostly about their academic failure. Since mathematics is a requirement for science, computer technology and engineering courses as well as for advanced mathematics courses, a low level of mathematics has become a barrier preventing many learners from pursuing careers related to these areas at tertiary institutions (universities or universities of technology).

Several studies conducted locally as well as internationally have highlighted certain shortcomings in the mathematical achievements of South African learners. In the Third International Mathematics and Science Study (TIMSS, 1997) seventh grade and eighth grade learners in South Africa were ranked last in mathematics out of 41 participating countries. They achieved a score of 348 for seventh grade learners compared with the international mean score of 484. In the eighth-grade the score was 354, compared to the international mean of 513. Furthermore, in a joint survey conducted by the Foundation for Research and Development and the Human Sciences Research Council, it was stated that South Africans ranked 18th out of 20 world nations on natural and environmental sciences (Calendar, 1998). Regarding the performance of learners in the South African grade twelve examinations, the Limpopo Province (where this study was conducted) produced the poorest or second poorest matriculation mathematics and science results out of nine provinces for the past five years (Strauss, Plekker & Van der Linde, 1999).

Although South African learners are not performing well in mathematics internationally and locally, the situation is even worse among black learners (Brodie, 2004). For example, the failure rate for black Grade 12 learners in mathematics in 1999, 2000, 2001 and 2002 was 88.3%, 84.5%, 80% and 76.8% respectively (Kahn, 2001).

According to Kahn (2001) this data indicate that the number of higher grade mathematics passes for black learners is around 3000 per year. This current pool thus serves as the source for tertiary institutions' graduates in science, engineering, technology, and mathematics professions among the black population. The National Commission on Higher Education (NCHE, 1996) supported this finding in their documents when they stated that South African blacks are underrepresented in the scientific, engineering and mathematical professions. Furthermore the report of the South African Institute for Race Relations, showed that in fields such as commerce, mathematics, and engineering there are two non-black graduates for every black graduate (http://allafrica.com/stories/200112110604.html).

In view of the importance of mathematics in society, the preceding discussion raises serious concern among educators and policy makers, firstly, because these learners comprise the majority of high school learners in South Africa (Maree, 1997). Hence this will affect the quality and quantity of human resources of the nation as a whole. The underperformance of learners in mathematics in high schools is also of concern to the instructors at tertiary institutions. The most obvious reason why school mathematics education should matter to university instructors is that a continuing influx of mathematically incompetent students would lower standards in the university mathematics curriculum (Wu, 1997). Secondly, several studies (Peng & Hill, 1995) show that high school graduates (matriculants) with low achievement in science and mathematics, who continued their education after high school, were less likely than other students to register for science and mathematics-oriented fields at the university.

Although the above information may not represent a complete picture of mathematics education in South Africa, it certainly indicates that mathematics education is not in a healthy state. However, the above picture conceals the outstanding performances in mathematics of some historically disadvantaged learners and from whom one would not expect much in the way of success (Department of Education, 2000a).

In an effort to identify the causes for low achievement in mathematics, some researchers (Attwood *et al.*, 2001, Brodie, 2004, Maree, 1997, Murray, 1997) have suggested that achievement in mathematics in secondary schools is influenced by a number of variables. These variables include learners' abilities, attitudes and perceptions, family and socio-economic status, parent and peer influences, school-related variables such as poor learning environment, learning cultures, past racial discrimination and low expectations by principals and teachers. Such factors alone cannot account for the lack of mathematics achievement and persistent differences among traditionally disadvantaged learners. In particular these explanations fail to account for intragroup achievement differences and the success of some South African disadvantaged learners in spite of these background factors. Some well-achieving disadvantaged learners come from the same communities and share similar socio-economic backgrounds, schools and classrooms. According to Singh *et al.* (2002) many of these variables are home and family-related and thus are difficult to change, and outside the control of educators.

In traditionally disadvantaged schools, let alone in Grade 12 classes, learning difficulties in mathematics could originate from the learners' under-preparedness, the teacher's presentation of the subject matter, knowledge of the role of mathematics in future career opportunities, or difficulties in the classroom situation or mathematical language. These are some of the school-related variables that can be addressed. Since mathematics is mainly taught in the classroom, observation of classroom practices may throw more light on some of the factors that facilitate achievement in traditionally disadvantaged secondary schools.

1.2 THE MAIN RESEARCH PROBLEM

Mouton (1996) believes that research begins with reflection, which includes unstructured thoughts, assumptions and questioning. This reflection can be seen as a run-up to the development of a research problem.

The central research question to be addressed in the study is:

What factors facilitate achievement in Grade 12 mathematics in traditionally disadvantaged schools, particularly in Limpopo Province?

This study therefore seeks to identify the characteristics, similarities and differences of the selected high- and low-achieving schools in mathematics with similar learners' backgrounds.

1.3 FORMULATION OF THE RESEARCH QUESTIONS

In any scientific study the research problem has focus, direction and an element of planning. Relevant questions focus the researcher's attention on the aspects that should be scientifically described. This will provide a direction factor for the study (McMillan & Schumacher, 2001).

In order to start any realistic attempt to trace factors that facilitate achievement in mathematics in traditionally disadvantaged secondary schools, a thorough investigation will first be conducted to detect the possible causes of what is perceived to be a very poor situation. Moreover, in an attempt to gather more information concerning the research problem, this study will seek to find answers to the following questions:

RESEARCH QUESTION 1

What are the attitudes and competencies of mathematics teachers in high-performing and under-performing schools?

RESEARCH QUESTION 2

What are the learners' attitudes towards mathematics and their perceptions of their successes and/or failures in mathematics?

RESEARCH QUESTION 3

What factors facilitate successful classroom practices in mathematics in Grade 12 schools?

Hopefully, this study will stimulate public school administrators, teachers and others to investigate new ways of helping disadvantaged learners to achieve better results in mathematics. Secondly, through research we endeavour to explain some disadvantaged learners' success in mathematics. In addition disadvantaged learners need to know why some of their peers are successful.

This study focuses in particular on the role of the teachers as agents of mathematics socialization, including their beliefs and goals for disadvantaged learners; the reasons for their particular way of teaching, specifically their ideas about mathematics and its value and usefulness, and what they consider as vital in mathematics teaching, particularly in grade 12 classes.

Secondly this study is particularly concerned with establishing whether learners will still want to continue with mathematics at tertiary level after their grade twelve experiences, including their affinity for mathematics, focus on their future plans, perceptions of mathematics, beliefs regarding mathematics and its usefulness, and their beliefs concerning success and failure in mathematics, and most importantly the role of peers in mathematics socialisation.

Thirdly this study concerns the teachers' attitude towards their learners as well as their explanations of learners' successes and failures in mathematics.

Lastly this study concerns establishing the way in which classroom practices serves as contexts that promote positive or negative mathematics beliefs for achievement and persistence.

1.4 EXPECTED OUTCOMES OF THE STUDY

Factors that contribute to better achievement in mathematics of learners in traditionally disadvantaged schools will be identified and studied. The methods that will be used to achieve this aim are focus group interviews, classroom observations and individual interviews with the selected students and teachers.

Despite an abundance of literature that describes failure among disadvantaged learners in mathematics, very little research explains why some of these students succeed in mathematics, and why they do so at levels comparable to those of their peers in other groups. Hence, by comparing mathematics teaching and learning in schools with similar backgrounds, indication of why the school is achieving above or below expectation in Grade 12 mathematics can be determined on the basis of its characteristics. . Furthermore, if this research could determine factors that facilitate achievement in mathematics in traditionally disadvantaged schools, it could create opportunities for those who would otherwise fail. Findings from this study should also begin to fill a void of knowledge, while adding understanding that could lead to useful activities to persuade more students from traditionally disadvantaged backgrounds to develop their full potential in mathematics.

1.5 SIGNIFICANCE OF THE PROPOSED STUDY

Firstly, in identifying factors that facilitate achievement in mathematics in a traditionally disadvantaged school, policy makers and mathematics educators could possibly be assisted in formulating strategies aimed at improving the performance of learners from traditionally disadvantaged backgrounds. Secondly, since the highest percentage of high school learners living under poor social and economic conditions are found in the Limpopo Province (Zaaiman, 1998), this study anticipates that more than socio-economic variables influence the mathematics achievement of disadvantaged secondary school learners. Thirdly, the findings of this study will be important to professionals working with similarly disadvantaged learners as well as with those who want to enhance their understanding of the factors that facilitate mathematical achievement among disadvantaged learners.

1.6 MOTIVATION OF THE STUDY

The researcher's own interest in this study derives from serving previously as a high school mathematics teacher employed by the Department of Education and currently a trainer of teachers and a university lecturer. During his career the researcher taught mainly mathematics to high school learners or prospective mathematics teachers. Moreover, the University of Venda, at which the researcher is an instructor, has been conducting winter upgrading courses for mathematics and science high school teachers since 1997. This programme is aimed at assisting teachers in improving their knowledge of mathematics and science. The researcher is responsible for teaching the mathematics part of this programme.

1.7 MOTIVATION FOR SELECTING GRADE 12 CLASSES

This study focuses on Grade 12 because of the following reasons:

- Grade 12 teachers are expected to be fully committed to teaching as learners are preparing for school-leaving examinations. Moreover many of the learners will want to enter tertiary educational institutions such as universities or universities of technology and are also expected to be committed.

- Secondly learners in Grade 12 are likely to have formed their opinions regarding mathematics and would have experiences to share.
- Thirdly, secondary schools in South Africa are mostly classified as effective or ineffective on grounds of the level of learners' achievements in the Grade 12 examination results.

1.8 RESEARCH DESIGN OVERVIEW

According to Cormack (1996), the research design represents the major methodological thrust of the study, being the distinctive and specific approach, which is best suited to answer the research questions. The research questions, the aim and the objectives of the study thus influence the selection of the research design (Brink, 1999).

The purpose of the research design, as stated by Burns and Grove (2001), is to achieve greater control of the study and to improve the validity of the study in examining the research problem. For the research design of this thesis the following are specified, namely:

- Data collection strategies
- Sampling strategies
- Participants in the study
- Data analyses strategies
- Triangulation

1.8.1 Data collection and analysis strategies

This study will be exploratory and descriptive involving qualitative and quantitative data gathering in the form of:

- Six weeks of classroom observations.
- Repeated focus group interview sessions with teachers and students separately.
- Analysis of audiotapes and videotapes of some lessons and focus group interviews.
- Analysis of questionnaires completed by both teachers and students in Grade 12.

1.8.2 Triangulation

Neuman (1994:141) defines triangulation as "the use of two or more methods of data collection techniques, in order to examine the same variable". The ideal with triangulation is that measurements improve when diverse indicators are used. As the diversity of the indicator increases, confidence in measurement grows, because obtaining indicator measurements from highly diverse methods results in greater validity. Triangulation techniques attempt to map out, or explain more fully, the richness and complexity of human behaviour by studying it from more than one angle, thus making use of both qualitative and quantitative data. According to Cohen and Manion (1997) triangulation is appropriate in the following instances:

- when a more holistic view of educational outcome is sought;
- where a complex phenomenon requires elucidation;
- when different methods of teaching are to be evaluated;
- where a controversial aspect of education needs to be evaluated more carefully;
- when an established approach yields a limited and frequently distorted picture;
- where a researcher is engaged in a case study.

Triangulation will be used in this research.

1.8.3 Sampling strategy

For the purpose of this study a purposive or judicious sample will be used. This type of sample is based entirely on the judgement of the researcher, in that a sample is composed of elements that contain the most characteristic, representative or typical attributes of the population (Neuman 1994, Strydom & De Vos, in De Vos, 2001).

The subjects of this research will be Grade 12 teachers and learners from historically disadvantaged schools from similar backgrounds. Gender is not relevant. In order to obtain a sample with a range of mathematical skills, teachers will be requested to select learners according to their performances in the grade 11 mathematics final examination. One high-achieving learner score of at least 75%, one middle-achieving learner (score between 40% and 60%), and one low-achieving learner score, at most 40%, will be selected. If there are no learners who scored more than 75% in the schools chosen, then all three learners will be correspondingly chosen on the basis of their examination rankings as compared with other learners in the class. Finally, subjects should be willing to participate in the study.

1.8.4 Participants / respondents[1] in the study

The study will be conducted in Vhembe district of the Limpopo Province, and in particular in the Soutpansberg area. The Soutpansberg area has sixty-five secondary schools. A total of four classrooms from four schools involving Grade 12 learners were selected for Phase 1: *Classroom observation* of the study. Four teachers were involved in Phase 2: *Focus group interviews*; two from well-performing schools in mathematics (ranked top five for the past three years) and two from under-performing schools in mathematics (ranked bottom five for the past three years). Furthermore, eighteen learners in total from ten schools (five high-performing, five low-performing) were asked to participate in Phase 2 of this study, classified as best, average and below average learners. For Phase 3: *Quantitative data* a total of ten schools were selected, five high-performing and five low-performing schools (mentioned above).

1.9 ETHICAL CONSIDERATIONS

Ethical considerations are of the utmost importance when one is conducting research (Strydom in De Vos, 2001). The researcher accepts the assertion that research contributes to scientific knowledge and that human and technological advances are based on this knowledge. In particular, it is accepted that educational research should contribute to better the scholarship of teaching and the development of the learner. The researcher agrees with Strydom (2001: 23-35) that the following should be observed:

- *Gaining of consent from the participants.*
- *No deception on the part of participants.*
- *No violation of the participants' privacy.*

[1] The word "participants" applies to the qualitative sections of my study and the word "respondents" to the quantitative sections.

- *Release and publication of the findings in an accurate and responsible manner.*

In view of the above ethical considerations the researcher observed the following:

1.9.1 Permission

Permission to conduct research in Region 3 has been sought from the Regional Director. (Letters requesting permission and their replies can be found in Appendices A and B, respectively).

1.9.2 Appointments

Letters were posted to the principal of each selected school, followed by visits and appointments to conduct interviews or submit questionnaires. Group meetings were held with the teachers and learners to explain the research project and the process.

1.9.3 Confidentiality

All respondents will be assured of confidentiality by means of a written notice. Participants will be given a pseudonym to protect their identities and to ensure confidentiality.

1.9.4 Post-research relationships

The research report will be made available to the Special Collection Section of the University of Venda for Science and Technology and to the University of Pretoria where respondents would have access to it.

1.10 DEFINITION OF KEY CONCEPTS

An explanation of the title, namely, *tracing factors that facilitate achievement in mathematics in traditionally disadvantaged secondary schools*, will explain the meaning of the terminology involved as it is applied within the context of this study. Other terms used in this study will be defined as they occur.

1.10.1 Disadvantaged learner

According to Sarason (1993) researchers investigating the subject-disadvantaged learners must operationally define this population. In this regard several researchers (Gordon, 2004, Levin, 1995, Pallas, 1989) have used a variety of definitions, usually selecting some subgroup from this diverse population. For example Levin (1995) has defined disadvantaged learners as learners who lack the home and community resources to benefit from conventional schooling practices.

According to Gordon (2004) the term "disadvantaged learners" refers to a group of learners which differs from other terms in a number of ways, but has in common characteristics such as coming from populations with low social status, low educational achievement, tenuous or no employment, limited participation in community or organisations and limited ready potential for upward mobility. In a similar way the British National Commission on Education (BNCE, 1996) defined educational disadvantage learners as those learners denied equal access to educational opportunities, the tendency of the learners to leave education at the first opportunity, and the hindrance of achievement by social and environmental factors.

In order to construct a reliable and dependable definition of disadvantaged learners, several characteristics are taken into consideration. Such characteristics, commonly associated with disadvantaged learners, are low socio-economic status, isolation, rurality, low ethnic group status, second language problems, family breakdown, violence and peer group and gender problem (Zaaiman, 1998).

For the purpose of this study the term "disadvantaged learner" will be used to denote those learners whose environment does not transmit to them the necessary values for success in schools.

1.10.2 Factor

A factor is defined as one of the elements contributing to a particular result or situation (Costello, 1992). By factors the researcher refers to the elements that contribute to good achievement in mathematics by learners from disadvantaged backgrounds.

1.10.3 Effective learning

According to Mwamwenda and Mwamwenda (1987) effective learning is defined as the learning that takes place when learners learn according to their needs and understand the subject matter. Smith (1998) views effective learning as the learning that requires learner's involvement and it often best takes place when learners have the opportunity to express ideas and obtain feedback from their peers. For the purpose of this study effective learning means learning that leads to improved learners' achievement in mathematics, but not mere memorization of tasks by learners. In Chapter 2 an overview of effective learning relevant to the focus of this study is given.

1.10.4 Learner

Currently the term "learner" is preferred to the term pupils although the two are regarded as synonyms. Since one should guard against the use of so-called "buzz-words" the trend is to use the word "learner" instead of "pupil" within the context of this study (Maree, 1997). Both words are derived from and related to different languages (Gove cited in Maree, 1997). The word "learner" can have the following meanings: persons who learn; persons preparing for a particular subject; person who through lengthy and systematic study attain a high degree of expertise, skill and efficiency; persons who have the following attitudes or characteristics: curiosity, perseverance, initiative, originality, creativity and integrity. These characteristics are precisely those that are regarded as essential for achievement in mathematics. For the purpose of this study learners refer to persons who are scholars or are engaged in some or other form of high school mathematics study.

1.10.5 Achievement

Gove (in Maree, 1997:15) defined the term "achievement" as follows:

> *A result brought about by resolve, persistence and endeavour; performance by a student in a course; the quality and quantity of a student's work during a given period; or the capacity to achieve a desired result; the manner of reacting to various stimuli.*

Achievement may also be defined as the mastering of major concepts and principles, important facts and propositions, skills, strategic knowledge and integration of knowledge (Niemi, 1999). For the purpose of this study the word "achievement" indicates the learners' level of self-fulfilment in mathematics, as well as their ability to attain particular levels of achievement in mathematics through exertion and perseverance.

1.10.6 Secondary school mathematics

Secondary school mathematics refers to mathematics that is taught in Grades 7 to 12, which might be broadly conceived of as mathematics beyond arithmetic and the basics of measurement and geometry.

1.11 THE ROLE OF THE RESEARCHER

In qualitative research the researcher has an important role to play. The researcher agrees with Schurink (in De Vos, 2001: 261) that the following rules should be observed:

- Making sure that the environment is not contaminated (e.g. by tape recorders and video cameras), especially not without the permission of subjects.
- Answering questions as honestly as possible.
- Avoid unnecessary, technical information that could confuse subjects about the research.
- Being very sure of the aims of your research and how you intend achieving them.
- Observe ongoing social processes without disrupting or imposing an outside point of view.

It was therefore very important that I fulfil all the necessary roles, if the research is to be conducted successfully.

1.12 LIMITATIONS AND ASSUMPTIONS OF THE RESEARCH DESIGN

The limitations on which the present study is based are as follows:

- This study is confined to Grade 12 mathematics learners and teachers and does not include those from lower grades. It is envisaged that factors that facilitate achievement in Grade 12 mathematics learners will also apply to learners in lower grades.
- Although there may be many factors that facilitate achievement in mathematics, this study will be restricted to those factors that are not beyond the control of educators. This decision is based on the fact that certain factors might be home and family-related and these can be very difficult to change.
- The study concentrated on schools that were found in disadvantaged areas at least 20 kilometres from Makhado.

Lastly, the situation might arise that some teachers who are to be observed, will not feel comfortable about being videotaped, especially those from underperforming schools. In such a case the researcher will then be forced to choose another teacher to observe and this might delay the research process. Secondly, the focus group interviews allow the participants to influence, and interact with one another and consequently they are able to influence the course of the interview.

1.13 SUMMARY AND CHAPTER DIVISIONS

CHAPTER 1

In Chapter 1 a broad orientation of the study, including an introduction to the study is discussed. The title is explained, the research approach followed in the study is outlined and the researcher's view on ethical considerations is highlighted.

CHAPTER 2

Chapter 2 is an overview of related literature on factors that facilitate achievement in mathematics.

CHAPTER 3

In Chapter 3 a description of the research design and methodology of the study are discussed.

CHAPTER 4

Chapter 4 consists of a case study of classroom observations and focus group interviews.

CHAPTER 5

An analysis and interpretation of the learners' quantitative data are presented in Chapter 5. Comparisons are made between learners from high-performing schools and low-performing schools on factors that facilitate achievement in mathematics.

CHAPTER 6

In Chapter 6 analyses and interpretation of teacher data is presented. This includes an explanation of factors that facilitate achievements in mathematics from the teachers' point of view. Comparisons are made between teachers from low-performing schools and high-performing schools on factors that facilitate achievement in mathematics.

CHAPTER 7

In the final chapter (Chapter 7), the researcher's findings and conclusions as well as the implications of the study are discussed. Recommendations for future research have also been made.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

> *Successful exposition may take many different forms but the following are some of the qualities which should be present: it challenges and provokes the pupils to think; it is reactive to pupils' needs and so it exploits questioning techniques and discussions; it is used at different points in the process of learning and so, for example, it may take the form of pulling together a variety of activities in which pupils have been engaged; and it uses a variety of stimuli* (DES, 1985: 38).

In the last decade issues of disadvantage and mathematics achievement have moved to the centre of policy-makers' agenda and academic debate. Underachievement in mathematics is particularly recognised as a major problem in schools serving disadvantaged communities in South Africa (Mkhabela, 2004).

As explained, in Chapter 1, mathematics is a pillar of almost all the streams in academic sectors. Given the important role mathematics plays in tertiary education and most careers, it is not only beneficial but also essential to establish some of the factors that facilitate achievement in mathematics in disadvantaged schools. This study will hopefully facilitate the quest to improve achievement in mathematics in disadvantaged schools and establish what schools can learn from one another. Although there are studies conducted in other countries regarding factors that facilitate achievement in mathematics, few such studies were conducted in disadvantaged secondary schools in South Africa.

According to Hughes (1999) the most important conclusions from qualitative research on factors related to achievement in schools are that (a) teachers are critical resources; (b) the composition of the student body matters; (c) schools make a difference, and (d) physical facilities, class size, curriculum, instructional strategies and other resources influence student learning indirectly through their effect on the behaviour of teachers and students.

In an effort to identify the causes for low achievement in mathematics, some researchers (Attwood, 2001; Brodie, 2004; Maree, 1997; Moyana, 1996; Murray, 1997; Malcolm *et al.*, 2000) have suggested that achievement in mathematics in secondary schools is influenced by a number of variables. These variables include learners' abilities, attitudes and perceptions, family and socio-economic status, parent and peer influences, school-related variables such as poor learning environment, learning cultures, past racial discrimination and low expectations by principals and teachers.

According to Singh *et al.* (2002) many of these variables are home and family-related and thus are difficult to change and beyond control of educators. Such factors alone cannot account for the lack of mathematics achievement and persistent differences among traditionally disadvantaged learners. In particular these explanations fail to account for intra-group achievement differences and the success of some South African disadvantaged learners in spite of these background factors. Some well-achieving disadvantaged learners come from the same communities and share similar socio-economic backgrounds, schools and classrooms.

In investigating factors that facilitate achievement in mathematics, variables related to school, learners and teachers were reviewed**.** In this regard Malcolm *et al.* (2000) in their literature review suggest that when investigating factors that facilitate achievement in science and mathematics, a more extensive investigation should consider learner, teacher and school variables. The chapter concludes with some learning theories relevant to secondary school mathematics learning and teaching.

2.2. SCHOOL-RELATED VARIABLES

Several studies have shown a positive correlation between a disadvantaged school environment and learners' achievement at school. For example learners in the Western and Northern Cape provinces, which have large white populations and well-endowed communities and schools, lead in pass rates in grade twelve examinations whereas those in Limpopo Province with its black population majority rank last in this regard (Murray, 1997). Attwood (2001) also found that grade eight learners in schools situated in economically depressed areas of the Cape Flats have a lower mathematics achievement than those who come from families with high socio-economic status. Furthermore, a comprehensive study on the status of mathematics and science teachers in South Africa found that black learners were underprovided for and performed worse than their white peer group in these subjects (Arnott *et al.*, 1997).

Although the above findings show in general that disadvantaged learners tend to achieve less well than other learners, some studies indicate that some disadvantaged learners perform better than advantaged learners. In this regard a September 2002 issue of the *Sunday Times* spotlights some successful rural schools. All the schools were from disadvantaged communities (*Sunday Times*, 2002).

From the United States of America there are studies that show some successful programmes for disadvantaged learners (Hilliard, 1988). Hilliard (1988) cited a programme for disadvantaged students in which the conditions in the community surrounding the schools were unchanged. The poor conditions surrounding the schools did not change the expected educational outcomes. Parental involvement, though desirable, was not a necessity. Deprivation in learners' lives outside the school was not eliminated. No special pedagogies were employed. According to Hilliard (1988) results were obtained because learners were offered excellent quality instruction. In this regard a review of 377 studies by Hanushek (1989) shows no consistent pattern between school resources (in terms of money spent on schools) and achievement. Hanushek (1989) concluded that no strong or consistent relationship exists between school resources and learners' performances and that more resources would not yield performance gain for learners.

2.2.1 Learning environment

According to Smith and Ragan (1993) a learning environment comprises teacher, existing curriculum, instructional equipment as well as the institutional and larger learner community. In this regard Shields (1991) stated that the school environment is the broader climate or context of the school that either facilitates or constrains classroom instruction and learning. Ross, Farish and Plukett as cited in Zaaiman (1998) describe the learning environment that is considered disadvantageous for Australian schools by using detailed census-based social profiles of school catchment areas. A learning environment, particularly the school, was considered as disadvantaged if a high proportion (of the enrolment) of learners came from neighbourhoods having certain characteristics known to be associated with a low capacity to take advantage of educational facilities. These characteristics include, among others, a high percentage of persons in low status jobs with low income or with lack of formal educational qualifications. Furthermore, many families with single parents and more non-fluent English speakers (English as a second language) were found in the low socio-economic areas. The homes of the disadvantaged tend to be more crowded, lacking in magazines, newspapers, and other objects that are likely to help in the development of the learner. Parents of the disadvantaged learner give little language encouragement to their children, have less direct interaction with them and take less interest in their learning.

For a number of interrelated reasons many of these disadvantaged learners' families and schools in South Africa are concentrated in the rural areas and in the outskirts of our great metropolitan areas known as townships and squatter camps. One can therefore state that learners who attend under resourced South African schools have been educationally disadvantaged through a lack of opportunities to access quality educational services. The most underresourced schools are the ones that belonged to the previously black-only educational system (Zaaiman, 1998). According to the Department of Education (1997) Limpopo Province, where this study was conducted, as well as the Eastern Cape and Kwazulu Natal are worst off in terms of the need for physical facilities, services, and equipment and teaching resources.

2.2.2 Curriculum

According to Pinar, Reynolds, Slattery and Taubman (1995) the concept of curriculum is highly symbolic; it is what the older generation chooses to tell the younger generation. Beggs (1995) states that curriculum traditionally means a list of content topics in a national or school syllabus and examination prescription, generally referred to as course outline. According to Beggs (1995: 97-106) a mathematics curriculum includes:

- Mathematical content (what mathematicians know)
- Mathematical processes (what mathematicians do)
- Mathematical thinking and logical reasoning, problem-solving making connections and using computational tools
- Contexts in which the topics are set
- Assessments strategies that are used, and appropriate teaching methods (DoE, 2002).

The International Mathematics Study (Schmidt *et al.*, 1996), sponsored by the International Association for the Evaluation of Educational Achievement (IEA), consider the study of mathematics at three levels:

- The *intended* curriculum is that which is reflected in curriculum guides, course outline, syllabi and textbooks, adopted by the educational systems. In most countries a nationally defined curriculum emanates from a ministry of education or similar national body. In South Africa the National Government develops intended goals or specifications of curricula content.
- The *implemented* curriculum is that which is actually taught in the classroom by the teacher. The difference between the intended and implemented curriculum could be due to many factors: the curriculum is too long, the learners do not master some of the competencies and the teacher does not have time to cover all of them. The teachers have different priorities regarding what should be taught; the teachers did not master some of the competencies to be taught and thus do not include them in the classes; or teachers do not have some of the educational materials needed to teach some competencies. From their review of literature Chen *et al.* (1988) acknowledge that content coverage is related to learners' achievement.

- The *attained* curriculum is a measure of what students have learned, and is reflected in the students' achievements and attitudes. According to Schmidt *et al.*, (1996) achievement is referred to as the attained curriculum.

The attained curriculum, and not the intended curriculum, explains mathematics achievement of the learners. The author of this study is of the opinion that learners have to have the opportunity to learn all the mathematical topics on which they have to be evaluated.

2.2.3 School and class size

School size and class size have been shown to have an impact on achievement. Lee, Smith and Croninger (1997) observed that larger schools had a negative influence on academic achievement in high school mathematics and science. In contrast, Rutter (1983) found no relationship between the size of the school and scholastic achievement; effective schools can be very small, very large or somewhat in-between. Rutter (1983) further observed that the relationship between the class size and a learner's achievement is not well defined for classes with 20 to 40 learners. Class sizes of below 20 learners have been found to be advantageous for disadvantaged learners. In this respect Rutter (1983) argued that small school size facilitates social interaction and inhabits teacher specialisation.

2.2.4 Culture

South Africa is a country of diverse cultures as manifested by the notion of "rainbow nation". Fantini and Weinstein (1968) point out that culture is the aggregate of attitudes, traditions, and ethical codes peculiar to the particular society. Internationally much has been written about the relationships between culture, mathematics learning and teaching. The topics range from cultural bases for mathematics, mathematics development from different cultures, the effect of culture on mathematics learning and political effects of societies on mathematics. Maree (1994) cites Scholnick as stating that people's cultural backgrounds can influence aspects of mathematics that different cultures may stress. Maree (1994:145) quotes Scholnick as follows:

> *There are strong biases about who can learn mathematics, and pervasive differences in learning skills…. There is a hot debate about whether there are generic differences in mathematical capacities…Similarly, there may be cultural differences in the patterning of skills that reflect attitudes and values about the role of mathematics in daily life …Although mathematics is not a Rorschach blot that every society and family within a society can interpret, nevertheless, there may be fundamental differences in aspects of mathematics that different cultures may stress … that may account in part for the difference in mathematics achievement.*

Research in mathematics education has sought to understand how cultural differences affect learners' performance in mathematics. Analyses of studies on culture and mathematics reveal some general cultural factors that affect mathematics performance, namely:

- Societal influence
- Parental attitudes, values and beliefs
- Teacher attitudes, values and beliefs
- Learners' perceptions and beliefs
- Language

Johnson (1984) states that blacks in the United States of America underachieve greatly in mathematics and as a reason for this underachievement he blames cultural-related factors such as:

- An inability to see the usefulness of mathematics to their lives, both present and future;
- a lack of success in previous mathematics courses;
- a failure to receive positive career counselling;
- an absence of role models;
- a lack of significant others, such as parents, who show an interest in mathematical achievements;
- a view of mathematics as a subject appropriate for white males only (Maree, 1994).

2.2.5 Effectiveness of schools

Effective school characteristics are what help to create a fertile school culture that facilitates learners' achievement. Several researchers (Henson & Eller, 1999; Berliner, 1990, and Rutter, 1983) have identified such characteristics. Their findings indicate that learners excel when the following factors are present (Henson & Eller, 1999; Berliner, 1990, and Rutter, 1983):

- Strong leadership is provided by a principal who works with the staff to communicate the mission of the school; provide reliable support for staff; and meet with teachers and other members of the staff frequently to discuss classroom practices.
- High learner achievement is the foremost priority of the school, and the school is organised around this goal as shown by teachers who demonstrate high expectations for learners' achievement and make learners aware of and understand these expectations.
- Parents are aware of, understand, and support the basic objective of the school and believe they have an important role to play in their children' education.
- Teachers work together to provide an orderly and safe school environment.
- Schools use evaluation to measure learners' progress and promote learning.

2.3 LEARNER-RELATED VARIABLES

2.3.1 Attitudes and beliefs

According to McLeod (1992) factors such as attitudes and beliefs play an important role in mathematics achievement. The general relationship between attitude and achievement is based on the concept that the better the attitude a learner has towards a subject or task, the higher the achievement or performance level in mathematics.

Stuart (2000) argues that teacher, peer and family attitudes toward mathematics may either positively or negatively influence learners' confidence in mathematics. The findings are that learners who have positive attitudes towards their teachers have high achievement levels. Newman and Schwager (1993) found that at all grades a sense of personal relatedness with the teacher is important in determining a learner's frequency in seeking help from the teacher. They further state that this aspect of the classroom climate has been shown to be related to good academic outcome. In the same vein Dungan and Thurlow (1989) state that the extent to which learners likes their teacher, influence their liking of the subject.

2.3.1.1 Career choice and mathematics achievement

Research on attitudes towards career choice and towards mathematics teachers is extensive. Eccles and Jacobs (1986) found that self-perceptions of mathematics ability influence mathematics achievement. Norman (1988) concluded from a wide review of literature that there is a positive correlation between career choice and mathematics achievement. Subsequently Trusty (2002) reported that learner attitudes impact on later career choices in mathematics. Ware and Lee (1998) found that mathematics attitudes during high school had a positive effect on choosing science careers. Accordingly, Armstrong and Price (in Pedersen *et al.*, 1986) found that the career aspirations of high school learners influence their participation in mathematics, which in turn influenced their mathematics achievement. Trusty and Ng (2000) studied learners' self-perceptions of mathematics ability and found that positive self-perception mathematics ability has relatively strong effects on later career choices.

2.3.1.2 Enjoyment and ability

Ma (1997) observed that in the case of trigonometry learners, the attitude that mathematics was important and enjoyable was significantly associated with achievement in mathematics. According to Ma (1997) learners who have more enjoyable experiences while learning mathematics achieve higher scores. In a study of Grade 10 to 12 geometry classes, Schoenfeld (1989) explores aspects of the relationship between learners' beliefs about mathematics, their sense of mathematics as a discipline and their relationship with it, and their mathematics performance. Schoenfeld (1989: 346) found the following:

> *Learners who think less of their mathematical ability tend more to attribute their mathematical successes to luck and their failures to lack of ability, whereas those who consider themselves to be good at mathematics attribute their success to their ability.*

Learners studied by the researcher made a distinction between the mathematics they know and experience in the classrooms and abstract mathematics, the discipline of creativity, problem-solving, and discovery, about which they are told but have not yet experienced (Schoenfeld, 1989). According to Schoenfeld (1989), the learners tend to think of classroom mathematics as requiring memorisation of equations and formulas and knowing the rules.

In mathematics education most of what is known about beliefs and attitudes of the learners towards mathematics is based upon large-scale survey data (Martin, 2000). For example the National Assessment of Education Progress in the United States of America has shown that African American learners constantly express the most positive attitudes towards mathematics among all learner groups. Other studies show that many African American learners identify mathematics as their favourite subject. Similar studies in South Africa show that most of the learners have positive attitudes towards mathematics (Howie, 2001). According to Howie (2001) the high rate of absenteeism reported among learners indicates that the problem lies more with learners not being motivated enough to attend school. Molepo (1997) found that the rural communities regard mathematics as an important subject that can play a role in developing them socio-economically.

2.3.1.3 Peer pressure

Peer pressure in mathematics affects all learners, successful ones as well as those who are less successful. The effect of negative peer pressure has been recorded in numerous articles (Dungan & Thurlow, 1989; Reynolds & Walberg, 1992; Stuart, 2000). In this regard Stuart (2000) argues that peer and family attitudes towards mathematics may either positively or negatively influence learners' confidence in the subject. In their review of literature Dungan and Thurlow (1989) found that learners' attitudes towards mathematics have been associated with peer group attitudes. Accordingly, Reynolds and Walberg (1992) identified peer attitudes as one of the most influential factors in learners' mathematical achievements. According to Harris (1995) learners are ridiculed by their peers for taking challenging mathematics while others are encouraged by their peers to pursue academic excellence in mathematics.

2.3.1.4 Peer support

Evans, Flower and Holton (2001) define peer support or tutoring as that part of the teaching process that involves learners teaching other learners. Griffiths, Houston and Lazenbatt (in Evans *et al.*, 2001: 161) state that:

> *Peer tutoring is a structured way of involving students in each other's academic and social development. As a learning experience it allows students to interact and to develop personal skills of exposition while increasing their knowledge of a specific topic.*

Tutors may be high-ability learners or learners in higher grades. Tutors may also be low-ability learners who assist other low-ability learners. Abrami, Chambers, D' apollonian and Farrell (1992) report that learners may benefit motivationally from being in groups which provide peer encouragement and support. As a result their achievements can be improved. The view of this researcher is that since peers can encourage one another to view mathematics positively or negatively, a major task for teachers is to understand the nature of peer relationships so that this influence can be directed towards positive engagement.

2.3.2 Effort and recognition

2.3.2.1 Self-esteem and mathematics anxiety

Research on attitudes towards mathematics has focused on two major dimensions, namely **mathematics self-concept** or **self-esteem** and **mathematical anxiety**. According to Fiore (1999) reinforcing effort in mathematics begins with helping learners to develop a positive self-concept. Michell *et al.* (2003: 42) states that:

> *Mathematics self-concept refers to a person's perception of their ability to learn new topics in mathematics and to perform well in mathematics classes and tests.*

Fennema and Sherman (1978) find that the mathematics self-concept is correlated with achievement in mathematics. They further find that mathematics self-concept is higher in males than in females at high school. In contrast Maqsud and Khalique (1991) find that there is a significant positive relationship between self-concept and attitude towards mathematics for female groups, but no significant correlation between these variables for male groups was found. Maqsud and Khaqlique (1991) go on to report that self-concept measures for both males and females do not reveal any significant association with their mathematics achievement.

Visser (1989: 38) defines mathematics anxiety as follows:

> *Maths anxiety may be defined as an irrational and impedimental dread of mathematics. The term is used to describe the panic, helplessness, mental paralysis and disorganization that arise among some individuals when they are required to solve a problem of mathematical nature.*

This definition has been supported by Mitchell *et al.* (2003) when they state that mathematics anxiety refers to a person's feelings of tension and anxiety that interfere with the manipulation of numbers and the solving of mathematical problems in a wide variety of ordinary and academic situations. According to Visser (1989) this phenomenon could occur at any time during a learner's career and it usually does not disappear spontaneously. Mathematics anxiety has been found to be consistently related to lower achievement in mathematics at all ages (Betz, 1978 & Hembree, 1990). Nimer (1990) establishes a significant relationship between low achievement in mathematics and high levels of mathematics anxiety. In support of this finding, a consistent, negative relationship between mathematics anxiety and performance is reported by Wong (1992).

A number of researchers have suggested the following methods to facilitate the processes that are likely to lead to improvement in learners' attitudes towards mathematics and other subjects. Some of these address the feeling of mathematics anxiety or negative mathematics self-concept and they are as follows:

- Teaching learners to praise others (Henson and Eller, 1999).
- Assigning tasks that challenge learners and yet are within their ability range and give them the autonomy required to complete the task (Henson and Eller, 1999).
- The content of mathematics must be taught so that learners understand. The more they understand, the less anxiety learners will exhibit (Reyes, 1990).

- Learners increase their mathematical understanding and reduce their anxiety when they work collaboratively in small groups using examples to demonstrate concepts (Sherard, 1995).
- Teachers should encourage learners to ask questions while creating a comfortable class environment that emphasizes learning through class participations (Tobias & Weissbrod, 1980).
- Teachers should encourage learners to understand their own personal learning style by discussing the relationship of their learning style to math concepts (Fiore, 1999).
- Incorporating co-operative learning in the classroom was shown to have a positive effect on learners' achievements and attitudes towards mathematics (Walmsley & Muniz, 2003).
- Writing an essay about prior math experiences, both positive and negative, also helps learners understand that their success or failure may be more related to environmental factors than their own intelligence (Fiore, 1999).
- Teaching learners to develop self-evaluation skills and to make realistic evaluations of themselves (Henson and Eller, 1999).

2.3.2.2 Interest

Some research has suggested that, compared to other subjects, there is a relatively strong relationship between interest and achievement in mathematics (Schiefele, Krapp & Winteler: 1992). In this regard, Maree (1994) stated that the following factors are of significance in the learners' interest in mathematics:

- Learners' feelings play an important role in mathematics interest.
- Learners' interest and ability are positively related. According to Maree (1994) the better a learner performs in mathematics, the more he/she will like the subject and vice versa.

2.3.3 Language

Mother tongue is very important to the clear formulation of mathematical concepts as all ideas are communicated between the teacher and the learner, either through oral or written material (Cocking & Mestre in Kaphesi 2004). In this regard, the question of whether language proficiency is related to learning ability in mathematics and general academic achievement has been debated for many years. Much of the debate has centred on the performance of disadvantaged learners with limited proficiency in English. Factors in language proficiency and academic achievement include bilingualism, ethnicity, socio-economic status, use of non-standard dialects and other social and cultural variables. The problem posed by a foreign language when learning mathematical concepts, is confirmed by Orton (1992:141) when he states:

> *Communicating mathematical ideas so that the message is adequately understood is difficult enough when teacher and learner have a common first language, but the problem is more acute when their preferred languages differ.*

Emphasising the importance and relevance of language in mathematics teaching, Orton (1992) further indicates that:

> *Language is important not only for communicating but also because it facilitates thinking. The language used for thinking is most likely to be the first language, thus mathematics communicated in one language might need to be translated into another to allow thinking, and would need to be translated back in order to converse with the teacher.*

In this regard Berry (1985) has contrasted the mathematical progress of a group of university mathematics students in Botswana and a similar group of Chinese University students in Canada. The former group claimed they had to do all their thinking in English, because their own language did not facilitate mathematical proof, and they found this difficult. The Chinese students, on the other hand, daimed that they carried out their proofs in Chinese and then translated back to English, and that they were able to do this quite successfully. Berry concludes that the more severe problems would be likely to lie with learners trying to learn mathematics through the medium of an unfamiliar language, which is very different from their own.

In this regard Berry as cited in Orton (1992: 143) has summarised the language problems as follows:

> *In general it is likely to be easier for a student to function effectively in a second language which is semantically and culturally close to his mother tongue than in one which is remote…[for]…the structure of a person's language has a determining influence on that person's cognitive processes…such as classification and recognition of equivalences - processes which are central to the understanding of mathematical concepts.*

According to Dlamini (2008: 11) there are certain considerations that need to be noted in relation to language and mathematics. These are as follows:

- English language is a poor predictor of future performance for learners in Swaziland in the mathematics field of study.
- High achievers in mathematics may not be high achievers in the English language.

2.3.4 Learner motivation

The question of how to motivate learners in the classroom has become a leading concern for teachers in all disciplines, let alone in mathematics. A learner is motivated by a desire for knowledge. Stimulation of this desire is one of the basic tasks of a teacher. In this regard Wlodkowskin (1986: 6) defines motivation as:

> the word used to describe those processes that can (a) arouse and instigate behaviour; (b) give direction or purpose to behaviour; (c) continue to allow behaviour to persist; and (d) lead to choosing or preferring a particular behaviour.

Motivation deals with the reasons why learners become interested and react to those events that catch their attention. There are two distinct types of academic motivation that are interrelated in most academic settings, namely intrinsic and extrinsic motivation.

According to Piek (1984:22):

> *Extrinsic motivation stems from outside the subject matter area, but is in some way analogous to it. One thinks here of favourable circumstances, an exemplary teacher, the subject matter and the method of instruction, competition, prizes, allocation of marks, promotion and various other rewards.*

In this type of motivation, learners tend to centre on such performance goals as obtaining favourable judgement of their competence from teachers, parents, and peers or avoiding negative judgements of their competence (Ames & Archer, 1988; Duda & Nicholls, 1992).

Academic intrinsic motivation is the drive or desire of the learners to engage in learning **for its own sake.** Hunter (as cited in Molepo, 1997:63) describes the meaning of intrinsic motivation as follows:

> *When the activity itself is rewarding (enjoying reading or swimming) we have a situation where motivation is intrinsic, that is the activity will achieve its goal.*

The implication of this type of motivation is that learners who are intrinsically motivated engage in academic tasks because they enjoy them. Learner's motivations tend to focus on learning goals such as the understanding and mastery of mathematical concepts. When learners engage in tasks in which they are motivated intrinsically, they tend to exhibit a number of pedagogically desirable behaviours including time spent on tasks and persistence in the face of failure (Duda & Nicholls, 1992). In order to increase achievement in mathematics for traditionally disadvantaged learners' proper use of both intrinsic and extrinsic motivation is important. The author of this study is of the opinion that one of the tasks of the teacher working with disadvantaged learners is to ensure that the confidence and interest of these learners in mathematics is cultivated.

According to Alderman (1990) there are many aspects of learner motivation but four seem to be particularly important, namely:

- *The learning culture* – this is mainly about peer pressure and the ethos that exist at schools.
- *Intrinsic purpose of learning* – this shifts the emphasis from extrinsic motives for learning to intrinsic motives.
- *Self- efficacy* – this concerns learners' belief in themselves and their ability to learn.
- *Task value* – this is about the learners' interest in the task and the importance and value

Alderman (1990: 28) points out that:

> *Teachers who are successful in reaching disadvantaged learners combine a high sense of their own efficacy with high realistic expectations for learner achievement.*

Teachers with a high sense of efficacy or confidence in their ability to influence learner motivation are more likely to view disadvantaged learners as teachable (Ashton & Webb, 1986).

2.3.5 Learners' academic involvement

The concept of learners' involvement in learning is closely related to that of academic achievement. According to Sigh, Granville and Dika (2002) academic engagement is defined as active involvement and commitment as opposed to apathy and lack of interest. For instance, doing homework, coming prepared for classes, regular attendance and not skipping classes reflect learners' engagement and motivation. Astin (cited in Steyn, 2003: 91) points out that:

> *The theory of learner involvement encourages educators to focus less on what they do and more on what learners do.*

2.3.5.1 Homework

Homework is one of the instructional tools used by teachers to determine a learner's academic engagement. Homework here is defined as any subject work completed outside the regularly scheduled class. According to Grouws (2001) the purpose of homework includes the following:

- Developing skills
- Increasing understanding
- Demonstrating application
- Developing connections

A synthesis of research by Cooper (1994) and Pezdek, Berry and Renno (2002), shows that homework could have both positive and negative effects. Cooper (1994: 1) reports the positive effects of homework to include: *better retention of factual knowledge; increased understanding; better critical thinking; concept formation and information* *processing*. Cooper (1994) also noted that positive long-term academic effects include improved attitude towards school and better study habits and skills. Cooper (1994) also reports significant negative effects of homework, namely loss of interest on academic material, pressure to compete and perform well; parental interference, confusion regarding instructional techniques, copying homework from other learners and physical and emotional fatigue. Mullis (1990: 351) found that in some states in the United States of America, learners who reported doing homework had low achievement in mathematics. Research has shown, however, that the positive effects of homework outweighed the negative effects.

2.3.5.2 Time on task

According to Schoenfeld (1985) high school learners who perform poorly in mathematics tend to believe that mathematics problems should be solved in 10 minutes or they will never be solved. Schoemer, Calvert, Garglietiti and Bajaj (1997) observe that the more learners believe in fixed ability or quick learning, the lower their mathematics scores.

2.3.6 Learning approaches

Learning approaches (strategies) are defined as the behaviours and thoughts that learners use to select, organise, and integrate new information with their existing knowledge (Weinstein & Mayer: 1986). According to Biggs and Telfer (1987) there are three types of learning approaches, namely, **deep approach, surface approach and achieving approach.** These approaches have been widely used in learning. Table 2.1 identifies and compares characteristics of a learner who follows a deep approach and one that follows a surface approach.

Table 2.1 Approaches to learning according to Marton and Saljo

A learner who follows a deep approach		**A learner who follows a surface approach**
• tries to understand the 'big picture' • tries to relate content in a broader context • tries to synthesise aspects and integrate them within the 'big picture' • identifies core principles and distinguish detail • seeks for deeper meaning of course contents and • is committed to and enjoys the learning task		• focuses on aspects and not on the 'big picture' • sees the learning task as a short-term activity, for example to pass a test • cannot synthesise aspects and integrate them into a 'big picture' • invariably masters content through memorization • is focused on time and immediate completion of the task and not on a possible deeper meaning thereof and • is not necessarily committed to the learning task or enjoyment of the process

Adapted from Steyn (2003: 39)

In this regard Entwistle and Ramsden (1983) state that learners choose a specific learning strategy depending on their cognition of the learning task. They (Entwistle & Ramsden, 1983) go on to say that learners adapt their learning strategies through contact with other learners. In addition to deep and surface approaches there is the achieving approach. This is a learning approach motivated by the need to achieve success, in particular through obtaining high grades (Entwistle & Ramsden, 1983). This approach to learning has the following characteristics:

- putting consistent effort into studying;
- finding the right condition and material for effective study;
- managing time and effort efficiently.

Because the intention of learners using an achieving approach is to obtain high grades, they perceive the task as a medium to achieve the end and not as a learning opportunity. According to Biggs and Telfer (1987) learners may combine the achieving approach with either the deep or the surface approach in the form of deep-achieving approach or surface-achieving approach. The opinion of the author of this study is that the deep-achieving approach makes learners learn and achieve with understanding.

2.3.7 Learners' poor achievement in mathematics

A limited number of researchers have cited reasons for poor mathematics achievement among disadvantaged learners in the classroom situation. The following paragraphs will outline some of these reasons. According to Gourgey (1992) the following reasons were stated as poor achievement by many learners, let alone among disadvantaged learners.

- Feeling of being powerless when mistakes are made and not knowing how to correct them.
- Distrust of own intuition.
- Maths is emotionally charged, evoking strong feelings of aversion and fear of failure.
- Maths is seen as a subject to be performed by applying algorithms dictated by higher authority, rather than understanding underlying logical principles.

The researcher of this study agrees with the opinion of Russell (1995) who remarks that learning requires personal effort and learners need to understand that teachers, parents and peers cannot do the work required of learners.

2.4 TEACHER-RELATED VARIABLES

Meyer and Koehler (1990) state that one of the most important factors in developing learners' mathematics ability is the attitude of their teacher of mathematics. According to Meyer and Koehler (1990) knowledge of the learners' thinking is important while teachers' knowledge of mathematics content and pedagogy is also critical to the culture of the learning environment. According to Lubinski (1994) knowledge of the content and pedagogy in conjunction with learners' thinking, allows a teacher to design blueprints for worthwhile mathematics tasks.

In this respect it is reasonable to expect that teachers will feel successful when their learners perform well in mathematics, irrespective of whether or not they come from a historically disadvantaged school situation. It should also be expected that teachers would feel frustrated and unsuccessful when the learners perform badly. What is not clear, is who should be blamed, the teachers or the learners? Fennema and Franke (1992: 176) observe that:

> *If teachers attribute success or failures of students to themselves, then they will do something to alleviate the problem. If, on the other hand, the reason that learners succeed or fail lies within learners, then the teachers do not feel as much responsible for the failure.*

2.4.1 Attitudes and beliefs

2.4.1.1 Attitudes towards mathematics

In mathematics research, one area of focus has been on teachers' beliefs and attitudes towards mathematics. Ernest (1989) observes that the practice of teaching mathematics depends on a number of key elements, such as the teachers' mental contents and schemes, particularly the system of beliefs concerning mathematics and its teaching and learning; the social context of the teaching situation, particularly the constraints and opportunities it provides and the teachers' level of thought processes and reflection.

Fennema and Romberg (1999: 174) have made similar observations that teachers' beliefs influence the way teachers teach and talk about mathematics to their learners. She observes that:

> *If teachers believe that mathematics is useful, it seems reasonable to assume that they will work harder to ensure that their learners learn mathematics.*

Mudeliar (1987) also asserts that teachers' attitudes towards mathematics have a strong bearing on learners' attitudes and achievement in mathematics. In a review of related literature on learners' attitudes towards mathematics, Dungan and Thurlow (1989) conclude that learners' attitudes towards mathematics are derived from teachers' attitudes towards the subject. These attitudes in turn affect learners' mathematics achievement.

O'Laughlin (1990) found that novice teachers maintain definite beliefs regarding knowing, learning and teaching, which usually lead them to endorse didactic approaches with the teacher acting as the primary conveyer of knowledge. A teacher's beliefs about learners' abilities greatly influence the decisions the teacher makes about the learning environment (Lubinski, 1994). Lubinski (1994) also feels that teachers, who believe that the content of the mathematics in their classroom is guided by the textbook, make decisions that differ from those of teachers who believe that learner' interest and ability guide the content of the mathematics. In this regard Leder and Gunstone (cited in Ethington, 1990) referred to Colburn who recommends that the textbook should not be followed slavishly, but should be adapted to suit the needs of both the teacher and learners.

Research suggests that teachers' beliefs and teachers' knowledge are related to the instructional decision-making process (Fennema & Franke, 1992; Thompson, 1992). Consequently what a teacher believes about the content, methods, and materials available to teach mathematics influences the teacher's instructional decisions.

Schmidt (1999: 81) also observes that:

> *What teachers teach and how they teach it are affected by their subject matter belief and preferred pedagogical approaches, things that are consequences of their training and experiences.*

Fennema and Franke (1992) further indicate that the way teachers teach is not only affected by their own beliefs and by their conception of subject matter discipline in mathematics, but also by their beliefs about their learners and by their understanding of appropriate pedagogy.

In their survey of teachers' beliefs Schmidt (1999) classifies teachers' beliefs into four categories:

- Discipline-oriented teachers: These teachers indicate that it was important to remember formulas, and that mathematics was essentially abstract, and that mastering algorithms and basic computation was more important. They also indicate that the **real-world use** of mathematics was less important. They more often indicate that success in mathematics learning was more a matter of natural talent than other factors.

- Process-oriented teachers: Teachers in this group indicate that it was relatively important to remember formulas, to focus on algorithms, or to emphasise basic computation. They hold that mathematics was not abstract, and that its real world use was important. They also tend to emphasise creativity and thinking about mathematics conceptually.
- Procedure-oriented teachers: This group though having more common beliefs with the first group are more concerned with emphasising the real-world use of mathematics. They regard algorithms as only modestly important and indicate that subject matter should be present conceptually. To them mastering mathematics is just a talent.
- Eclectic-teachers: these teachers essentially emphasise nothing and do not possess a distinctive character. They are both somewhat discipline-oriented and somewhat real-world oriented.

2.4.1.2 Attitudes towards learners in mathematics

Research related to the issue of attitude towards learners in mathematics is extensive. One of the most important factors in developing learners' mathematics ability is the attitude of the teacher towards learners. Fennema and Romberg (1999) state that it is not only the teachers' beliefs about mathematics and its usefulness that are important, but also that the teachers' beliefs about their learners' ability to do mathematics have an influence on how they teach and subsequently on how learners learn.

In a report of a study of Japanese classrooms intended to acquaint American educators with mathematics teaching and learning in Japan, Becker, Silver, Kantowski, Travers and Wilson (1990: 13) make the following comment:

> *Even a casual observer realizes that all students are regarded as capable of learning mathematics and other subjects…The Japanese assume that learning is a product of effort, perseverance, and self-discipline rather than ability. Consistent with this philosophy, the schools have no ability grouping in elementary and junior high schools and virtually no individualised classroom instruction.*

The above suggests that for learners to learn mathematics effectively, teachers need to regard the learners as capable of learning and expose them to quality experiences that enhance learning.

Chen, Clark and Schaffer (1988) establish in their literature review that teachers positively influence learning and achievement through high expectations in relation to learners' learning. Cheung (1998) found that if a learner believes a teacher has a low opinion of him/her, it is possible that the learner will perform accordingly.

2.4.2 Teacher quality

Sarason (1993) maintains that if one wants to change the education of learners, one needs to first change the education of the teachers. According to Sarason (1983) it is necessary to prepare educators for what life is like in classrooms, schools, school systems and society. The preservice and continuing education of teachers of mathematics should provide them with the opportunity to examine and revise their assumptions about how mathematics should be taught, and how learners learn mathematics (National Council Teachers of Mathematics, 1989:160).

2.4.2.1 Teacher's role

The National Education Policy Act of 1996 (DoE: 2000) lists seven roles for educators, namely educators as

- ***Learning mediators***

  Educators have to mediate learning in a manner which is sensitive to the diverse needs of learners, including those with learning impediments and demonstrate sound subject content knowledge.

- ***Interpreters and designers of learning programmes and materials***

  Educators have to provide, understand and interpret learning programmes, identify the requirements for a specific context of learning and select and prepare suitable textual and visual resources for learning. They should select the sequence and pace of the learning in a manner sensitive to the differing needs of the subject/learning area and learners.

- ***Leaders, administrators and managers***

Educators have to make decisions appropriate to the requirement level, manage learning in the classroom administrative duties efficiently and participate in school decision-making structures. This has to be done in ways that are democratic, which support learners and colleagues, and which demonstrate responsiveness to changing circumstances and needs.

- ***Scholars, researchers and lifelong learners***

Educators have to achieve ongoing personal, academic, occupational and professional growth through pursuing reflective study and research in their learning area, in broader professional and educational matters, and other related fields.

- ***Community, citizenship and pastoral role***

Educators have to practise and promote a critical, committed and ethical attitude towards developing a sense of respect and responsibility towards others. In the school the educators have to demonstrate an ability to develop a supportive and empowering environment for the learner and respond to the educational and other needs of the learners and fellow educators

- ***Assessors***

Educators have to understand that assessment is an essential feature of the teaching and learning process and know how to integrate this into the process of learning. The educator must have an understanding of the purposes, methods and effect of assessment, and also be able to provide helpful feedback to learners. They should design and manage both formative and summative assessment in ways that are appropriate to the level and purpose of the learning and meet the requirements of accrediting bodies.

- ***Learning specialists***

Educators have to be thoroughly familiar with the knowledge, skills, values, principles, methods, and procedures relevant to the discipline, subject, learning area, phase of study, or professional or occupational practice. They should know the different approaches to teaching and learning, and how these may be used in ways which are appropriate for learners and context. Educators should have a well-developed understanding of the knowledge appropriate to their specialisation.

2.4.2.2 Pedagogical content knowledge

Learners' achievement in mathematics is also likely to be affected by the teacher's pedagogical content knowledge (Vatter, 1992). According to Shulman (1987) pedagogical content knowledge is the capacity of a teacher to transform the subject knowledge that he or she possesses into forms that are pedagogically powerful and yet adaptable to the variations in ability and background presented by the learners. Shulman (1987:9) further argues that a teacher must:

> *Understand the structure of subject matter, the principles of conceptual organisation, and the principles of inquiry that help answer two kinds of question in each field: what are the important ideas and skills in this domain? How are new ideas added and deficient ones dropped by those who produce knowledge in this area? That is, what are the rules and procedures of good scholarship or inquiry?*

According to Ethington (1990) much of the literature suggests that it is critical for secondary mathematics teachers to have strong mathematical knowledge, a positive attitude towards mathematics and teaching, as well as an alignment with proper pedagogical beliefs. For instance Ma (1999) describes what she calls *profound understanding of fundamental mathematics* in terms of the depth, breadth and thoroughness of the knowledge that the teachers need. **Depth**, according to Ma (1999) refers to the ability to connect ideas to the larger and powerful ideas of the domain, whereas **breadth** has to do with connections among ideas of similar conceptual power. According to Ma (1999) **thoroughness** is essential in order to *weave this into a coherent whole*. Ma (1999: 123) further argues that:

> *Teachers' knowledge of mathematics for teaching must be like an experienced taxi driver's knowledge of a city, whereby one can get to significant places in a wide variety of ways, flexibly and adaptively.*

2.4.2.3 Teacher experience and in-service training

According to Ball and Wilson (1990) mathematics education majors have not been exposed to enough alternative teaching methods to be capable of teaching mathematics with an emphasis on meaning. Ball and Wilson (1990) go further and mention that preservice secondary mathematics teachers often lack sufficient mathematical understanding to teach the subject effectively.

In 1991 the National Council of Teachers of Mathematics together with the Association for Supervision and Curriculum Development published A *Guide for Reviewing School Mathematics Programs.* In this document they state that in order to have high-quality mathematics programs, teachers of mathematics must be well-prepared, process and demonstrate positive attitudes, continue to grow professionally, and be actively involved in educational issues that affect the quality of their learners' learning (NCTM & ASCD, 1991). Mullis (1991) in his assessment of the state of mathematics achievement in the USA found some modest evidence of a positive relationship between the extent of in-service education and learners' achievement in Grade 8. However, in Grade 4, in-service education did not seem to be significantly related to mathematics achievement.

The lack of adequate in-service training opportunities for some teachers is a barrier to learners' academic achievement in mathematics. In "Learning without Limits: An agenda for the Office of Postsecondary Education" (2000), it is reported that experienced teachers do not have adequate opportunities to improve their knowledge and skills, and that in-service training opportunities for teachers are "second rate" (2000:32). The report cites the following problems regarding the in-service training of teachers:

- In-service training remains largely short-term and non-collaborative.
- In-service training is often unrelated to the teachers' needs and the challenges faced by their learners.

- Teachers are offered in-service training opportunities that last for a few hours (less than eight).

Lockheed and Komenan (1989) show a significant positive relationship between teacher experience and learner achievement in some developing countries, for instance in Nigeria and Swaziland. In contrast Chen at al (1988) establishes no significant relationship between teacher experience and learners mathematical achievement.

2.4.2.4 Competence

Georgewill (1990) in his review of literature shows that professional education is necessary, particularly for secondary school teachers in a special field like mathematics. Shaveson, McDonnell and Oakes (1989) go further and state that what teachers actually do, depends not only on their competence, but also on the conditions under which they must provide instruction. They noted that a fully competent teacher might perform less than adequately in the classroom, if he or she is working in a disorganised and unsupportive environment for teaching and learning. On the other hand, teachers with only minimal competence can perform quite adequately, given supportive and favourable working conditions.

Peng and Hill (1995) in their assessment of the state of mathematics achievement in the United States of America find that teachers of learners from disadvantaged schools, namely Hispanic, Black, and American Indian learners were not necessarily under-prepared in terms of certification, education level or number of years of teaching although their learners continue to attain lower average achievements in science and mathematics. In South Africa Maqsud and Khalique (1991:379) note that in spite of the availability of well-qualified mathematics teachers in some Bophuthatswana (North-West Province) schools, Grade 12 results of such schools remain far below acceptable standards.

Several studies (Henson & Eller, 1999; Nelson & Prindle, 1992) document the characteristics of effective teachers. Although the majority of these studies do not focus specifically on mathematics, the opinion of the writer is that the characteristics they identify are applicable to teachers in all subject areas. According to Henson and Eller (1999) the following are the characteristics of effective teachers working with learners in regular classroom. They:

- set high goals and communicate these goals to learners;
- appreciate creativity and enjoy the unpredictability of working with divergent thinkers;
- are flexible in their thinking and willing to admit mistakes or change their positions or opinions when evidence warrants this;
- are willing to be flexible in terms of time of the task during the school day, and they devote extra time after school to working with their learners;
- are well organised and flourished in classrooms where there were multiple activities running concurrently.

In studies focusing on mathematics classrooms, expert teachers were identified as having a strong background in mathematics, demonstrating expertise in and enjoyment of problem-solving and being able to engage in deep mathematical thinking (Nelson & Prindle 1992; Shefield 1994). These teachers also had general knowledge, interest in non-mathematical ideas and concern about problems facing their communities.

2.4.3 Mathematics lesson structure

A number of researchers have investigated the building blocks of mathematics lesson structure, because contributes to effective teaching and learning. In their comparison of a typical lesson structure in the United States of America and Japan, Schmidt *et al.* (1999) find that most lesson structures focus on five global behaviours, namely:

- Reviewing the content covered in a previous lesson (5 min).
- Reviewing homework assignment in a previous lesson (10 min).
- Providing instruction on new subject matter (20 min).
- Having students work on in-class exercises that were either used in the lesson development or otherwise discussed in the lesson (15 min).

- Having students work on homework that would not be discussed until a later lesson. (15 min).

However, what was different was the extent to which certain teachers used these activities. In the United States they found that mathematics instruction for both nine and thirteen year olds seems to be dominated by class work and reviewing homework. Teachers spent some time teaching new material but it was not the dominant feature of lessons. Less than forty percent of United States teachers provided twenty minutes or more of instruction on new material during a class period. Japanese teachers by contrast spent most of their time on the combination of instruction on new material and class work, which was, for the most part, actively tied to the instruction of the new material during the course of the lesson. In this regard, Stevenson and Stigler (1992) attributed some of Japan's leading mathematics achievement to mathematics lesson structure.

In examining the way how mathematics has been taught, Wood, Cobb and Yackel (1992: 179) observe that:

> *Teaching mathematics in schools is characterised by heavy reliance on the textbook by teachers both as a source of activities and for explanations of procedures to use in completing the task.*

In this context the role of the teacher is that of an instructor whose instructions are followed in order to arrive at a given product. The learners are then expected to follow the teacher's example carefully and answer the questions that the teacher asks without necessarily engaging in dialogue when information is exchanged. Thomas (1986) has investigated achievement levels for learners learning mathematics in different situations.

This includes:

- Whole-class lecture – demonstration situations; here the teacher instructs the whole class as one group for the greater part of the lesson.
- Co-operative learning when the teacher divides the class into small heterogeneous groups.

- Individualised situations where the students are given the individual seatwork and ask for the teacher's help when they need it.
- Within-class ability groups where the teacher divides the class into small groups based on ability.

The findings from these (Slavish & Karweit, 1984; Thomas, 1992) studies suggest that there are significant increases in achievement levels, measured by differences in scores in a pre-test and a post-test, when learners learn in small groups (co-operative learning) as opposed to individual seatwork.

In their study of mathematics teaching in Grades 4 to 6, Slavish and Karweit (1984) investigated the achievement effects of three commonly used methods, whole class instruction, within-class ability grouping and co-operative learning. They found that there were significant differences in the overall effects on learner's achievements. Slavish and Karwait's (1984) overall finding from their study is that two of the three modes they investigated, within-class ability grouping and co-operative learning in small heterogeneous groups, led to higher achievement levels in mathematics as compared to the whole-class mode.

In a study of Asian and United States of America (U.S.A.) classrooms, Stevenson and Stigler (1992: 65) report that **group orientation** in Japanese and Chinese classrooms

> *promotes the feeling of group membership*. Accordingly, participation in groups *enables children to learn and judge each other and appreciate the variety of ways individuals can contribute to a group's success (1992: 66).*

In contrast, in United States of America classrooms, Stevenson and Stigler (1992) report that students are observed working at their own pace and continuing to struggle with the assigned problems that others have already completed. This denies the students *social interaction with those who finished early.* According to Stevenson and Stigler (1992), teaching in groups, as is done in the Asian classrooms, is more advantageous than the individual approach of United States of America classrooms. Some research evidence suggests that students who prefer to co-operate, learn best in co-operative programmes, while other students who prefer to compete, do best in competitive programs (Smey-Riechman, 1988).

2.4.4 Teaching methods and strategies

Robitaille and Garden (1989) point out some factors that influence effectiveness of teachers, namely their teaching strategies, beliefs about teaching, and the general classroom processes that provide an immediate learning environment for mathematics. In this regard Dreckmeyr (1994: 67) defines

> *a teaching strategy as an extensive teaching plan which includes all elements of the instruction-learning events, such as form, content, classification, principles and aids.*

Teaching strategies can be classified in several ways for example, teacher-centred or learner-centred. Teacher-centred strategies are those in which the teacher has direct control. Learner-centred strategies are those strategies that allow learners to play a more active role.

In this regard, Stein, Leinhardt and Bickel (1989) suggest some factors in providing effective instruction for disadvantaged learners, namely

- They argue that the most important factor is the teacher.
- Time on task. They suggest that learners must be engaged in appropriate instruction for sufficient time to master the academic skills.
- The presentation of the lesson. Successful lessons include appropriate expectations, frequent monitoring and helpful feedback.

Furthermore they argue that the entire school experience of the learner should be designed to produce the maximum learning success for each individual. The negative effects of disorganised home environment can be overcome by providing a safe and consistent school environment. The learners' feelings of alienation can be overcome by showing genuine care for them and by involving them and making the school their own.

Accordingly Ysseldyke, Spicuzza, Kosciolek and Boys (2003: 163) identify some of the instructional features that are related to improved learners' achievement in mathematics. Some of these features include:

- Direct and frequent monitoring of progress.
- Corrective and motivational feedback.
- Learner academic involvement.
- Total length of time allocated for instruction.

2.4.5 Indicators for effective classroom teaching

According to Perrott (1982) good teaching cannot be defined because it is so complex. However, he (Perrott, 1982) tabulates some observable indicators of effective classroom teaching as indicated in the table below. These indicators include Ryan's factors, Flanders' indicators of indirect teaching style and Rosenshine and Furst's correlates positively.

Table 2.2 Observable indicators of effective classroom teaching

Ryan's factors
1.Teacher is warm and understanding
2.Teacher is organised and businesslike versus unplanned and slipshod
3.Teacher is stimulating and imaginative versus dull and routine
Flanders' indicators of indirect teaching style
1. Teacher asks questions
2. Teacher accepts learners' feelings
3. Teacher acknowledges learners' ideas
4. Teacher praises and encourages learners
Rosenshine and Furst's correlates
1. Teacher is enthusiastic
2. Teacher is businesslike and task-oriented
3. Teacher is clear when presenting instructional content

4. Teacher uses a variety of instructional materials and procedures
5. Teacher provides the opportunities for learners to learn the instructional content

Adapted from Perrott (1982: 3)

Most of the research on effective teaching was found to be consistent with the findings of Ryan, Flanders and Rosenshine (Perrott, 1982:4). Although a detailed discussion of these indicators is beyond the scope of this study, the author feels that they, in essence, also underpin the factors that facilitate achievement in mathematics in traditionally disadvantaged schools.

In its new curriculum standards, the National Council of teachers of Mathematics (1989) recommended decreased emphasis on a number of traditional practices in the teaching of mathematics. The following are examples of beliefs which are consistent with these traditional practices:

1. The teacher should:
   1.1 adhere closely to the textbook;
   1.2 provide step-by-step instruction in the use of algorithms or procedures;
   1.3 provide for extensive practice by learners.

2. Learners should:
   2.1 spend significant length of time practising one-step problems and problems categorised by types;
   2.2 rely on the authority of the teacher or an answer key;
   2.3 learn isolated topics;
   2.4 memorise rules, algorithms, formulas, and procedures without understanding.

Following are some of the beliefs which are consistence with effective classroom teaching:

Table 2.3 Beliefs consistent with effective classroom teaching

STUDENTS should:

1. value mathematics
2. be confident in their mathematical ability
3. be allowed to challenge concepts traditionally presented as “facts”
4. be able to
    a) work with others
    b) reason and communicate mathematically
    c) apply concept to real application
    d) risk discussing their ideas
    e) see mathematical connections

THE TEACHER should:

1. be a guide of learners’ knowledge
2. engage learners in activities which promote high levels of understanding and encourage
3. watch and analyse learners learning
3. place less emphasis on the “ right answer”
4. ask questions which encourage learners to make own connections

METHODS can include the following:

1. small-group work
2. peer instructions
3. whole-class discussion with the teacher as moderator
4. investigation of alternative problem-solving strategies
5. discussion of “mistakes”
6. text used only as one of many resources

Borich (1996) gives the following summary of teacher variables that may be necessary to obtain high achievement gains in (social) settings of low socio-economic status. These involve the following:

- Generating a warm and supportive effect by letting learners know that help is available;
- getting a response, any response, before moving on to the next bit of new material;
- presenting material in small bits, with a chance to practise before moving on;
- emphasising knowledge and applications before abstraction, putting the concrete first;
- giving immediate help (through use of peers perhaps):
- generating strong structure and well-planned transition.

In the following section some teachers' instructional strategies that apply in mathematics are discussed.

2.4.6 Co-operative learning

One of the methods of learning mathematics is co-operative learning. Co-operative learning, peer learning, or collaborative learning are all terms used to describe groups of learners, whether small or large, who are engaged in different learning environments to learn to solve problems, to understand the cause and effect, to develop and defend different perspectives, and grow as learners and decision makers. Felder and Brent (in Steyn, 2003) define cooperative learning as a subset of collaborative learning. According to them, in collaborative learning learners are interacting with one another while they learn actively and apply course material. In cooperative learning (Bruffee, 1999:1):

> *Learners discuss issues in small consensus groups. They plan and carry out long-term projects in research teams, tutor one another, analyse and work on problems together, unravel difficult lab instructions together, read aloud to one another what they have written, and help one another edit and revise research reports and term papers.*

According to Tinzmann, Jones, Fennimore, Blakker, Fine and Pierce (1990) collaborative learning has four general characteristics:

- Shared knowledge among teachers and learners
- Shared authority among teachers and learners
- Teachers as mediators
- Heterogeneous groupings of learners

Davidson (1990: 53) offers the following motivation for employing cooperative learning in mathematics classes:

- Small groups provide a social support mechanism for the learning of mathematics.
- Small-group learning offers opportunities for success for all learners.
- Mathematics problems are ideally suited for group discussion in that they (usually) have solutions that can be objectively demonstrated.
- Mathematics problems can often be solved by several different approaches. Learners in groups can discuss the merits of the different proposed solutions and perhaps different strategies.
- The field of mathematics is a field with exciting and challenging ideas that merit discussion. One learns by talking, listening, explaining and thinking with others.
- Mathematics offers many opportunities for creative thinking. Learners in groups can often handle challenging situations.

Dossey, McCrone, Giordano and Weir (2002: 502) express the importance of co-operative learning as follows:

> *Co-operative learning or small-group learning ideally provides students with a less threatening environment in which to work since they don't feel the pressure to perform in front of their peers. In addition and possibly more importantly, when students work with others, there is the possibility that students will share ideas, build on the ideas of others, justify their ideas, and, hence create a deeper understanding of the concept being explored. This is of course, the ideal outcome.*

Small-group collaborative learning provides an alternative to both traditional whole-class expository instruction and individual instructional systems.

While research shows positive effects on learners' achievement by learners engaged in co-operative learning, a number of authors have pointed out possible problems with co-operative small-group work, namely;

- Shared learners' misconceptions can be reinforced by group work (Good & Brophy, 1997).
- Learners might be tempted to engage in off-task social interaction (Good & Galbraith, 1996).
- Learners may also receive differential status in groups. Some may start to perceive themselves as having little to contribute to the group, or may find that their contributions are not greatly valued.
- Small group work may then favour high-ability learners more than lower-ability ones. Studies have found lower ability learners to be less active in small groups, in part because they understand the task less well and in part because learners' talk can also express low expectancies of certain other learners (Good & Brophy, 1997).
- Small-group work requires far more classroom management skills from the teacher.

Brahier (2000: 158-159) states that in the co-operative learning environment:

> *The activity should be structured so that every student has no choice but to be actively involved in the problem-solving process. Also, each student has individual accountability, which means even though the work is done as a team, in the end, each student is required to individually demonstrate an understanding of the concepts through an interview, a written test or some other means.*

Dossey *et al*. (2002: 503) point out that:

> *In preparing for group work, the teacher must make decisions about the size, composition and how to arrange the groups. Many advocates of cooperative groups (Davidson, 1990; Foster & Theesfeld, 1999; Neyland, 1994) suggest creating diverse groups so that students of low and high ability, different genders and differing background are grouped together. This diversity will most likely offer a variety of ideas and opinions that may be valuable for exploring a problem situation.*

2.4.7 Problem-solving

According to Charles and Lester (1982:5) *a problem* is defined as a task for which:

- The person confronting it wants or needs to find a solution.
- The person has no readily available procedure for finding the solution.
- The person must make an attempt to find a solution.

According to Charles and Lester (1982) this definition emphasises three crucial components of a problem:

- A desire or need on the part of the problem-solver to attain a goal.
- The fact that the goal cannot be reached directly and immediately.
- The fact that a conscious effort is made to reach the goal.

The Cockcroft committee (in Backhouse, Haggarty, Pirie & Stratton, 1992: 137) describe problem-solving as *the ability to apply mathematics to the variety of situations*. They further state that:

> *However, the solution of a mathematical problem cannot begin until the problem has been translated into the appropriate mathematical terms. This first and essential step presents very great difficulties to many pupils - a fact, which is, too often appreciated.*

Polya (1971) defines problem-solving as searching for an appropriate course of action to attain an aim that is not immediately attainable. Schoenfeld (1998: 88) defines a problem in relation to its effect on the learner as a task,

- *in which the student is interested and engaged and for which he wishes to obtain a resolution, and*
- *for which the student does not have a readily accessible mathematical means by which to achieve that resolution.*

Schoenfeld's definitions suggest that a problem is not a problem unless the learner is interested in solving it.

The following are types of teacher behaviour that should be used at each of Polya's stages (Charles & Lester, 1982: 37):

- ***Understanding the problem.*** The teacher might ask questions to help the learner understand the problem. Learners should also be trained to ask themselves questions when they are confronted by a problem.
- ***Devising a plan.*** In this phase the teacher should direct learners' attention to related problems on previously used strategies where possible.
- ***Carrying out a plan.*** In this step learners should be encouraged to solve the problem on their own. If the selected plan does not work, the teacher can encourage the learner or group of learners to try an alternative plan suggested in phase 2.
- ***Looking back.*** This phase is essential for consolidating the knowledge gained from the solution and for developing in learners the processes needed for solving the problem. In this regard Schroeder and Lester (1989) describe three ways in which problem-solving is interpreted in the classroom, namely;
- ***Teaching for problem-solving***. In teaching for problem-solving, the goal is to first teach the concepts so learners will later apply that knowledge to a problem-solving situation
- ***Teaching about problem-solving***. Teaching about problem-solving is the teaching of strategies in order to solve problems.
- ***Teaching via problem-solving.*** Teaching via problem-solving is teaching mathematics in a problem-solving environment. Learning in this approach involves learning through a concrete problem and eventually moving to abstraction.

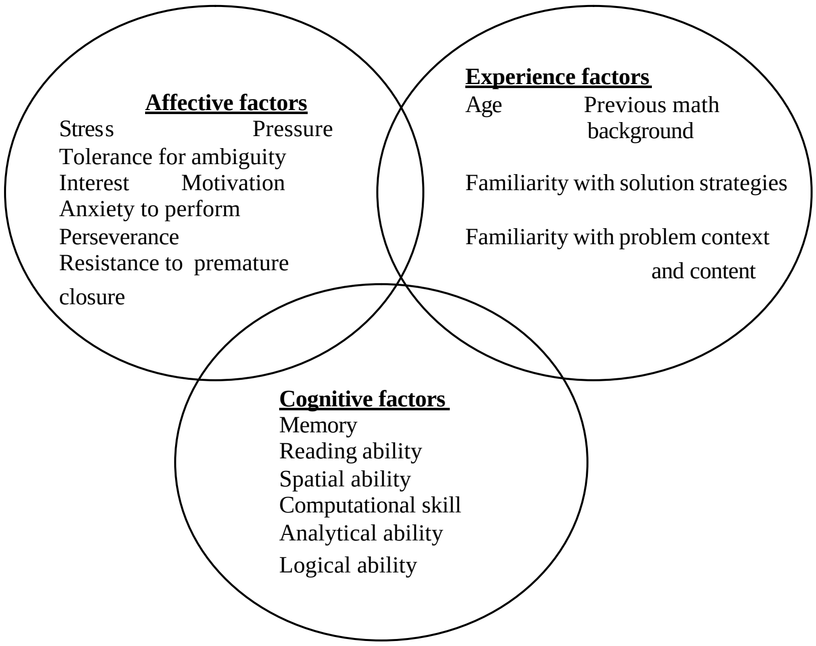
Erickson (1986) finds that a teacher teaching **for** problem-solving uses much direct instruction in her classroom while a teacher teaching **via** problem-solving facilitates learners' exploration. Hoffer and Gamoran (1993) studied the impact of various instructional approaches on learners' achievement. They find that one of the three main determinants was emphasis on problem-solving and this was particularly effective in the case of low- and middle- ability groups.

Bell (In Maree, 1997: 70) stresses the importance of problem-solving in mathematics as follows:

> *Problem-solving is an appropriate and important activity in school mathematics because the learning objectives which are met by solving problems and learning general problem-solving procedures are of significant importance in our society.*

According to Charles and Lester (1982: 37) there are three sets of factors that influence the problem-solving process, namely **affective factors**, **experience factors** and **cognitive factors**. Figure 2.1 is a summary of the contents of each of these factors. In the opinion of the author of this thesis, these factors are important to consider in order to facilitate mathematics achievement in secondary schools, let alone in Grade 12 disadvantaged learners' classrooms.

Figure 2.1 Some factors that influence the problem-solving process



Adapted from Charles and Lester (1982: 37)

Within this framework one can conclude that a learner who has the entire prerequisite to solve a problem may fail to do so through either lack of motivation, high degree of stress, or lack of familiarity with appropriate solutions.

2.5 EPISTEMOLOGICAL CONSIDERATIONS

According to Bigge and Shermis (1999: 3) learning theory is defined as

> *"a systematic integrated outlook in regard of the nature of the process whereby people relate to their environments in such a way as to enhance their ability to use both themselves and their environments in a most effective way".*

The intent of this section is to provide an overview of theories of learning suggested by psychologists in relation to the learning of mathematics. Theories help teachers to conceptualise learner communication, promote interpersonal relationships between teachers and learners, help teachers to implement professional ethics and have an impact on how teachers regard themselves.

The importance of learning theories is summarised by Ertmer and Newby (in Steyn, 2003:79) when they remark that:

> *"Learning theories provide instructional designers with verified instructional strategies and techniques for facilitating learning as well as a foundation for intelligent strategy selection."*

In this regard Owens (1995:158) states that *"No discipline can claim uniform agreement on the theoretical framework for teaching and learning"*. Romberg (1988) alludes to the fact that there are many theories because the way humans learn is extremely complex. Romberg (1998: 23) states the following reasons in support of his remarks:

- Lack of general agreement on the definition of learning
- Different kinds of learning
- Different philosophical assumptions about the nature of the learning process.

In this study the author has chosen to concentrate on theories that are seemingly significant in influencing the way mathematics is currently studied in grade twelve, namely **behaviourism, gestalt learning theory** and **cognitive learning theories**. Each learning theory represents a particular view of knowledge. The author agrees with the opinion expressed by Maree (1997) that each theory is valid to a certain extent.

2.5.1 Behaviourism

Behaviourism focuses on the outcomes of learning rather than on how learning occurs. It assumes that learning occurs by passively, but rationally, reflecting on stimuli from the environment. According to Leonard (2002:38), in behaviourism *learners are placed in a controlled environment in order to be directed to a specific set of behavioural changes based on a set of predetermined, instructor-based objectives*. Learning is viewed as change in behaviour (or performance) and the changes in scores on some measure of performance are often used as evidence of learning.

In spite of the criticism against behaviourism, its underlining principles have influenced the teaching of mathematics in secondary schools to a large extent. For example, drill-and-practice routines such as factorizing trinomials and solving linear equations are influenced by behaviourism (Romberg, 1988).

2.5.2 Gestalt learning theory

Crowther (in Steyn, 2003:24) defines "*gestalt as an organised whole that is perceived as more than the sum of its parts*".

Steyn (2003) points out that the definition of *gestalt* has particular significance for the learning of mathematics at all levels. While behaviourism in many of its forms is an adequate model for many forms of learning (particularly low-level concept and skills), it was totally inadequate for explaining how one discovers a relationship, proves a theorem, and solves complex problems. According to Romberg (1988) repeated practice and reinforcement cannot make someone a creative mathematician; the invention of new ideas does not occur. Romberg further notes that learning is not simply change in performance. Therefore change in scores and an increase in the number of correct answers fail to capture changes in strategies or ways of thinking about a problem.

Gestalt theory posits that learning involves active construction rather than passive absorption from the environment and it implies that learners experience the world in meaningful patterns and then construct meanings from those patterns. This theory states that evidence of learning has been in terms of changes in the way persons said they thought about problems. Most early work on mathematical problem-solving (e.g. Polya, 1945, Hadamard, 1945) is rooted in this theory.

2.5.3 Information processing

Gagne (in Maree, 1997:32) defines learning as follows:

"Learning in human disposition or capability, which persist over a period of time, and which is not simply ascribable to processes of growth".

In developing his information processing model of teaching, Gagne first lists five major categories of learning capabilities, namely intellectual skills, cognitive strategies, verbal information, motor skills and attitudes (Bigge & Shermis, 1999). Gagne regards these categories as educational outcomes and as descriptive of possible different kinds of human performance. Gagne's theory implies that skills in mathematics are analysed according to learning hierarchies.

2.5.4 Cognitive learning theories

Behaviourism focuses mainly on the outcome of learning whereas the cognitive learning theories focus on the process of learning. Cognitive theories of learning emphasise that learners are ultimately responsible for their own understanding through active construction of meaning (Bigge & Shermis, 1999).

2.5.5 Constructivism

Constructivism is a theory of knowledge with roots in philosophy, psychology, and cybernetics (Jaworski, 1994). In the following section radical and social constructivism are defined.

(a) Radical constructivism

According to Glasersfeld (in Jaworski, 1994:15) radical constructivism asserts two main principles whose application has far-reaching consequences for the study of cognitive development and learning, namely

- Knowledge is not passively received by learners but actively built up by the teachers and learners in the classroom.
- Acquisition of knowledge is an adaptation process during which learners reorganise their experiential world.

(b) Social constructivism

The social constructivism view of learning is based on the theories of Piaget (1926) and Vygotsky (1978).

Ernest (1999) provides an account of social constructivism, identifying two key features:

- First of all there is the active construction of knowledge, typically concepts and hypotheses, on the basis of experiences and previous knowledge. These provide the basis for understanding and serve the purpose of guiding future actions.
- Secondly there is an essential role played by experience and interaction with the physical and social worlds, in both physical action and speech modes.

According to Balacheff (1990) the **constructivist hypothesis** states that knowledge is constructed by the learner, not passively received, and that one comes to know by an adaptive process of organising one's experiences rather than by perceiving some external reality.

2.5.6 Constructivism and epistemology

Balacheff (1990) characterises the learning and teaching of the mathematics process as a relationship between two hypotheses, namely Constructivism and Epistemology and two constraints namely the nature of mathematics knowledge and the nature of the classroom. In relation to **epistemological hypothesis** Balacheff (1990) states that mathematical knowledge is developed through solving problems. Problems set the stage for construction of knowledge by establishing the need for mathematical knowledge and the context in which mathematics is learned. Under this hypothesis problems only generate mathematical knowledge to the extent that learners perceive the problem as their own.

Taken together, **constructivist** and **epistemological** hypotheses imply the centrality of the process of developing responsibility for learning from the teacher, where it has traditionally resided to the learner. They also suggest a view of learning and knowledge as a private domain intrinsic to the individual. According to Owen (1995) this view of learning and knowledge conflicts with two constraints inherent in the teaching process and in mathematics outside the classroom.

- Mathematical knowledge is social knowledge.
- The mathematics class exists as a community.

2.5.7 Constructivismand mathematics learning

According to Piaget (in Bigge & Shermis, 1999:18) the key processes in the stages of child development are ***assimilation*** and ***accommodation***. Assimilation consists of the modification of the input from the environment. In this process new knowledge meshes with the child's existing insight. Accommodation consists of the change in the child's internal patterns of understanding to fit reality. In this process existing internal insights are reconstructed to "***accommodate***" new information.

In this regard, Piaget (in Bigge & Shermis, 1999) argues that the mental development of any child consists of a succession of three periods: namely **sensorimotor** (birth to eighteen months or two years), **symbolic** (from eighteen months to age seven or eight), and **concrete-operational** (from ages seven or eight to twelve years). In the concrete-operational period children learn to do what they had learnt previously through physical action. Piaget's mental development refers to children from birth to twelve years. According to Piaget (Bigge & Shermis, 1999:19) the **formal operational stage** begins from ages twelve to fifteen years. Learners in the formal operational stage function on an abstract level that is an adult level of thinking and not bound by concrete experience. Piaget (cited in Maree, 1997) is of the opinion that insight into the basic structure of mathematics and an execution of mathematical operations are mastered by the learners when they construct their interactions within their physical, social and cultural environment. Piaget (in Maree: 1997) cannot accept that learning is subordinate to development.

Vygotsky (1978) maintains that culture, social instructions and customs are the dominant factors in a child's cognitive development, especially in the area of thought and language. The process of complexity and adaptation among children according to Vygotsky is influenced by such factors as the home environment, peer relationships, the food they eat, the clothes they wear and the mastery of language (Henson & Eller, 1999). This suggests that the changing social characteristics of disadvantaged learners can impact on their cognitive development.

Vygotsky (1978) emphasises the importance of the conceptual scaffolding for the gradual internalization of knowledge, obtained by social interaction between a novice and a more competent peer or adult who provides a model. Vygotsky (1978) notes the following elements of constructivism:

- The significant role of dialogue in learning
- The place of peers in instructional practices of various learning tasks
- The interactive structure of all learning tasks. Thus learning is the result of internalization of social interaction.

The instructional processes which Vygotsky emphasises teacher co-operation, teachers supporting their learners and language development of the learner.

In this regard Driver and Bell (1986) identify six main characteristics of the constructive approach, namely,

- Academic outcomes depend on knowledge, purpose and motivation brought by the learner into the learning situation.
- Learning involves personal construction of meanings.
- Meaning is constructed through an active, continuous process.
- Constructed meanings are evaluated by learners, who can reject or accept them.
- The learners hold final responsibility for learning.
- Types of meanings are constructed by learners based on experiences with real objects learnt and through natural language.

2.6 SUMMARY

The major aim of this chapter was to review relevant literature of factors that facilitates achievement in mathematics. This review of literature indicates some factors that facilitate achievement in mathematics. The first section of the literature review covers these factors that are related to school. Variables such as learning environment, societal influence, teacher attitudes and perception, language and culture were reviewed.

The second part of the review addresses the variables that are related to learners and mathematics achievement. Variables such as learners' motivation, learners' academic engagement, learning approaches, peer influence and support, influence of career choice and mathematics enjoyment were reviewed. The literature review shows a significant relationship between all peer group attitude variables considered in this study and achievement in mathematics. Almost all sources reviewed for the purpose of this study report a significant positive relationship between learners' mathematics self-concept, attitudes and study methods and learners' mathematical achievement.

The third section of the review shows some factors that are related to teachers' performance and learners' achievements in mathematics. Variables such as teacher pedagogical content knowledge, competence and qualification, teacher interest and commitment and teaching methods were discussed. Studies on teachers' attitudes and methods reported a significant relationship between these teacher variables and mathematics achievements. Inconclusive findings are reported for teachers' competence where this review reported poor performance of learners despite some better-qualified teachers. It was however, the purpose of this study to further investigate the attitudes and attributes of the mathematics teachers.

The final section reviewed literature pertinent to an overview of some theories and practices for teaching and learning mathematics. The notions from the general theories of learning often do not apply to the learning of mathematics in direct and obvious ways. The author of this study accepts the view that each theory has an influence and will continue to influence the way scholars and teachers view the learning of mathematics.

2.7 CONCLUSION

According to Mullis (1991) learners' achievement in mathematics is a function of learners' home environment, attitudes towards mathematics, mathematics curriculum, instructional contexts and practices and school variables that explain variations in learners' achievements. Ewen (2002) remarks that the question of how to motivate learners in the classroom has become a leading concern for teachers of all disciplines including mathematics. According to Ewen (2002) school teachers need to be well grounded in learners' motivation and learners' management (Wong, 2003) because this is relevant to mathematics achievement.

The review indicated that although South African learners from disadvantaged communities express positive attitudes towards mathematics, the failure rate in this subject is still high. The author of this study is of the opinion that there is a need to expand the knowledge based on factors that facilitate achievement in mathematics among South African learners, especially those from disadvantaged schools, beyond data that have been collected using survey methods

CHAPTER 3

RESEARCH DESIGN AND METHODOLOGY

3.1 INTRODUCTION

According to Brink (1999), the aim of data analysis is to reduce and synthesise information to make sense out of it and to allow inference about a population, while the aim of interpretation is to combine the results of data analysis with value statements, criteria, and standards in order to produce conclusions, judgements and recommendations. The methods used to process the results, together with the methods used to analyse and interpret results, are discussed in this chapter. Initially the research design is described. This is followed by stating the population, the sample and sampling procedures. The chapter also outlines the methods of data collection and the plan for data analysis. Lastly issues related to the reliability, validity and bias are discussed.

3.2 RESEARCH DESIGN

According to Cormack (1996), the research design represents the major methodological thrust of the study, being the distinctive and specific approach, which is best suited to answer the research questions. The research questions, the aim and the objectives of the study thus influence the selection of the research design (Brink, 1999).

The purpose of the research design, as stated by Burns and Grove (2001), is to achieve greater control of the study and to improve the validity of the study by examining the research problem. In deciding which research design to use, the researcher has to consider a number of factors. These include the focus of the research (orientation or action), the unit of analysis (the person or object of data collection) and the time dimension (Bless & Higson-Smith, 1995).

In order to obtain a full picture of the factors that facilitate achievement in mathematics in historically disadvantaged schools, I have made use of triangulation. This is the process whereby data is obtained from as many different sources as possible, using more than one method to secure the data. In this regard this study was conducted in three phases involving qualitative and quantitative data in the form of:

- Six weeks of classroom observations and interviews with teachers (**Phase 1: qualitative data);**
- Focus group interview sessions with learners (**Phase 2: qualitative data**);
- Questionnaires for both teachers and learners (**Phase 3: quantitative data**).

All three phases will be discussed in detail in section 3.7

3.3 RESEARCH QUESTIONS

The objective of the study is to trace factors that facilitate achievement in mathematics in traditionally disadvantaged secondary schools. There are several factors that facilitate achievement in mathematics that relate to the learners, the teachers, difficulty of the subject, the curriculum, school, society, and learning and instructional methods. Based on this objective and following the review of the related literature, five main research questions and their hypotheses were constructed as follows:

RESEARCH QUESTION 1

What are the attitudes and competencies of mathematics teachers in high-performing and in under-performing schools?

Question 1 of this study focuses in particular on the role of the teachers as agents of mathematics facilitation, their qualifications and background, the teachers' way of teaching and their ideas about mathematics, its value and usefulness, and what they consider as vital in mathematics teaching, particularly in Grade 12 classes. The question also investigates teachers' attitudes towards their learners and towards teaching in general as well as their explanations of learners' successes and/or failures in mathematics.

RESEARCH QUESTION 2

What are the learners' attitudes towards mathematics and their perceptions of their successes and / or failures in mathematics?

Question 2 of this study is particularly concerned with establishing learners' affinity for mathematics, their future plans, perceptions of mathematics, beliefs regarding mathematics and its usefulness, beliefs concerning success and failure in mathematics, and most importantly the role of peer influences in mathematics.

RESEARCH QUESTION 3

What factors facilitate successful classroom practices in mathematics in Grade 12 schools?

Question 3 of this study focuses on establishing the way in which classroom practices promote positive or negative mathematics beliefs for achievement and persistence.

3.4 SAMPLING OF SCHOOLS

The participants in this research were grade twelve teachers and learners from historically disadvantaged schools from similar socio-economic backgrounds. Gender was not considered. Ten rural schools in Limpopo (Vhembe District) participated in the study. All of them were government schools. Although this was a convenience sample, with schools selected on the basis of their accessibility and performance, all schools were from the Vhembe district, and represent high-performing schools (HPS) and low-performing schools (LPS) in mathematics. Five high-performing schools and five low-performing schools participated in the study.

3.5 DEFINING THE SAMPLE

For the purpose of this study a purposive or judicious sample was used. This type of sample is based entirely on the judgement of the researcher in that a sample is composed of elements that contain the most characteristic, representative or typical attributes of the population (Neuman 1994; Strydom & De Vos, in De Vos, 2001). In this regard all schools were located in historically disadvantaged communities.

3.6 ORGANISATION OF THE STUDY

The study was conducted in three phases. The first and the second phase were concerned with a qualitative design and the third phase of data collection with a quantitative design. In the following section I outline a brief overview of some characteristics of qualitative and quantitative research methodology and their benefits to the current study, followed by an explanation of why triangulation was the important choice for the research design.

3.6.1 Qualitative research methodology

McMillan and Schumacher (2001) outline the following characteristics that define qualitative research. They are:

- Explicit description of data collection and analysis.
- Detailed description of the phenomenon.
- Inductive reasoning applied to evidence gained from sources.
- Synthesised interpretation.
- Extensions of understandings by others.

Creswell (1994:150) lists the advantages of using qualitative research methodology as follows:

- The researcher has firsthand experience of the participant during observation.
- Information can be recorded as it occurs during observation.
- The researcher can control the line of questioning in an interview.
- Qualitative research is value laden.
- Unusual aspects can be noted during observation.
- It saves the researcher transcription time.
- The participants can provide historical information.

It needs to be stated that we do not fully agree with all of these claims. For example, transcription can take much more time than the primary data.

In the qualitative part of this research classroom observations, focus group interviews and individual interviews for teachers were used. The various steps included in the three phases of qualitative data collection of this study design were as follows:

- **Phase 1:** Six weeks of classroom observations and interviews with teachers
- **Phase 2**: Focus group interview sessions with learners
- **Phase 3**: Questionnaires for both teachers and learners

3.6.1.1 Phase 1

3.6.1.1.1 Part 1: Classroom observation

According to Moyles (2003) one area that has important implications for the improvement of teaching and learners' achievement is the use of classroom observation methods to investigate processes and behaviour that actually occur in classrooms. Some of the major strengths of using classroom observations are that they:

- permit researchers to study the process of education in natural settings,
- can be used to stimulate change and verify that the change occurred (Anderson and Burns, 1989).

The descriptions of instructional events that are provided by this method have also been found to lead to improved understanding and better models for improving teaching (Good and Biddle, 1988).

In this regard of classroom observation was conducted in four schools for six weeks. Two of the schools were high-performing and two were low-performing. The classroom observations were limited to four schools to permit repeated observation and comprehensive interviews with each of the teachers observed. While recognising that selection of these four schools and teachers limited my ability to generalise to other populations, I believe that the findings provide information for use by practitioners who work with learners from disadvantaged schools.

(a) Facts that were true in all the classrooms

In this section I wish to introduce the reader to the classrooms that I studied and the background characteristics of the teachers I have observed and worked with. The names of the schools and participants have been changed in order to preserve confidentiality. I observed six mathematics lessons in each classroom. This was done once a week for six weeks at times agreed on with the teachers. For each lesson I sat either at the back or the front of the class observing what was happening in the class and wrote observation notes that described the classroom activities. Some of the observations include:

- Learners solving problems on the chalkboard
- Teacher – learners interaction
- Learners helping each other in exercises
- Teacher attitudes towards learners
- Language used during discussions
- Teacher's mathematical knowledge

Details of the observation checklist are in Appendix C. Each learner in all four classrooms had a chair, table or a desk and the seating arrangement remained the same throughout the data collection period and, in fact, throughout the year. In three schools learners were not grouped according to standard grade or higher grade for teaching purposes. In only one school learners were grouped as higher or standard grade and kept in separate classrooms.

The typical school day in each of the schools began at around seven thirty in the morning. The first lesson began around 07:30 in all schools. All schools had a total of twelve periods, with four periods before short break (ten minutes) followed by four periods before lunch. The lunch break was half an hour. There were four periods after lunch in all schools. In most schools mathematics was taught during the early part of the morning, either during the first, second or third period. The reason for this, according to the teachers, was that learners are more alert and attentive to mathematics in the early parts of the day.

The following table shows days and topics observed in each school.

(b) Topics observed in each school

Table 3.1 Days and topics observed

Day/Topic	**School A High-performing**	**School B High-performing**	**School C Low-performing**	**School D Low-performing**
Day 1	Exponential functions	Quadratic equations	Logarithms	Sequence and series
Day 2	Nature of the roots	Trigonometry graphs	Distances and mid-points	Trigonometric ratios
Day 3	Curve sketching in calculus	Nature of the roots	Solving inequalities	Reduction formula
Day 4	Maxima and minima	Remainder and factor theorem	Geometry of the circle	Exponents revision
Day 5	Sine and cosine rules	Ratio and proportion revision	Application of differential calculus	Calculus curve graphs
Day 6	Mid-points and line segments	Height and distances	Exponents Revision	Maxima and minima

Six mathematics lessons were observed in each low-performing and six in each high-performing school in mathematics. For each group, two lessons were conducted in March, two in September and two in October. Two lessons in each school were video-taped. The videotapes focused on interactions between the teachers and the class. Lessons ranged from thirty-five to seventy minutes.

Attention was on the teacher-directed activity around the mathematical tasks, either with the whole class or small groups. The researcher was well known to both the learners and teachers as a result of the many visits. During the lessons when events were videotaped there was almost no interaction between me and the activities in the class. The learners and teachers were accustomed to supervisors from the teacher training college who make regular visits and observe, take notes, and put questions to their student teachers. This familiarity minimised distraction caused by my presence while my non-participation allowed for uninterrupted documentation.

I did the documentation of the observation using a video camera, a small JVC Handycam. The videotape method was chosen for documentation for two main reasons: firstly, it allow for an extended period of time to analyse the data without losing any details. This helped to eliminate any premature categorisation scheme that would bias the observer in later observation (Erickson, 1986). Secondly, given the interpretative nature of the research, it allowed for sharing the total experience of the classroom lesson with other researchers who were not present at the time.

The four teachers were told that the videotapes would be analysed for research purposes but not used in any other way without their consent. The researcher's relationship with teachers and principals was one of trust, with all offering their full co-operation.

3.6.1.1.2 Part 2: Interviews with teachers

Interviews are one of the most important tools of qualitative research. When properly used, researchers often get a better response from these than from other data-gathering instruments. The reason for this is that people usually feel more comfortable talking than writing (Best & Kahn, 1998). In fact, it has been suggested that in unstructured interviews the interviewer is free to move the discussion in any direction of interest that may come up and that this technique is particularly useful for exploring a topic under discussion broadly (Trochim, 2002).

In addition to data classroom observation, unstructured interviews were held with four teachers involved. The objective of the interviews with teachers was to explore findings observed during the lessons.

In these interviews teachers were asked to respond in an open-ended fashion to the following issues.

- The most important factors that contribute to learners' good performance in mathematics.
- The most important factors that contribute to their learners' poor performance in mathematics.
- How teachers motivate learners in mathematics.

3.6.1.2 Phase 2: Focus group interviews

Focus group interviewing is described as a purposive discussion of a specific topic or a related topic, taking place between four to twelve people per group with a similar background and common interest (Cohen, Manion & Morrison, 2000). Traditionally focus groups were used in the business world and recently more often in psychology and education (Coker, 2003). According to Vaughn, Schumm, and Sinagub (1996:4)

> *One of the characteristics that distinguish focus groups from other qualitative interview procedures is the group discussion. The major assumption of the focus groups is that with a permissive atmosphere that fosters a range of opinions, a more complete and revealing understanding of issues will be obtained.*

According to Schurink and Poggenpoel in De Vos (1998:324) focus group interviews are useful for:

- Conducting research at a relatively modest cost and in a relatively brief period of time.
- Allowing the moderator to probe and create the flexibility that is so important for exploring unanticipated issues.
- Developing themes, topics and schedules for subsequent interviews and/or questionnaires.
- Providing speedy results.
- Shedding light on little-known phenomena and social processes.

Focus groups may develop concepts or theoretical explanations of what was observed (McMillan and Schumacher, 2001). Focus groups purposefully determine the perceptions, feelings and thoughts of participants. People are the product of their environment and are influenced by other people. Learners may need to listen to opinions and perceptions of other people, particularly their own peers, to become aware of factors that facilitate achievement in mathematics. The limited published research on factors that facilitate achievement in mathematics in traditionally disadvantaged secondary schools, in particular grade twelve makes the use of a focus group a practical method for this research.

According to Cohen, Manion and Morrison (2000: 288) the following should be considered when one conducts focus group interviews:

- Deciding on the number of focus groups for a single topic. One group is not enough.
- Over-recruiting by as much as twenty percent taking into account people who may not turn up.
- Keeping the meeting open-ended but to the point.
- Deciding on the size of the group. A group of four to twelve is suggested.
- Ensuring that participants have something to say and feel comfortable enough to say it.

Cohen, Manion and Morrison (2000) furthermore suggest that focus groups can either be used to triangulate with more traditional forms of interviewing, questionnaire and observation methods or as a stand-alone method of inquiry when conducting educational research.

In the following section I discuss the sample size and the homogeneity of participants.

Size and homogeneity of the groups: Three focus group sessions were conducted. A total of eighteen learners (twelve males and six females) from ten schools participated in the focus group interviews. Focus group interviews comprised only grade twelve learners and explored learners' experiences in the subject, focusing on issues observed in phase one and individual teachers' interviews concerning among other factors motivation, work patterns and help-seeking behaviour of learners. Homogeneity of the participants was considered in order to obtain a sample with a range of mathematical skills. In this regard teachers were requested to select learners according to their performances in the Grade 11 mathematics final examinations. One high-achieving learner (more than 75%), one middle-achieving learner (between 40% and 60%), and one low-achieving learner (less than 20%) were selected. If there were no learners who scored more than 75% in the schools chosen, then all three learners were correspondingly chosen on the basis of their examination rankings as compared with other learners in the class.

The first group consisted of six high-achieving learners, four of whom were also registered for the subject Additional Mathematics. The second group consisted of seven middle-achieving learners. The last group consisted of five low-achieving learners. I have been involved in teaching grade twelve mathematics, and was familiar with the organisation and teaching content of the subject. The selection of the learners according to their performance was only for the qualitative part of the study. Lastly, only subjects who were willing to participate in the study were chosen and gender was not relevant.

3.6.1.3 Data analysis of qualitative research

In qualitative research data, analysis begins during the process of data collection. The reasons are as follows:

- The results of early data analysis guide subsequent data collection, which plays an important role in data selection and reduction.
- Early data analysis allows timely theorising about results (Cohen, Manion & Morrison, 2000).

3.6.1.3.1 Steps in data analysis

The analysis of the interview data involved a systematic approach for discovering and categorising the ideas conve yed by the interviewee (Carlson, 1999). The first step in data analysis is the data-coding process. It is almost impossible to interpret data unless one codes them. Codes define categories, pooling a wealth of material into some order and structure. Coding is the process of dividing data into parts by using a classification system.

Different approaches may be followed with regard to data analysis. In this research Tesch's (in De Vos, 1998) approach and Strauss and Corbin's (1998) approach were used. Tesch's approach was adopted to analyse focus group interviews with learners and Strauss and Corbin's approach was used to analyse teacher individual interviews, as exposed subsequently.

3.6.1.3.2 Tesch's approach

Tesch (in De Vos, 1998: 343-344) proposes eight steps to consider in data analysis:

Step 1: The researcher ought to read the entire transcript carefully to obtain a sense of the whole and to jot down some ideas.

Step 2: The researcher selects one case, asks "what is this about?" and thinks about the underlying meaning in the information. The researcher's thoughts can be written in the margin.

Step 3: A list is made of all the themes or topics. Similar themes or topics are clustered together.

Step 4: The researcher applies the list of themes or topics to the data. The themes or topics are abbreviated as codes, which are written next to the appropriate segments of the transcripts. The researcher tries out this preliminary organising scheme to see whether new categories and codes emerge.

Step 5:The researcher finds the most descriptive wording for the themes or topics and categorises them. Lines are drawn between categories to show the relationships.

Step 6: The researcher makes a final decision on the abbreviation for each category and alphabetises the codes.

Step 7: The data material belonging to each category is assembled and a preliminary analysis is performed.

Step 8: The researcher recodes existing material if necessary (De Vos, 1998: 343-344).

3.6.1.3.3 Strauss and Corbin's approach

Strauss and Corbin's approach is the data analysis approach in which the first step is called open coding and the second step of data analysis is axial coding. According to Creswell (1998: 239) the researcher takes the categories of open coding and identifies one as a central phenomenon or idea, and asks the following:

- What caused this phenomenon to occur?
- What strategies are employed in response to it?
- What context (specific) and intervening conditions influenced the strategies?
- What consequences resulted from these strategies?

In this regard, the first phase of the analysis, referred to as open coding, involved a process by which the content of the interview was carefully searched for discrete instances of teachers' expression of concept or idea. Once the main idea/phenomenon was identified, the identified concepts are grouped according to their properties. After performing the Strauss and Corbin (1998) coding procedures a combined axial coding is performed on the collection of axial coding results. Once the categories were identified, they were given a name, to characterise their relationship to the main phenomenon or idea.

The analysis of individual interviews with the teacher was achieved by using Strauss and Corbin's (1998) open and axial coding techniques. For example, during individual interviews with teachers the teachers independently mentioned three items that contribute to their learners' achievement in mathematics. These items were later grouped into a single category by their common characteristics. The coding results provided a comprehensive summary of the contents of the collection of interviews. The following section is the discussion on how coding was conducted.

3.6.1.3.4 Data coding and categorisation of interviews

In this study I used categorisation to refer to noting the themes and patterns in the interview data. I identified themes from the interview data and from actions that were observed in the case of observation data. As I developed the themes, questions were constantly asked as to whether the information was relevant to the research question or not. For each theme developed, a code was given a label, for example, for sub-research question no. 2, "What in your opinion makes learners succeed in mathematics?", one of the themes the researcher found was "interest and devotion". A code Q2A to represent this theme was used, which indicated that this was an answer to question 2 and that it was the first theme that each of the learners and teachers seem to consider important. For each data set, the researcher labelled the narratives that referred to interest and devotion as Q2A.

In each case I was looking for similarities and differences in the data (Poggenpoel, 1998). The researcher noted only themes that were common in all cases and those that appeared only in some cases but not in others. I considered the information from each learner and teacher vital even if the theme did not appear in each data set. Special care was taken not to lose the richness in the narrative data from the interviews by relating the theme to the context (Poggenpoel, 1998). The researcher used "open coding" where each piece of data was coded into as many themes as it represented. Commonalities and differences were included for all four classrooms, across teachers and across learners to ensure that the "unique context of each case is retained, and the data interpreted within that context" (Poggenpoel, 1998). When coding the data there were more commonalities than differences in each group.

3.6.1.3.5 Processing interview data

Miles and Huberman (1994 in Cohen, Manion & Morison, 2000: 283) suggest the following tactics for generating meaning from transcribed and interview data:

- Counting frequencies of occurrence of themes
- Noting patterns of themes, which may stem from repeated themes
- Seeing plausibility - trying to make good sense of data, using informed intuition to reach conclusions
- Clustering-setting items into categories
- Identifying and noting relations between themes
- Building a logical chain of evidence-noting causality and making inferences
- Making conceptual coherence-moving from constructs to theories to explain phenomena.

For the purpose of this study data gathered from the taped interviews sessions, as well as from the focus group interviews, were analysed according to a combination of the aforementioned processes as follows.

In the case of each of the research questions

- I read the data from each set without writing anything down.
- I read the data a second time and noted the themes and patterns, in the interview data, that struck me as the teacher or learner answers to the research questions. I also noted the themes that emerged as characteristics of the teaching and learning process from the transcribed observation notes.
- I wrote down these themes as categories as they appeared in each data set. These themes were laid out on a chart so that the information from each case was visible. I then developed codes for these themes that were related to the research questions.
- Using the codes for each theme, I went back to the data sets and coded the relevant segments in each theme. I used open coding and consequently some segments had more than one theme.
- I prepared the codes for each theme and excerpts taken from each data set related to that theme. For example in each case of interview data, I included words that each teacher or each learner used in their answers to my questions.
- From the data (and based on the themes), I then wrote an answer to the relevant research question.

The results of this data analysis will be dealt with in Chapter 4. In the following section a discussion concerning the specific technique of questionnaire usage will be discussed.

3.6.2 Quantitative research

As described by McMillan and Schumacher (2001) quantitative research involves the following:

- Explicit description of data collection and analysis procedures.
- Scientific measurement and statistics used.
- Deductive reasoning applied to numerical data.
- Statements of statistical relevance and probability.

Having obtained data from the focus group interviews and classroom observations, it was important for me to confirm the research findings using a quantitative, non-experimental, descriptive method. The advantages of using a quantitative method were:

- Identifying and exploring factors that facilitate achievement in mathematics from traditionally disadvantaged secondary schools.
- Exploring and testing relationships.

In this regard, two questionnaires were designed to gather information regarding factors that facilitate achievement in mathematics. Information related to factors that facilitate achievement in mathematics from traditionally disadvantaged secondary schools was used to validate the results gathered from focus group interviews and classroom observation. Both learners and teachers were required to complete a questionnaire and the results were analysed quantitatively.

I first conducted a basic inquiry of international test users to determine whether a questionnaire measuring factors that facilitate achievement in mathematics in historically disadvantaged schools exists. The internet was also used in this regard. Due to the lack of a standardised South African Grade 12 mathematics questionnaire and direct applicability of the other questionnaires, I designed my own. In each questionnaire individual (or group of) items were analysed.

3.6.2.1 Phase 3

3.6.2.1.1 Questionnaire for learners

In order to investigate trends that were evident in the first phase of the research, the factors that were identified by learners and teachers were used to create the parallel questionnaires (one for learners and one for teachers). The items were selected on the basis of frequency from the initial surveys for phases one and two of the research. The questionnaires were administered to 366 learners. The survey developed for learners in this study consisted of 54 questions. See appendix A.

3.6.2.1.2 Questionnaire for teachers

The teacher questionnaire was constructed from the factors that were identified by teachers in the first phase of the study. The teacher questionnaire was administered to twenty six teachers in selected schools. The survey developed for teachers in this study consisted of 83 questions of which three were open-ended. See Appendix A.

3.6.2.2 Data analysis of quantitative research

Statistical analysis of data involved comparison of learners from high- and low-performing schools, and teachers' item responses. The following statistical tests were used during the analysis of the data:

The Chi-Square test is used to determine the statistical significance of factors that facilitates achievement in mathematics and other variables, using significant levels of 0.05 and 0, 01. For instance, if the probability of uncertainty (p value) was more than 0.05 ($p > 0.05$) the null hypothesis was rejected, while in the case of $p < 0.05$ the null hypothesis was not rejected at the 5% level. Where the p-value was less than 5% the results were accepted as statistically significant and where the p-value was found to be less than 1% ($p > 0.01$), the results were regarded as "highly significant" as advised by Burns and Grove (2001). Observed and expected frequencies are used to describe data. Frequencies are number of subjects or objects in the sample that fall into the various categories of the variables of interest. Frequency distributions are compiled in order to arrange data belonging to the same category. Frequencies, percentages and cumulative percentages are used to describe different variables, and allow for clear presentation of the data. The Phi coefficient test is used with the Chi-Square test to describe the effect sizes[2] (*id est*, magnitude effect of relationships between variables). According to Burns and Grove (2001), Phi-values range from -1 and +1, with the magnitude of the relationship decreasing as the coefficient near zero. In each of the columns on teachers' and learners' questionnaires (Appendix A) there were three possible answers to each question, which were either:

[2] [2] w=0.1: small effect size; w=0.2: medium effect size; w=0.5: large effect size (Ellis & Steyn, 2003).

- Regularly, Always or respondent Disagrees
- Occasionally, Neutral or Sometimes
- Never or Disagree

The weight given to each possible answer was as follows:

Regularly, Always or Disagree	3
Occasionally, Neutral or Sometimes	2
Never or Disagree	1

The data was fed into a statistical database for analysis and will be discussed in detail in Chapter 5.

3.7 TRIANGULATION (QUALITY ASSURANCE)

Neuman (1994) defines triangulation as the use of two or more methods of data collection techniques in order to examine the same variable. Triangulation implies that measurements improve when diverse indicators are used. As the diversity of the indicators increases, confidence in measurement grows, since obtaining indicator measurements from highly diverse methods results in greater validity. Triangulation techniques attempt to map out, or explain more fully the richness and complexity of human behaviour by studying it from more than one angle, thus making use of both qualitative and quantitative data.

According to Cohen and Manion (1997) triangulation is appropriate in the following instances:

- when a more holistic view of educational outcome is sought;
- where a complex phenomenon requires elucidation ;
- when different methods of teaching are to be evaluated;
- where a controversial aspect of education needs to be evaluated more carefully;
- when an established approach yields a limited and frequently distorted picture;
- where a researcher is engaged in a case study.

In this study a multiple triangulation method was followed in which qualitative and quantitative data gathering in the form of:

- six weeks of classroom observations and structured interviews with learners and teachers;
- repeated focus group interview sessions with learners;
- analysis of audiotapes and videotapes of some lessons and focus group interviews;
- questionnaires completed by both teachers and grade twelve learners were used to enhance the validity of the findings and to overcome any biases that might stem from a single method only.

The triangulation approaches that were employed in this study can be categorised into the following types:

(a) Data triangulation

Data triangulation is defined as the collection of data from multiple sources with the intention of obtaining diverse views on the phenomenon under study for the purposes of validation (De Vos, 1998).

Data triangulation was used for this study and data sources for the focus groups comprised Grade 12 learners and teachers. Data interviews were obtained from teachers and learners from well-performing schools and underperforming schools in mathematics. Burns and Grove (1997) assert that responses from such multiple data sources enhance the reliability of the research results.

(b) Methodological triangulation

Methodological triangulation is defined by Kimchi, Polika and Stevenson (1991: 365) *"as the use of two or more research methods in a single study"*.

For this study a qualitative approach in the form of classroom observation and focus group interviews were used in order to gain insight into the study, and findings of this approach were used to formulate an instrument for the quantitative approach. The main advantage of using methodological triangulation in the present study was to increase convergent validity of the findings (Burns & Grove 2001). The integration of qualitative and quantitative methods can provide an extended understanding of the scope on factors that facilitate achievement in mathematics in historically disadvantaged communities and increase confidence when results are obtained.

(c) Space triangulation

Space triangulation attempts to overcome the limitations of studies conducted within one culture or subculture, as "not all the behavioural sciences are culture bound, they are subculture bound" according to Cohen and Manion (1997). Space triangulation was not used in this study as the research was conducted in the same country and within the same subculture, namely, Vha-Venda learners and teachers.

3.8 ISSUES TO CONSIDER WHEN USING TRIANGULATION PROCEDURES

Burns and Grove (2001) identify the following important issues when using triangulation procedures. They are:

- divergent results between numerical data and linguistic data can be interpreted;
- overlapping concepts that emerge from the data could be differentiated from one another;
- different method used should be considered equally sensitive and weighted equally;
- the problem of the study limitation.

One argument in support of blending qualitative and quantitative data in a single project is that they are complementary and represent the two fundamental languages of human communication, which are words and numbers (Polit & Hungler 1991).

It is with these thoughts in mind that the current research study has been designed. The methodological triangulation was used in order to offset limitations of using a single data-gathering method. Views from different groups were obtained, including learners and teachers from traditionally disadvantaged secondary schools.

3.9 QUALITY ASSURANCE: RELIABILITY OF THE STUDY

Reliability is the degree of consistency or dependability with which a research instrument measures the attributes it is designed to measure (Bush, 2002). Therefore reliability is concerned with the consistency, stability and repeatability of the informants' accounts as well as the investigators' ability to record information accurately (Brink & Wood 1998: 299). Babbie and Mouton (2001) suggest the following ways in which the reliability of a qualitative study can be compromised. These are:

- the observer' subjectivity;
- asking difficult questions and confusing the respondents;
- asking questions to which respondent has no answers;
- misinterpreting information from participants under observation.

In this regard De Vaus (2001: 31) sees unreliability in quantitative study as resulting from:

- different interviewers get different answers from different people;
- age, gender, class, and ethnicity influence responses;
- answers that are affected by mood and a particular context, and
- poor question wording

In this study reliability was enhanced by means of the following:

- Triangulation was facilitated.
- Teachers were used to select learners based on marks obtained in Grade 11.
- Different subgroups in schools were interviewed [learners (best achievers, average achievers and low achievers), teachers].
- For Phase 3 of this research, pretesting of the data collection instrument was done with six respondents who did not participate in the main study. A suitable time and venue were arranged. No one refused or failed to complete the questionnaire. The statements were discussed after the questionnaire was complete. The learners were most willing to offer comments as to how they each experienced the situation. The questionnaire took roughly 30 minutes to complete. It contains statements and instructions that were clear.

- Audio and a video recording as well as questionnaires were used as data collection methods in phase one.
- Some items from Steyn (2003) and Maree (1997) were used in phase three. Some are unaltered and some altered in the teacher and learner's questionnaires. Steyn (2003) and Maree (1997) found that in calculating reliability coefficients (Cronbach's Alpha) for their instruments were close to 1.
- Reliability was enhanced as learners and teachers, familiar with the topic under discussion, were able to supply answers to the questions that were asked.

3.10 QUALITY ASSURANCE: VALIDITY OF THE STUDY

Validity, as observed by Bush (2002), in research should be concerned with the accuracy and truthfulness of scientific findings. A valid study should demonstrate that which actually exists and a valid instrument should measure what it is supposed to measure (Brink 1991). Torn and McNichol (1998) advised that validity should be evaluated against four measures: the inter-rater validity, content validity, correctional validity and semantic validity.

In this study, the inter-rater validity was enhanced by inviting the statistician from the University of Pretoria's Department of Statistics to assist in the analyses of the research results. Content validity was enhanced by comparing the findings from interviews with literature reviews. Correctional validity was enhanced by comparing the findings from focus group interviews with those from unstructured interviews and questionnaires. These findings were found to be similar. Semantic validity was enhanced by the categories being mutually exclusive and exhaustive, as judged by the researcher and the statistician who was consulted after the unstructured interview schedule had been completed. In order to enhance the validity of this study, the following steps were taken:

- The literature was examined to identify variables to be delineated.
- The questions used for data collection were in line with the conceptual framework of the research and were found to take roughly 30 minutes to complete; contain statements that were easy to understand, and easy to fill in.

- Following the advice of Hall and Hall (1996) the instrument in Phase 3 of this research was taken to superiors in the University. The group consisted of statisticians from the department of Statistics from the University of Pretoria and my supervisors who examined each item of the questionnaire. They suggested a few minor changes and proposed the use of computerised marking facility.
- Due to the nature of the questionnaire, and acting on the advice of my statistician, we decided not to attempt to calculate the a-values.

3.11 BIAS OF THE STUDY

Bias is defined by Goddard and Melville (2001) as a systematic distortion of responses by the researcher, the respondents or by the instrument. In order to decrease bias, attempts were made to address this issue by means of the following:

- A comprehensive literature review
- A representative sample
- Verified statistical findings

3.12 ETHICAL CONSIDERATIONS

Ethical considerations are of the utmost importance when one is conducting research involving human participants (Goddard and Melville, 2001). It is incumbent upon researchers to design a study in which the principles of integrity, a respect for persons and justice are exemplified. The researcher accepts the assertion that research contributes to scientific knowledge and that human and technological advances are based on this knowledge. In particular, it is accepted that educational research should contribute to better the scholarship of teaching and the development of the learner.

According to Cohen, Manion and Morrison (2000) the following are the grounds on which informed consent may be established:

- Participants must be in a position, or old enough, to understand the choice that they are making and children need to have parent or guardian consent to participate.

- Disclosure of purposes of research.
- Disclosure of any risks to participants;
- A provision allowing participants to withdraw at any time.

In view of the above ethical considerations, I took the following steps:

3.12.1 Permission

Permission to conduct research in Vhembe district had been sought from the Regional Director. (Letters requesting permission and their replies can be found in Appendices A and B respectively). Permission for learners to take part in the study was obtained from the school principals, respective mathematics teachers and learners or learners' parents. The aims and objectives of the study were explained verbally to the learners by the researcher prior to their participation.

3.12.2 Appointments

The researcher posted or distributed letters personally to the principals of each selected school, followed by visits and appointments to conduct interviews or submit questionnaires (see Appendix A). Group meetings were held with the teachers and learners to explain the research project and the process. The researcher personally distributed the questionnaires to all schools with the help of the teachers.

3.12.3 Confidentiality

All respondents were assured of confidentiality by means of a written notice. Participants were given a pseudonym to protect their identities and to ensure confidentiality. At all times the learners were informed that they were free to withdraw from the study or not to answer any question if they so wished. Learners were assured of the confidentiality and anonymity of their answers and, in particular, that the information they provided for the research would not be divulged to their school and teachers at any time. Care was taken to ensure total confidentiality.

3.12.4 Consent

Written informed consent was obtained voluntarily without duress and coercion or bribery (Burns and Grove 2001) from the principals, teachers and parents of the learners or learners themselves of the participating schools (See Appendix B). The aims, objectives, methods, and duration of the research were described to the participants.

3.12.5 Data anonymity

The researcher assured all participants that all data collected would be destroyed after the data had been analysed and the research report compiled and finalised. No person, except the researcher, supervisors and the data analyst, would be able to access the raw data. Even the transcript of the raw data contained no names, only the numbers of participants.

3.12.6 Post-research relationships

The research report will be made available to the Special Collection Section of the University of Venda for Science and Technology and to the University of Pretoria where respondents could have access to it.

3.13 SUMMARY

Fouché (in De Vos, 2001) defines research design as a blueprint or detailed plan on how to conduct a research study. Thus a research design ensures that there is a structure for the manner in which data will be collected and analysed as well as the procedure to be followed. In this chapter the research design of the present study was addressed. Firstly the research design and research questions were exposed. Then the particulars of the research approach adopted for the study were given. The specifics of the research design were discussed dealing with ethical considerations, validity, subjects of the study and the data. Thereafter the details of the data collection procedures, the method of data collection procedures, the methods and the instruments as well as the data processing procedure were discussed.

In Chapter 4, I will provide, discuss and contextualise (*id est*., facilitate literature control with regard to) the results of the investigation.

CHAPTER 4

RESULTS OF QUALITATIVE INVESTIGATION

4.1 INTRODUCTION

The purpose of this chapter is to explain the findings of the qualitative part of this investigation. The responses that are presented here were collected from teachers' individual interviews, four classroom observations and three focus group interviews with a total of eighteen learners.

Since I had been involved in teaching Grade 12 mathematics, I was familiar with the organisation and teaching content of the subject. The information gained from the focus group interviews is relevant to the objectives stated in section 1.3 of this study. A detailed description of the coding approach and research methodology was given in CHAPTER 3 and a comprehensive literature review in CHAPTER 2. Table 4.1 is a matrix showing the research questions and the source of answers.

Table 4.1 Research questions and source of the answers

Research question	Data Source		
	Observation	Interviews	Video viewing
1. What are the competencies of mathematics teachers in high-performing and in low-performing schools?	X	X	X
2. What are the learners' perceptions of their successes and /or failures in mathematics?		X	
3. What are the attitudes of the teachers in high-performing and in low-performing schools towards the learners they are teaching?		X	

4. What factors facilitate successful classroom practices in mathematics in Grade 12 schools?	X	X	X
5. What are the attitudes of the learners in high-performing and in low-performing schools towards mathematics and achievement in mathematics in grade twelve?		X	

In the next section I outline the data captured in classroom observations and in teachers' individual interviews. The classroom observations and semistructured interviews with the teachers will be discussed with respect to each school. The findings are related in the form of small quotes from the teachers, with a summary table for each school followed by the summary table for all four schools.

4.2 PHASE 1: CLASSROOM OBSERVATIONS AND TEACHER INTERVIEWS

Teachers were interviewed in order to determine their perceptions of factors that facilitate achievement in mathematics. In this respect, according to Henning, Smith and Van Rensburg (2004: 72) a sound interview guide made up of critical questions should be used to capture the research. The interviews were conducted in English but interviewees were also allowed to respond in their mother tongue if it made them more comfortable to respond to specific questions and as a result some quotes were translated. Table 4.2 below contains a summary of the interview guide and actual questions that were planned.

Table 4.2: A summary of interview guide and planned questions

Question	Question type	Planned question
1	**Initial opening questions**: General, factual, quick, and establishes what is shared by each teacher.	(a) Tell me how you came to be a mathematics teacher? (b) Who, if anyone, influenced your action?

2	**Intermediate questions**: Introduce the topic and spark conversation.	(a) Will you continue as a mathematics teacher for the rest of your life? Why? (b) Tell me about the challenges you experience in teaching mathematics? (c) Tell me how you go about motivating your learners in mathematics. (d) Could you describe the most important factors that enhance achievement in mathematics?
3	**Ending questions**: Identify most important aspects of the topic, and tie up loose threads.	(a) Of all the factors we have raised, which are the most important ones? (b) Have we missed anything?

4.2.1 Results from school A: High-performing school

Teacher A was in his twelfth year of teaching, all of which has been in school A and most of which has been in Grade 12. There were a total number of twenty-three higher grade learners in his class and twenty standard grade learners. Teacher A has a secondary teachers' diploma and a further diploma in education. In school A Teacher A was not the only teacher who was qualified to teach mathematics. There were three other teachers who were qualified to teach mathematics and science but these other teachers were teaching science either in Grade 12 or mathematics in lower grades.

Even though Teacher A uses some traditional methods in his teaching, he also uses some modern teaching strategies. For instance he uses some examples that relate to real world problems to show his learners that what they are doing is also applicable in life. In developing his homework and classwork questions, he tries to include some items that are thought-provoking in terms of a real world context. According to Teacher A, all papers are supposed to resemble the final examination standard. He often puts more emphasis on the thinking behind the answer rather than on the answer itself.

His learners are often asked to explain their solutions to other learners. When Teacher A was asked how he became a mathematics teacher and what influenced him, he provided the following response:

> *Before I started teaching I was a mathematics learner at the same school. I was very much interested in maths and I was working on this subject all the time. My mathematics teacher motivated me and fortunately it is that same teacher whom I replaced.*

Teacher A was encouraged by his secondary school mathematics teacher once the teacher noted his interest. Teacher A continues and discusses some challenges in teaching mathematics in his classes, such as the attitudes of his learners towards the subject and how he tries to overcome these:

> *There are so many challenges in teaching mathematics today. Many learners come to school with the attitude that mathematics is a very difficult subject, so I had to eradicate that from their minds in the same way as what my teacher did to me, and in turn I become motivated to continue teaching as I see some of these learners succeeding. Also I have to show learners that I can teach this subject which many people think is a hard subject.*

According to Teacher A, one of the factors that facilitate learners' success in mathematics is a light teaching load. He explains how the school management has reduced his workload in order to cope with the situation in the following way:

> *When I started teaching at this school I was the only teacher who was teaching mathematics in the whole school and I was not teaching mathematics only, I had to teach biology and physical science as well, which was discouraging. But now things have changed. I am concentrating on mathematics only and this has given me an opportunity to further my studies in mathematics at Wits University.*

Teacher A believes that one of the reasons why his learners are motivated in mathematics is because he comes from a similar background as his learners. He contends that learners know his family background because he comes from the same local area. In this regard teacher A commented that:

> *Ways of motivation are different. I use myself as an example because most learners' backgrounds are like mine. I am from a very poor background and because I am from a local place most learners know me.*

In order to motivate his learners to succeed in mathematics Teacher A stated that he also invites people from outside to come and motivate his learners:

> *In most cases we invite people from different companies to come and explain to the learners how mathematics is applied…like now we are living in the time of technology, which needs mathematics learners. So when I invite these people they come and motivate them and show them that if you are good in mathematics and obtain good symbols we can absorb you here and there.*

Teacher A believes that for learners to succeed they have to associate themselves with other learners who are serious at school. He encourages his learners to associate with other successful and serious learners in their class.

> *Personally I have observed one thing. When you associate yourself with failures you are likely to fail. I am a person who usually associates myself with successful people. So for my learners to succeed they must associate themselves with learners who are serious about mathematics.*

Answering the question on challenges he faces, Teacher A mentions learners' background and some of their strengths:

> *Most of the learners here have a good background in mathematics, and some are very intelligent. I think they were born just like that. If you just come without being prepared you will be in for a great shock. They prepare themselves before coming to the class. In this school there is a culture of learners willing to learn on their own.*

Précis (Summary of aspects from school A relevant to research question)

The results of interviews with the teacher and classroom observations in school A can be summarised as follows:

- The teacher in this school was motivated by his former teacher.
- There is a low teaching load.
- Motivators from outside are invited.
- Some modern teaching techniques are used.
- Learners are encouraged to associate with serious learners of this subject.
- Career guidance in science and mathematics is offered.
- Learners can associate well with the teacher.
- There is a culture in the school of learners willing to learn on their own.

Table 4.3 Summary of the results from school A

Questions	Results
How did you become a mathematics teacher?	Motivated by mentor and personal interest in mathematics
Who, if anyone influenced your actions?	Mathematics teacher
Will you continue as a mathematics teacher for the rest of your life? Why?	He is motivated to continue teaching despite some challenges in teaching, because there are some learners who are succeeding
Describe the most important factors that facilitate achievement in mathematics.	Role models in mathematics and science, Exposing learners to science related career, Teacher development in the subject. Teacher self-efficacy. Learner association. Gifted learners. Learners' willingness to work hard.

Tell me about the challenges you experience in teaching mathematics.	Learners' attitudes towards mathematics. Teaching different subject in addition to maths. Ill-discipline. Lack of career guidance among learners.
Tell me how you go about motivating your learners in mathematics.	Invite people from different companies, and using himself as an example
Of all the factors we have raised, which are most important ones?	Good background in mathematics. Learner preparation. Self-concept. Learner discipline. Proper study techniques.

4.2.2 Results from school B: High-performing school

Teacher B, after graduating from the university has taught secondary level mathematics for a total of ten years, all of which have been in school B and most on Grade 12 level. He has 155 learners in Grade 12 with three classes of about fifty learners each. All learners in his classes are registered for higher grade and eight have registered for additional mathematics. He has a Bachelor of Science degree in mathematics education. He regularly attends workshops organised by mathematics teachers associations and meets regularly with some local teachers to discuss mathematics teaching issues.

Teacher B's classes appeared too large for effective teaching and learning to take place, and learners were not afforded enough opportunity for personal contact. In spite of the large classes, Teacher B always applies some strategies to engage learners in effective learning. During my class observations, learners were always in attendance and keen to participate in class discussions. Teacher B promptly started all his classes on time.

There were no disruptions during his lesson. He monitored learners' work, explaining problems to different groups of learners as his class was large. There was much respect from his learners. During each lesson he would call upon one of the learners to come and elaborate on a homework given the previous day. For instance, when introducing sequences and series, he gave his learners a practical exercise to be presented the following day and a prize was offered for the group that could come with the correct solution the following day. During the presentation Teacher B always encouraged his learners to participate in class discussions.

Despite teacher B's belief that one of the most important factors that contribute to his learners' good performance in mathematics is a result of interacting with other learners, he also advocates that there must be competition between learners. In this regard, Teacher B stated that:

> *I believe learners must be able to work together and give assistance to one another. They must be able to create a sort of competition among themselves. Not a destructive competition, I mean, a competition to motivate each other as friends. We have two Grade 12 classes in this school and learners are ranked from the highest to the lowest levels based on the recent examination results. This encourages them to always fight to be in the best group. Another thing I think is to involve their parents to supplement the motivation given by teachers at school.*

He also mentioned that learners should develop an interest in the subject and be conscious of the career they want to follow after Grade 12.

On the question of how to motivate learners in mathematics he stated that one of the factors that contribute to his learner's good performance is motivating them through career choices in mathematics. He stated that:

> *Most of our learners in Grade 12 do not know what they want to do after grade twelve. The year I took my learners on a trip to Gauteng to visit science laboratories and some other companies, our results improved in mathematics and physical science. When we came back from the trip everyone was encouraged to work very hard, because they were shown the importance of studying mathematics in high school.*

Furthermore, from Teacher B's point of view, the root of his learners' success in mathematics is the fact that he examines them frequently and finishes the syllabus early. Learners who do not do well in the test or examinations are given more time to master the topics with the assistance of the teacher.

Teacher B's learners change seating arrangements depending on their performance in the tests and examinations. A learner in another class will be transferred to a low-performing class if he/she performs lower than some learners in that lower performing class. In this regard Teacher B stated that:

> *Grade 12 syllabuses in our school end before June for all subjects. Our principal is very strict on that; you will feel ashamed if you do not finish the syllabus in time because you will be the only one left. The reason is that before the final examination our learners must write at least four exams with questions taken mostly from previous examination question papers, and learners who do not perform well are given thorough practice again.*

Commenting on other factors that contribute to learners' success, he alluded to the fact that it is important to teach learners application topics in mathematics. Teacher B indicated that mathematics learning is more meaningful when it is related to real life application. In this regard teacher B claimed:

> *I think problem-solving is one of the main reasons we teach mathematics. We do not teach mathematics so that learners can understand how to find the derivative of a function only. We teach them skills so that they can be able to solve real world problems that relate to the mathematics in class. They must be able to find the maximum and minimum values using calculus. Application of mathematics to real world problems is very important.*

Teacher B sees a clear connection between teaching problem-solving skills and teaching learners to apply concepts to real-life applications.

TABLE: 4.4 Summary of the results from school B

Questions	**Results**
How did you become a mathematics teacher?	He was good in mathematics. Financial backup to follow other careers.
Who, if anyone influenced your actions?	His parents motivated him to be a teacher.
Will you continue as a mathematics teacher	He is comfortable to continue working as a

for the rest of your life? Why?	teacher.
Describe the most important factors that facilitate achievement in mathematics.	Strong leadership at school. Learners association. Learner self-discipline. Good career guidance. Teacher self-efficacy. Use of previous examination question papers, Help from other teachers. Frequent testing. Relevance to real world.
Tell me about the challenges you experience in teaching mathematics.	Poor learners' learning techniques. Learners' inadequate mathematics background. Ill-discipline.
Tell me how you go about motivating your learners in mathematics.	Application of mathematics to real world problems. Visit mathematics/science related companies. Discuss the importance of mathematics.
Of all the factors we have raised, which are most important ones?	Assess frequently. Finish syllabus early. Interest in the subject. Good career guidance mathematics. Good mathematics background. Attends workshops and meets with some local teachers. Encourages group work.

Précis (Summary of aspects from school B relevant to research questions)

The views of the teacher in school B and observations that I have made during classroom visits are that, in this school:

- There is an involvement of parents in the school activities.
- Teachers know how to handle large classes.

- Competition among learners is encouraged.
- Learners are given enough time for practice.
- Application topics and problem-solving is emphasised.
- Learners are assessed frequently.

4.2.3 Results from school C: Low-performing school

Teacher C has taught mathematics for ten years, all of which have been in school C and most of which have been for Grade 12 classes. Teacher C has thirty-seven learners in her class. There were 12 learners who registered for mathematics in the higher grade and 25 of the learners who registered for mathematics in the standard grade. She has a Bachelor of Science degree in mathematics education (BSc.Ed.) and an honours degree in education (B.Ed.). In school C there were two teachers who were qualified to teach mathematics. Every year they alternate in teaching Grade 12. Class attendance in school C was generally poor. There were some learners who were absent for most of the periods when I was there. Teacher C feels that learners take class attendance lightly, and do not always see the necessity for attending regularly because "*most of them have already lost hope in mathematics*".

Teacher C indicates that she teaches mathematics and physical science to Grade 12 but if given an opportunity she would like to continue teaching mathematics only because it is her favourite subject. In this regard she noted that:

> *At the beginning I did not like mathematics. It was not my favourite subject, because learners do not like it. The attitude towards the subject is not good, but because of some good learners in my class, I now love it. Sometimes I struggle with some problems but finally I get the solution right. Also marking mathematics is easier than any other subject. It is challenging but ok. I wish I can teach mathematics even if it means so different grades.*

In each class teacher C's teaching was constantly characterised by evidence of traditional methods. Classes began with a review of previous work; and then adhered closely to the textbook and most of the exercises were taken from the same textbook. She gave step-by-step instruction to the learners, and then assigned some problems, which learners were to complete individually. She then walked around, monitored learners' work, explaining problems to individual learners. The learners were expected to learn the assigned material in small amounts, memorising algorithms with little or no intention of the understanding of underlying concepts.

When asked what helps learners to be successful in mathematics, teacher C responded:

> *Unfortunately, I would probably say working with a classmate helps learners the most. I'd rather say I help them the most, but I do not think this is true.*

Even though she thinks working with a classmate is helpful, teacher C does not see this strategy as helpful to learners by encouraging them to express their ideas mathematically and to explain their ideas to others. She defended this position by saying that most of her learners are playful and they discuss other business rather than concentrating on the task given, Teacher C always asks questions during the teaching process in order to gain the attention of her learners. However, these questions were not utilised in order to help learners make their own connections.

Attending extra lessons (like Saturday lessons) was also mentioned as a factor which can contribute to learners' good performance in mathematics. In this regard Teacher C stated:

> *…but here at our school only bright learners ask to be taught extra classes, the rest come because I threaten to punish them, and still not all of them are motivated to come. The lazy learners are a problem at this school.*

During the interview she was asked about how she motivates learners in mathematics. Teacher C replied:

> *Learners should have good examples in their communities. They do not have enough examples of people in the community that have passed mathematics. They think mathematics is for special people and that not all the people can do mathematics.*

Teacher C is of the opinion that one of the factors that makes learners perform well in mathematics is to respect and manage time profitably in learning the subject. Teacher C describes this fact in the following way:

> *I believe in time and time only. I normally tell my learners that it is not that mathematics is a subject which requires more time, because if you offer it enough*

> *time, it will be very simple. They need to practise regularly and give this subject time and avoid bad social behaviours.*

She also cites a few problems that she considers fundamental in the teaching of mathematics. The first is that the teacher may present mathematics to the learners but the learners *"do not understand you"* especially in linear programming and application of differential calculus. *"I do not know whether the problem is language or what?"* In her class, Teacher C also feels that the level of the learners' understanding is not always what she would like and that most of the learners are limited in their potential for learning the subject. In this respect she remarked:

> *I think most of the learners are just pushed to do maths by their parents or friends. They just can't do it.*

Of all the teachers in this study, the teacher in school C demonstrates most a teaching practice which most closely exemplifies traditional methods of teaching mathematics. In responding to questions about why she teaches the way she does, Teacher C expressed beliefs which were in large part correspond with traditional methods (explained in Chapter 2).

The following is a summary of what goes on in school C and includes responses from Teacher C.

Table: 4.5 Summary of the results from school C

Questions	**Results**
How did you become a mathematics teacher?	Did not like to be a mathematics teacher at first.
Who, if anyone influenced your actions?	Good learners in her class.
Will you continue as a mathematics teacher for the rest of your life? Why?	Teacher C is motivated to continue teaching.

Describe the most important factors that facilitate achievement in mathematics.	Time management. Teacher knowledge of the subject. Role models in the society. Solving real world problems. Seeking help from other teachers. Working with a classmate.
Tell me about the challenges you experience in teaching mathematics.	Class attendance taken lightly. Poor learners' mathematics background. Poor learners' mathematics self-concept. Mathematics role models in their communities. Ill-discipline. Lack of extra classes. Learners are playful during class discussion.
Tell me how you go about motivating your learners in mathematics.	Tell them to work hard. Sometimes have motivational talks.
Of all the factors we have raised, which are most important ones?	Poor class attendance. Not knowing what to do after Grade 12. Lack of teacher respect.

Précis (Summary of aspects relevant to research questions from school C)

The results of interviews with the teacher and classroom observations in school C can be summarised as follows:

- Learners are frequently absent from the class. (Unmotivated)
- Traditional, algorithmic approach in teaching is employed.
- Teacher does not believe in learners helping each other
- Not enough role models

4.2.4 Results from school D: Low-performing school

Teacher D has taught mathematics for fifteen years in school D. His teaching has mostly been on Grade 12 level. The total number of learners in his three classes is 138. Teacher D graduated from a teacher training college with a secondary teachers' diploma and never registered for any further mathematics course. Teacher D was not interested in becoming a teacher, let alone a mathematics teacher. In this regard he said:

> *The event that led me to become a mathematics teacher was mainly that my guardians wanted me to be a teacher whereas I wanted to work in a bank. I was dependent on them financially so I didn't have any alternative. Teaching was not my choice. Sometimes due to some de-motivation from the government I feel like quitting.*

In school D, mathematics has one qualified teacher. In this respect, teacher D is forced by the circumstances to teach grade ten to twelve mathematics classes alone. This causes the school subject allocation team to let some teachers teach mathematics in lower grades even if they are not qualified and do not have any interest in the subject. According to teacher D, the learners pick up the apathy rapidly and this affects their performance levels.

> *In our school we have a shortage of qualified mathematics teachers. As a result even people who had mathematics up to Grade 12 are forced to teach mathematics in lower grades. These teachers have no interest in the subject in the first place and this is transferred to the learners ultimately.*

Teacher D's teaching was also characterized by traditional methods of teaching. He rarely discusses homework given the previous day in detail, only providing answers. He adhered closely to the examples provided in the textbook. He mostly used the lecture method, and then assigned practice problems which learners were to complete individually. He then monitored learners' work, explaining problems on the board. Learners were expected to learn the concepts through memorisation and applying algorithms with little or no understanding.

Teacher D feels that teachers in his school are not respected and this in turn affects the performance of learners in mathematics and all other subjects in general. Teacher D finds the different levels of ability for the learners quite difficult to work with in the classroom. According to teacher D, his classes are far too big, resulting in difficulties with assessing and recording learners' progress, conducting tests and teaching, with the result that he is unable to provide time or motivation to help the weak learners.

According to teacher D, his experience in teaching mathematics is that learners have common problems. He said:

> *Since I started teaching and especially Grade 12, I found that learners have the common problem because they do not understand some topics, mostly those that involve application and they also forget easily. I do not know what the problem is. You teach, they understand but immediately they forget what you have just taught.*

Table: 4.6 Summary of the results from school D

Questions	**Results**
How did you become a mathematics teacher?	Teacher D was not interested in becoming a mathematics teacher, but his guardians wanted him to be a teacher.
Who, if anyone influenced your actions?	His guardians.
Will you continue as a mathematics teacher for the rest of your life? Why? Describe the most important factors that facilitate achievement in mathematics.	No. In case there is an alternative he will quit. Disciplined class. Homework controlled regularly. Learners knowing their careers choice.
Tell me about the challenges you experience in teaching mathematics.	Heavy teaching loads. Large classes. Learners negative attitudes. Lack of respect for teachers. Difficulty with teaching

	different levels of ability for the learners. Understaffing in mathematics.
Tell me how you go about motivating your learners in mathematics.	Motivation to help the weak learners.
Of all the factors we have raised, which are the most important ones?	Learners background in mathematics. Ill-discipline. Poor study techniques.

Précis (Summary of aspects relevant to research questions from school D)

The results of interviews with the teacher and classroom observations in school D can be summarised as follows:

- The teachers in this school are underqualified in mathematics and disinterested.
- Teachers are de-motivated.
- There is a lack of respect for teachers by learners.
- Teachers always complain that learners do not understand and forget mathematical concepts easily.

In the following section we summarise the results of the teacher interviews and classroom observation.

4.2.5 Summary of results from Phase 1

Overall it appears that teachers from low-achieving schools in this study were more inclined than teachers from high-performing schools to attribute learners' poor performance either to factors which were related to learners' background or behaviour. Teachers from high-performing schools convey high expectations for learners' backed up with support services, caring and devotion, creating a positive learning experience. For example, such teachers organise special classes for underperforming learners and recruit guest speakers to encourage their learners. Supplementary teaching based on learners' assessment was also encouraged in high-performing schools so that learners could improve their performance. Although teachers offered various factors that facilitate achievement in mathematics, results suggest that the most frequently endorsed factors were related mostly to learners' characteristics.

With regard to staff stability, the study found that all four secondary schools investigated had teachers that had been in their respective schools for long periods, had more years of experience, were older and had a similar level of education. Teacher education level cannot be construed as a reason for higher achievement.

In the next section the qualitative data collection technique of using the focus group interviews will be discussed. The finding from this section will be in the form of excerpts from the explanations from learners' responses.

4.3 PHASE 2: FOCUS GROUPS INTERVIEWS

In this section the discussion focuses on factors that facilitate achievement in mathematics in historically disadvantaged schools derived from three focus group interview with learners. The focus group interviews involved twelve males and six females from ten schools that participated in the research. The first interview group consisted of seven learners, the second group of five learners and the third group of six learners. The three groups met independently, and each group session was in the afternoon. Interviews explored learners' experiences in the subject, focusing on issues observed in the classroom observation of phase 1 and teachers' individual interviews concerning, among others, motivation, work patterns and help-seeking behaviour of learners.

Immediately after each focus group session, the tapes were listened to and transcribed. Simon (1999) stressed the importance of summarising findings immediately after each group ends so that one not only recorded the content of the group's discussions, but also how each participant expressed themselves. Through the use of focus groups, I was able to listen to the dialogue of historically disadvantaged learners to uncover common themes among participants.

Table 4.7 below is a summary of the interview guide and some actual questions that were planned for all the focus group interviews.

Table: 4.7 Summary of the interview guide for all focus groups

Question	Question type	Planned Question
1	**Opening question**: General, factual, quick establishment of what is shared by group	What is life like here in your school?
2	**Introductory question**: Introduces the topic and sparks conversation	Tell me why you chose mathematics as one of your major subjects?
3	**Transitional question**: Participants become aware of how others see the topic	In your opinion, what is the biggest success area for learners in Grade 12 mathematics?
4	**Key question (a)**	What are the learners' challenges for success in mathematics?
5	**Key question (b)**	Could you describe the most important factors that enhance achievement in mathematics?
6	**Key question (c)**	How do you know that a learner in your class will perform well in mathematics?
7	**Ending question**: Identifies most important aspects.	Of all the factors we have raised, which are most important ones?
8	**Final question**: Ties up loose threads	Have we missed anything?

The findings of the discussions from the three focus groups will be discussed with respect to each group. They will be related in the form of vignettes, with a summary for all the focus group interviews. The quotes listed in the discussion form just a small part of the larger conversation.

4.3.1 Focus group interviews: High-achieving learners

The first group consisted of six high-achieving learners, four of which were registered for an extra mathematics subject called Additional Mathematics. This group consisted of learners from high-performing schools.

Most learners in this group considered **learners' characteristics** such as work ethics, peer encouragement, hard work, and discipline as causes of good performance for learners in mathematics. Learners in this group were always working together with other learners in their class, mostly those who were motivated to do well in mathematics. These learners were there even when normal teaching was over and they never missed any mathematics classes. It was clear from the discussions that **intrinsic motivation** to achieve in mathematics was also a significant factor for the success of learners from this group. As three learners said during the interview:

> *One thing that motivates me is that math is interesting. I want to do something that is not common, something that other people are afraid of, something unique which is not done by many people, approaching life differently.*

> *I used to prepare myself a few days or a week before the examination or test but this time I have realised that I cannot manage. There is a lot of work that we need to finish. I used to play a lot but this year I have changed.*

> *I think this is the subject that requires someone to give himself more time to study and serious dedication. Not only relying on the teacher to give you information, because the teacher cannot do everything for you, teachers also have their own personal issues to deal with.*

Self-motivation was the item considered most likely to influence success by both learners from high-achieving schools. Focus group interview responses with this group suggested that learners' motivation was largely directed towards performance goals, such as homework completion, examination and test success. Unlike many of the learners who depend on teachers for mathematics exercises and solutions, successful learners (from high-performing schools) worked very hard on their own. Although some of them were critical about their teacher's mastery of some topics, they respected their teachers. When asked in a follow-up question about the advice to other learners to succeed in mathematics, one learner responded in the following way:

> *If I were to be asked to give advice to any learner, I can encourage a person to love the teacher who teaches him/her. It is difficult to be successful if you do not love and respect your teacher.*

Learners from high-performing schools tend to spend considerably more time on exercises that afford a great challenge and require well developed skills. The power of good self-concept to achieve good results in mathematics was echoed by other two learners from high-performing schools:

> *You must spend less time on the chapters that you already know and a lot of time with those that you do not understand well. If they are difficult for you, you must go to the teacher or a fellow classmate and ask him, but mostly to your classmate because if the teacher gives you the correct answer, you will think it is obvious because he/she is a teacher but if is your fellow classmate you will tell yourself that if he/she can do it, so can I.*

> *I think the most important thing is dedication on your part. Some of the topics you can teach yourself and understand. It is also better that you try to be ahead of your teacher every time so that when the teacher comes, you will only be adding to what you already know.*

From the interviews most learners in this group were always working together with other learners in their class who were motivated to do well in mathematics. Here are some two quotes from learners regarding their study techniques:

> *I practise maths with classmates who are serious about the subject, even our teacher used to encourage us to make up some groups. We used to have group discussions when practising previous years' question papers.*

> *As learners we sometimes turn to concentrate on the chapters that we understand better leaving out the ones that we do not understand and at the end we tend to be unsuccessful because in the exam or test teachers ask all that is in the syllabus, and so we need to balance all the topics not only picking up the ones that are easy.*

Learners in this group also recognised that their teachers wanted them to succeed in mathematics. These teachers were willing to stay longer with learners who were struggling to find the correct solutions. In this regard the positive effort from teachers who encourage their learners to do their best academically is illustrated by this comment:

> *In our school there was a time when our teacher used to keep some of us longer until we get the given exercises right and we had to get those exercises correctly. In fact most of those exercises were similar to the ones from previous examination papers .You have to get those exercises right because you will only get out of the classroom after completing the correct answers, It was like a punishment but it helped.*

Most of the successful learners indicated that mathematics is not a difficult subject for them. They indicated that in order to succeed you have to practise it daily. Some of the respondents indicated that they were always at the top of their class and were very disappointed when they received a lower score. In case they could not understand certain topics they were willing to seek assistance from other mathematics teachers besides their own teachers to help them. The majority of participants from high-performing schools seemed to receive a significant measure of encouragement and motivation to succeed from their teachers. Learners' descriptions of the influence of teachers reiterated that attitudes of teachers towards learners influence their persistence and achievement in mathematics. Two participants' comments help summarise what other teachers said when they communicated their expectations and their support of academic achievement to their learners:

> *Our teacher told us that universities are really different from high school, more hours of studying and no spoon feeding. He talks to us a lot about university mathematics, what we have to do in school to succeed and that a good symbol in mathematics is where it all starts and Grade 12 is a key to unlock the doors.*

> *My teacher used to motivate us every time. He talked about the importance of Grade 12 and that one must keep focused because this is the time that determines one's future.*

In each of these quotes, learners indicated an understanding that their teachers were encouraging them to do their best in order to succeed. All learners in this group were positively influenced by the things their teachers said and did to encourage them, and they had a basic understanding of what was required to be successful in mathematics. In the same vein, some learners shared the fact that the lack of home encouragement impacted on their persistence to achieve good results in mathematics. One learner commented:

> *In my case I do not get any help from home. In my family I am the first one who is doing mathematics and science and no one helps me with my maths.*

The learners from successful schools involved in my study benefited from support of their peers and friends who encouraged them to reach for their dreams by talking and doing well in mathematics. This support and encouragement, along with the positive contact from teachers and some tertiary institutions that are recruiting learners, created a situation at school that cultivated good performance in mathematics. Most of the learners in this group also gave examples of shared situations that helped explain how their family members encouraged them to "perform well in mathematics" because their family was good in sciences.

Most successful learners were very positive about themselves and sure of their career path. They knew what they were going to do after Grade 12. Learners reported that they were taking the subject because it was a requirement for the career they would like to follow.

There was a positive attitude expressed when learners felt that there would be tangible benefits resulting from performing well in the subject. They also knew about the minimum symbols required by the institutions they wanted to register at. Most of them did not receive the information from their teachers; instead they got the information from friends who had already graduated, or from recruiting universities or universities of technology. Both learners recognised the results of not doing well in mathematics and the financial implications for their parents or guardians. Their teachers were clear in their explanations to these learners about the need to do well in mathematics if they wanted to go to university. Their actions and attitudes towards tertiary institutions were grounded in their knowing what was required to get a good career. A number of different experiences both in and out of the classroom encouraged learners to attain better achievement in mathematics. Many learners asserted that mathematics career options influenced them to put more effort into their studies. For example learners discussed how important it was to know the career you wanted to pursue as strategy for success in mathematics achievement:

> *I have started thinking about what I would like to do in Grade 10, I have already set my mind on what I would like to do and this has helped me to work very hard in mathematics. In fact, I am good in mathematics.*

A number of different experiences both in and out of the mathematics classroom encouraged learners' pursuit of a degree in mathematics-related programmes. Many respondents asserted that the career guidance week and other mathematics-related activities influenced their interest in mathematics related careers and in better performance. For example, one participant said:

> *Yes, I want to do a Bachelor of Science degree in chemical engineering. I have decided on this career while in Grade 12. What motivates me is that there is a lot of people needed in this area and is a better paying job than other careers.*

Learners in this group believe that mathematics is a useful subject for obtaining employment and receiving bursaries. A comment from one of the learners was agreed on by all learners in the group:

> *When you go to certain companies, you find that mathematics is a requirement; you cannot enter into certain degrees without a good symbol in mathematics. A good symbol in mathematics will give you an opportunity of getting a bursary at the University.*

Learners' conversations in this group also helped explain how interactions with their peers about their career aspirations played an important part in their mathematics performance. Most of the learners reflected on at least one conversation they had had with a peer or friend who was planning to go to a tertiary institution. For example one learner explained that his best friend was going to study medicine.

Summary of focus group (High-achieving learners)

In general, learners from high-performing schools expressed positive perceptions of their teachers and peers. A majority of the learners interviewed felt they were expected to work hard, that they tried hard to get good grades in tests, respect their teachers, and had a good self-image, and that it is important to do well in mathematics. They were also intrinsically motivated.

4.3.2 Focus group interviews: Middle-achieving learners

The second group consisted of eight middle-achieving learners. Learners in this group were from both high-performing and low-performing schools. Most of the learners from both high and low-performing schools in this group explain how working with peers encouraged or discouraged them to perform well in mathematics. The comments of two learners explain this fact:

> *Group discussions are good but during the discussions there is someone who is just watching not working at all and you find that the one who gains much is the one that is doing all the writing because he/she can see all the steps, and the teacher will think that all the people are gaining whereas this is not the case.*

> *We used to practise with our classmates mostly those who were serious about the subject. Even our teacher used to encourage us to form some groups. Group discussions were done especially when we were practising on previous years question papers. In our case we were having our own group which was from previous years and it was not formed by the teacher. We just grouped ourselves.*

It is noted that there were some teachers who took their academic responsibilities lightly and did not arrive on time for teaching, or did not arrive at all. The consequences are that those teachers did not cover their syllabuses appropriately. Learners feel that this behaviour affects their performance at the end of the year. Learners also discussed the instruction they encountered in their mathematics class. The interview with this group provided further insight into learner's opinions of 'good' teaching and teachers. One learner stated:

The teacher must give us a clear explanation. He should write down every step on the board and give examples which are related to different exercises. He must show us clearly what he is talking about.

According to this group there appeared to be teachers that did not enjoy teaching mathematics, and as a result their attitudes were negative towards both the subject matter and towards the learners that they taught. According to this group, these attitudes did not improve teacher-learner communication and discouraged real learning of mathematics. Furthermore, learners in this group boldly stated that many teachers did not know how to teach properly.

There are those teachers who do not teach some of the topics, and they will tell you that you will be taught such topics in winter or Saturday schools. In our school linear programming was not taught in Grade 11.

Some teachers skipped some of the classes without any apparent reason. Both learners from low and high-performing schools seemed to appreciate teachers who provided a structured, logical succession for learners' work as well as enough explanation, encouragement, and friendliness.

I think what makes learners learn better is when the teachers correct the learners' work by themselves, not giving the work to our classmates because the teacher will not know what many learners do not understand. If that is done the teacher will have an opportunity to revise the section that is not well understood so that we can work on it again.

Many learners feel that their teachers concentrate only on those learners that are performing well in the class and some of them do not get proper attention. Most of the homework assignments and classwork are marked by their fellow classmates. This practice is seen by most learners as unfair.

Nakamura (1988) described motivational differences between high-achieving and under-achieving mathematically learners. One of the primary results of her research indicated that high-achievers tend to find more pleasure in school work than low-performing learners. High achievers (High-performing schools) also spend considerably more time than low performers (Low-performing schools) in activities that afford challenges and require well-developed skills. In other words, high performers tend to enjoy academic challenge, whereas low performers tend to feel overwhelmed by challenge.

> *When I practise math, I usually do those exercises that are challenging, the ones that are indicated by a star in some books. The difficult ones make those which are not marked by a star to be known even if you have not done them.*

Teachers have different expectations about the mathematics ability of some learners. The comments from learners are indicative of the influence of teachers' attitudes and peer influences. In some low-performing schools some teachers encourage learners to take mathematics on standard grade level rather than the higher grade. This could indicate low expectations which may affect a learner's chances of completing high school with the grade relevant for acceptance into mathematics-related careers at the university. Low expectation demonstrated by one teacher could have a carry-over effect that might influence a learner to believe that he/she does not have what it takes to be academically successful in other classes.

Learners were influenced by peers who often talked about going to university so they could fulfil their dreams of becoming an engineer or go into medical school. Another learner describes how he got information from his cousin who is working in a similar field and was influenced to follow the same career.

> *I received the information about different careers from my cousin who is working as an electrical engineer and he gave me all the information about this career hence I became interested in electrical engineering.*

Other learners participated in a career guidance day to cultivate their interest in mathematics and enhance their performance. According to one participant:

> *I got the information from the booklet provided by the recruiting institution after visiting us during career guidance day at our school.*

> *As for me I have decided on what I would like to be last year after attending the engineering week. It is the only time when I had information about actuarial science. Before I used to think that I wanted to become a doctor. It was my first choice but now it does not even constitute my second choice. At home they wanted me to become a doctor but I can't.*

The group also described how their teachers provide clues about the need to do well in mathematics. Teachers were clear in their explanations to their learners about the need to do well in mathematics if they wanted to go to universities. Their actions and attitudes towards tertiary institutions were based on knowing what is required to pursue a good career. Learners received and in most cases seemed to have internalised the messages from their teachers that mathematical success and university admission in mathematics and sciences were expected. Below are some quotes from learners regarding their teachers:

> *My teacher wants us to do well in mathematics. He always says that we have to do well in mathematics to make it in the world and to get a good job.*

> *He just told us to work hard in mathematics if we want to go to the university. I mean, it's just little advice that we get from him.*

Their teachers emphasised that the reason for performing well in mathematics and science was to prepare to enter universities of their choice and establish the possibility of receiving a bursary. In some low-performing schools from this group, some teachers suggest that learners take mathematics on standard grade level rather than on the higher grade.

> *When we passed to Grade 12, our teacher directed four of us to take mathematics on the higher grade.*

According to this group this could indicate low expectations that may affect a learner's chances of completing high school with the grade relevant for acceptance into mathematics-related careers at the university. Respondents were also able to recognise obstacles to their academic success. According to learners from a low-achieving school, teachers' lack of commitment was said to contribute negatively to learners' mathematics achievement. Below is one of the participant's comments:

> *I think one of the things that can make learners learn better is that the teachers must look at the work of each an every learner by himself so that he can see where other learners are lagging behind, because you may find that a big percentage of learners are left behind and this will lead them to bridging programmes at the university which according to me is a repeat of Grade 12.*

Summary of focus group interviews middle-achieving learners

In general the majority of middle-achieving learners (from both high-achieving and low-achieving schools) expressed the following perceptions of factors that facilitate achievement in mathematics:

- High expectation by teachers and peers;
- teacher dedication towards their work and learners;
- teacher instructional and assessment methods;
- career knowledge;
- group work with fellow classmates.

4.3.3 Focus group interviews: Low-achieving learners

The last group consisted of five low-achieving learners. Twelve participants were invited but only five turned up. Most learners in this group admitted that they were not self-disciplined enough. Some of them, when given some work to do, would simply not do it and others just copied from their classmates. Some learners agreed that they did not practise mathematics enough, attend classes late, and they did not even consult their teachers when they did not understand some topics.

> *Most of us learners are lazy. Because when we are given the work like today, arriving home we just put it aside and do not look at it. We are very fond of bunking the work. You only look at it when there is an announcement of a test.*

Many learners say that there were no proper learning facilities at home where they could learn effectively. Many of them did not give themselves enough time to practice mathematics because of the lack of time management. They did not know how to stop their friends from visiting them when they were studying.

Learners from low-achieving schools reported on their de-motivation to attend mathematics classes. These learners stated that the reasons for de-motivation focus on poor instructional methods and perceived lack of supportiveness of the teachers. Learners from low-achieving schools tend to avoid challenging exercises. The comments of some learners help describe and explain how their teachers encourage or discourage through instructional methods:

> *I think the teacher must do a lot of follow-up of the learners because he/she may think that all the rules have been understood by all learners whereas the majority of the learners haven't. The teacher should make sure that all learners have understood the basics because they are very important.*

The impression is that learners in this group, generally speaking, are not well motivated. Some appear to be bored with what they were learning and others remarked that they would not pass because the subject was difficult. It was felt by some learners that teachers did not always create the right climate in the classroom, one that was conducive to raising learners' motivational levels. The following are selected comments:

> *I think a teacher should be close to his/her learners and he must give his/her learners more work so that they can work hard by themselves, and not the teacher doing everything for them.*
>
> *I think it is the combination of several factors, mostly lack of motivation from the teacher and not studying well.*

On the other hand, other learners from low-performing schools discussed the impact of the negative influences from their peers in mathematics. One stated that:

> *Most of the learners here at our school have told themselves that mathematics is difficult. When we write a test we know that many of us are going to get zeroes and most of us do not practice anymore. They are discouraged even when the lesson is on, you may find that some are asleep not listening at all. They are some learners who spread bad news that mathematics is difficult; no matter what you do you will not pass it.*

Learners in this group acknowledge that their mathematics background is poor. They say that their teachers in lower grades where not active enough. Most of their teachers did not give them enough tests, homework and classwork. Even those that gave some did not correct it. Some of the mathematics topics which were supposed to be treated in Grade 11 (for instance linear programming) were not discussed. In our interviews learners from low-performing schools frequently reported doing only the compulsory exercise questions; for the most part problems in the text books were referenced solely in connection with parallel previous examination questions. In the following quote this student discussed the role a teacher should play in the encouragement of all learners including those who are not performing well. He stated:

> *The problem is that after writing some test our teacher encourages only those that are doing well, the rest of us are just ridiculed. And some of us are likely forgotten and thrown at the back.*

Most learners commented that they were sometimes humiliated and degraded by teachers. The teachers treated them just like little children. Some teachers are seen as unapproachable, while others do not allow learners to consult them. Learners cannot ask questions in the class because they were ridiculed. The following comments from learners support the statement:

> *I think everyone is afraid of her (teacher). When you ask a question you get a very negative response. You get the impression that you are bothering her. When you approach her you must be ready for anything.*

> *The other factor that helps to make learners learn better is to avoid changing teachers. In Grade 10 you are taught by another teacher and until Grade 12, the teacher is not the same. I think someone must get used to the teacher to perform well.*

Summary of focus group interviews for low-achieving learners

In general the low-achieving learners in this study do share many of the following traits. They have:

- Low motivation from their teachers.
- Prevalent attitude from their teachers that they will fail because they do not have role models in mathematics.
- Low confidence, low respect for their teachers and the perception that they are not respected.
- Limited special programs to offset the effect of lack of mathematics engagement.
- Limited access to knowledge of mathematics career opportunities

4.3.4 Comparison of all focus group interviews

For convenience the findings in this phase are also divided into five themes. All the focus group interviews with the learners are categorised and identified according the learners' responses during the focus group interviews. The five themes are:

Theme 1: Learners commitment
Theme 2: Attitudes and self-concept
Theme 3: Study and learning methods
Theme 4: Perceptions of peers and teachers
Theme 5: Influence of learners career prospect

AREA OF SUCCESS	FG1	FG2	FG3
Learners commitment			
Participated in a mathematics or science tour/excursion	✓	**X**	**X**
Teacher respect	✓	✓	**X**
Regular class attendance	✓	✓	**X**
Attend extra classes	✓	✓	**X**
Remain after school doing math	✓	**X**	**X**
Come to class having done homework	✓	✓	**X**
Desire to be rated with the best	✓	✓	✓
Regular practice	✓	**X**	**X**
Devoted teachers	✓	**X**	**X**
Study and learning methods			
Poor study technique	**X**	✓	✓
Work with other learners	**X**	**X**	**X**
Teacher change	**X**	**X**	✓
Too many in the class	**X**	✓	✓
Participation in class discussion	✓	**X**	**X**
Teacher gives different examples	✓	✓	**X**
Teacher being friendly	✓	✓	**X**

Chance to explain responses	✓	X	X
Attitudes and self-concept			
Active participation	✓	X	X
Homework completion	✓	X	X
Not afraid of the teacher	X	X	✓
Regular attendance	✓	✓	X
Learners' self-concept	✓	X	X
Solving extra problems	✓	X	X
Worked on challenging exercises	✓	X	X
Perceptions of peers and teachers			
Supportive teachers	✓	✓	X
Expected to perform highly	✓	✓	X
Knowledgeable teachers in lower grades	✓	X	X
Attempt challenging exercises	✓	X	X
Good teachers in lower grades	✓	✓	X
Caring teachers	✓	✓	X
Influence of learners career prospect			
Exposure to mathematics-related careers	✓	✓	X
Mathematics usefulness in future career	✓	✓	✓

4.3.5 Summary of results obtained from Phase 2

In a comparison of high-achieving schools and low-achieving schools learners' perceptions, several differences were found. Learners from high-achieving schools put more emphasis than did those from low-achieving schools on factors directly within their control, such as class attendance, active participation and homework exercises completion, whereas learners from low-achieving schools placed more importance than high-achieving schools on the instructional methods and teacher personality, either in the form of caring or not.

Both learners from high-achieving and low-achieving schools put the emphasis on study and teaching methods as a more influential factor in mathematics achievement than adequate mathematics background knowledge. This finding supports research findings which suggest that for many learners poor performance is largely due to ignorance of the study methods required, or the inability to apply these methods appropriately, rather than lack of ability (Manalo, Wong-Toi & Henning, 1996). Learners from high-performing schools also placed greater emphasis than learners from low-performing schools on those factors related to teaching and working with a classmate.

All learners in the focus interviews understand the importance of mathematics in their lives. The importance of mathematics was mostly related to future careers or considered being clever by the classmates. This trend was evident in the themes that emerged from the qualitative data.

4.4 CONCLUSION

Chapter 4 comprised the qualitative part of the research, examining factors that facilitate achievement in mathematics. The perceived factors were examined by means of classroom observation, interviews with teachers and focus group interviews with learners. Although both learners from high- and low-achieving schools discuss different factors that lead to good achievement, there were specific factors that were common to a number of high- and low-performing schools.

This study indicates that the relative perceptions of the majority of the learners in high and low-achieving schools are about the same concerning work standards, expectations of high performance level by teachers and the desire to do well in mathematics.

In the following chapter results of phase three which is the quantitative part of this research will be discussed. Comparison of the success factor in high- and low-performing schools will also be discussed in Chapter 5 based on both the results of the qualitative and quantitative method.

CHAPTER 5

ANALYSIS AND INTERPRETATION OF QUANTITATIVE DATA: RESPONSES FROM LEARNERS

5.1 INTRODUCTION

The objective of this chapter is to present and discuss the information gathered from the questionnaires that were developed following the results from classroom observations and focus group interviews with learners. Data collection is explained in Chapter 3. The statistical information in this chapter was derived from a sample of 366 learners from ten schools comprising five high-performing schools (HPS) and five low-performing schools (LPS), analysing their performance in mathematics as described in Chapter 3.

For responses to items in the questionnaires a Likert Scale was used consisting of three categories with a score of 1 representing either Regularly, Agree or Always, a score of 2 either Occasionally, Neutral or Sometimes and a score of 3 corresponding to either Never or Disagree, depending on the nature of the question. For statements that were negatively phrased low scores support the positive version of the statement. See Appendix D for the complete questionnaire**.** As a number of respondents failed to answer certain questions, the total number of respondents to an item does not always add up to the total number of respondents in the questionnaires.

The decision on what specific factors to include in the questionnaire was based on classroom observations, focus group interviews and the literature review as reported upon in Chapter 4. The questionnaire consisted of six categories, namely, the

A Parental education level
B Learners' commitment
C Learners' attitude, self-concept and career prospects
D Learners' perceptions of and interaction with peers

E Learners' perceptions of teachers

F Learners' perceived causes of poor performance in mathematics.

Items in the questionnaire were grouped in the six categories. In the discussion of the results in this chapter I will, for each of the categories, firstly summarise of the results of items in the particular category, and the *p* values obtained from the chi-squared statistical test that was used to analyse the results. Subsequently I will give more detailed results of each of the items for which there was a statistically significant difference between responses of learners from high and from low-performing schools. In some instances items will also be discussed for which the difference between responses of learners from high and from low-performing schools was almost significant. Items for which there was no significant difference between the results of the high- and low-performing schools will be briefly discussed.

The reader is requested to note the following: Although the researcher is keenly aware of the fact that few of the findings reported in this thesis are practically significant (based on the calculation of effect sizes), after deliberation with my supervisors I nonetheless embarked on a thorough discussion of those findings in the case of which significant p-values were found. After all, we are of the opinion that reporting and discussing the possible meaning of statistical significance (as indicated by significant p-values) are as much a part of research and reporting at doctoral level as is reporting on practical significance. We nonetheless urge you to interpret these findings with due circumspection, especially in the light of this explanation.

For each of the categories the section will be concluded with a précis of the results of items within the particular category. Throughout the entire chapter a significant level of 5% is used. Numbers appearing in all tables in this chapter are percentages of column totals.

The item numbers that relate to each of the five categories appear in Table 5.1 below

Table 5.1 Distribution of items into categories

Category	Number of items	Variable numbers in the questionnaire
A. Parental level of education and involvement	3	2, 3, 36
B. Commitment	11	4, 5, 6, 7, 27, 28, 29, 30, 32, 35, 38
C. Attitude, self-concept and career prospects	10	10, 11, 12, 13, 14, 15, 16, 17, 21, 33
D. Perceptions of peers	7	19, 20, 22, 24, 25, 31, 34
E. Perceptions of teachers	5	8, 9, 18, 23, 26
F. Perceived causes for poor performance in mathematics	12	40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51

5.2 CATEGORY A: PARENTAL EDUCATION AND INVOLVEMENT

The questions in this section include questions on the father and mother's educational level, which was used to indicate socio-economic status of the families in these schools. No significant differences were identified for any of these items. What is notable from the results of these items are the low percentages of agreement in general. The highest percentages (around 50% for HPS and 41% for LPS) occurred for the item in Grade 8 and lower for mother or female guardian. The highest percentages (around 35% for HPS and 36% for LPS) occurred for the item in Grade 8 and lower for father or male guardian. From this section it is clear that the level of parental education was low for learners in both the high-achieving and low-achieving schools. It could be possible from this section that some learners mostly from LPS were not completely sure about the exact educational level of their parents.

Family involvement

Results of an item on the involvement of parents or other family members in the learner's studies are indicated in Table 5.2.1.

Table 5.2.1: Comparison between HPS and LPS with regard to family involvement

		LPS	HPS	*p*-value
Item 36 "I get assistance from family."	Regularly	34.68	43.66	0.2247
	Occasionally	30.11	25.35	
	Never	35.14	30.99	

Effect size: 0.09 (Small effect size)

There is no significant difference ($p = 0.2247$) between responses from HPS and LPS and we cannot conclude that learners from HPS get more assistance from family members than those from LPS. The effect size is small, suggesting that this result has little practical value.

5.3 CATEGORY B: COMMITMENT

Category B of this study was concerned with establishing the learners' affinity for mathematics and their commitment to do well in mathematics. These items also establish learners' perceptions of influences outside the classroom on their performance. Table 5.3 contains the items that fall into this category. We were also interested in whether learners wanted to continue with mathematics at tertiary level after grade twelve.

Table 5.3: Commitment

There is a difference between HPS and LPS with respect to	***p*-value**	**Significance (5% level)**
Participation in a mathematics or science tour/excursion (Item 4)	0.0611	Not significant
Watching mathematics or science TV shows (Item 5)	0.3352	Not significant
Reading mathematics or science magazines or news articles on mathematics (Item 6)	0.6323	Not significant
Attending mathematics Saturdays or winter schools (Item 7)	0.0221	Significant
Skipping mathematics classes (Item 27)	0.0083	Significant
Coming to class without a pen or pencil (Item 28)	0.7415	Not significant
Try to solve math problems before seeking help (Item 29)	0.0828	Not significant
Attending extra classes (Item 30)	0.0195	Significant
Remaining after school to do mathematics (Item 32)	< 0.0001	Significant
Coming to class without having done mathematics homework (Item 35)	< 0.0001	Significant
Personal effort in mathematics work (Item 38)	0.0017	Significant

5.3.1 Items with a significant difference

We now report on items in which the difference between responses from HPS and LPS were statistically significant.

Attending mathematics Saturdays or winter schools

Results for this item are presented in Table 5.3.1.

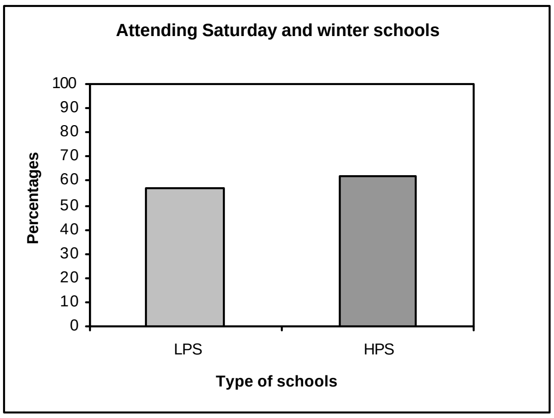
Table 5.3.1: Comparison between HPS and LPS with regard to attending mathematics Saturdays or winter schools

		LPS	HPS	*p*-value
Item 7 “I attend mathematics Saturdays or winter schools.”	Regularly	57.34	62.41	0.0221
	Occasionally	30.73	34.04	
	Never	11.93	3.55	

Effect size: 0.05 (Small effect size)

From Table 5.3.1 we can conclude that more learners from HPS than LPS agree with the statement that they attend mathematics Saturday or winter schools, about 62% as against 57%. These results are graphically presented in Figure 5.3.1. It is noticeable how high the percentages are, in both cases, for regularly attending Saturday or winter schools. In the HPS less than 4% never attend such schools. The effect size is small, suggesting that this result has little practical value.

Figure 5.3.1: Percentages of learners of HPS and LPS that agree with the statement



Skipping mathematics classes

Results for this item are presented in Table 5.3.2.

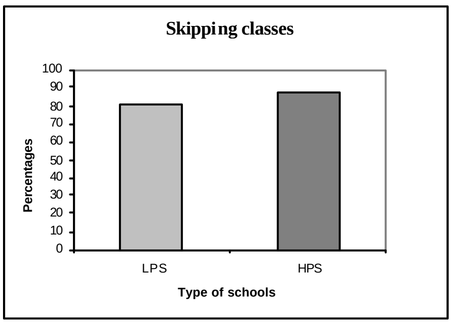
Table 5.3.2: Comparison between HPS and LPS with regard to attendance of mathematics classes

		LPS	HPS	*p*-value
Item 27 "I skip mathematics classes."	Regularly	3.18	7.04	0.0083
	Occasionally	15.91	6.34	
	Never	80.91	86.62	

Effect size: 0.16 (Small effect size)

The participants indicated varied responses to the statement on skipping classes. The statement in this item was negatively phrased, and so low percentages would support the positive version of the statement. Around 3% of learners from LPS say they regularly or occasionally skip mathematics classes compared to only about 7% of learners from HPS, both small percentages indicating that skipping classes is not a regular occurrence for either of the groups. Skipping classes is clearly not perceived as a major problem. The significant difference arises as a result of the responses of learners who occasionally or never skip classes. More than twice as many learners from LPS say they occasionally skip classes than from HPS. In addition a large group of around 87% of learners from HPS say that they never skip mathematics classes compared to around 81% of learners from LPS. The effect size is small, suggesting that this result has little practical value.

Figure 5.3.2: Percentages of learners of high-performing schools and low-performing schools that disagree with the statement



Attending extra classes

Results for this item are presented in Table 5.3.3.

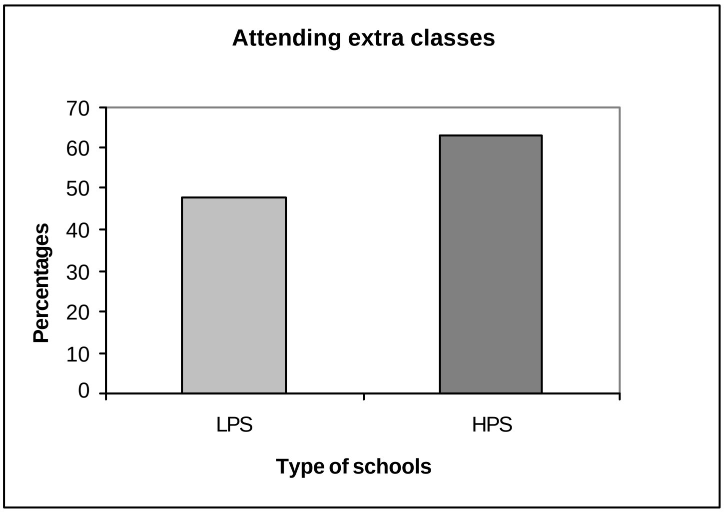
Table 5.3.3: Comparison between HPS and LPS with regard to attendance of extra mathematics classes

		LPS	HPS	*p*-value
Item 30 "I attend extra classes."	Regularly	47.73	62.86	0.0195
	Occasionally	35.91	25.71	
	Never	16.36	11.43	

Effect size: 0.1479 (Small effect size)

Around 63% for learners from HPS compared to around 48% for learners from LPS say that they attend extra classes, a significant difference. In addition, around 16% of students from LPS say they never attend extra classes compared to only around 11% of students from HPS. Because the difference is significant we can conclude that learners from HPS attend extra classes more than learners from LPS. The effect size is small, suggesting that this result has little practical value.

Figure 5.3.3: Percentages of learners of high-performing schools and low-performing schools that agree with the statement



Remaining after school doing mathematics

Results for this item are presented in Table 5.3.4.

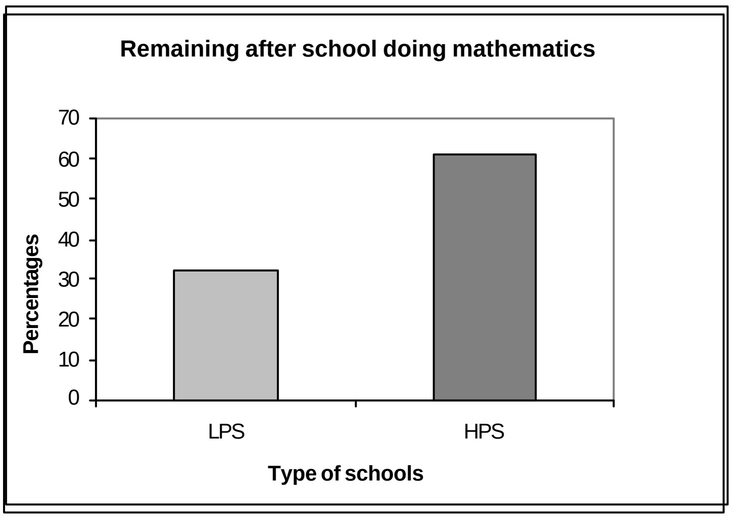
Table 5.3.4: Comparison between HPS and LPS with regard to remaining after school doing mathematics

		LPS	HPS	*p*-value
Item 32 "I remain after school doing mathematics."	Regularly	31.82	60.56	0.0001
	Occasionally	40.00	30.28	
	Never	28.18	9.15	

Effect size: 0.3059 (Medium effect size)

In this item almost twice as many learners from HPS than learners from LPS agree that they remain after school practising mathematics (around 61% compared to around 32%). In addition about three times as many students from LPS as students from HPS say that they never remain after school doing mathematics (around 28% compared to around 9%). These results offer a clear indication that remaining after school doing mathematics is an activity characteristic of HPS. The effect size is medium, suggesting that in practice, remaining after school has some effect on performance as defined in this thesis.

Figure 5.3.4: Percentages of learners of high-performing schools and low-performing schools that agree with the statement



Coming to class without having done mathematics homework

Results for this item are represented in Table 5.3.5.

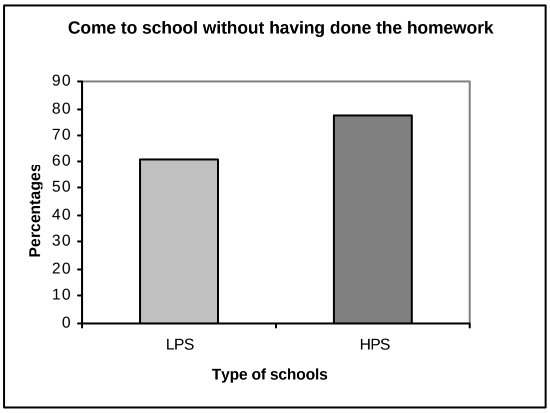
Table 5.3.5: Comparison between HPS and LPS with regard to coming to class without having done mathematics homework

		LPS	HPS	*p*-value
Item 35 "Come to class without having done my homework."	Regularly	5.00	9.29	0.0001
	Occasionally	33.64	13.57	
	Never	61.36	77.14	

Effect size: 0.23 (Small effect size)

This item required that learners respond to whether they do their homework or not. A first observation is that small percentages (5% and 9%) of learners regularly come to class without having done their homework, a pleasing result although it is surprising that more learners from HPS do this than learners from LPS. The larger percentages occur in the "Never" category. About 77% of learners from high-performing school disagree that they come to class without having done their homework whereas about 61% of learners from low-performing school disagree. Because this difference is significant the conclusion therefore is that learners from HPS are more inclined to do their homework. However the effect size is small, suggesting that this result has little practical value.

Figure 5.3.5: Percentages of learners of high-performing schools and low-performing schools that disagree with the statement



Personal effort put into mathematics work

This item was formulated somewhat differently from the other items in the questionnaire. Here a question was asked and learners had to pick one of five different options. Results for this item are presented in Table 5.3.6.

Table 5.3.6: Comparison between HPS and LPS with regard to personal effort put into mathematics work

		LPS	HPS	*p*-value
Item 38 "How much effort do you usually put into your mathematics work?"	I do not try at all	0	2.17	0.0017
	I do just enough to get by	4.50	6.52	
	I give an average amount of effort	9.46	2.90	
	I try very hard but not as hard as I could	30.63	19.57	
	I work as hard as I can	55.41	68.84	

Effect size: 0.2189 (Small effect size)

The high percentages occur in the response "I work as hard as I can" where learners from HPS outperform learners from LPS. It is noticeable that even for LPS more than half the learners (55.41%) claim that they work as hard as they can and around a third claim that they work very hard but perhaps not quite as hard as they could. Learner perceptions are not always a reliable indication of the true situation. Although they claim to work as hard as they can, it could be an indication of not accepting responsibility for their failure, trying to put the blame elsewhere. The effect is small, suggesting that this result has little practical value.

5.3.2 Items with a difference that was not significant

For three items the differences between high- and low-performing schools were not significant. Items for which the difference in opinion between learners from HPS and learners from LPS was not significant are listed in Table 5.3.7.

Table 5.3.7: Items for which the different was not significant

		LPS	HPS	*p*-value	*w*-value
Item 4 "I participated in a mathematics or science tour/ excursion."	Regularly	31.94	20.57	0.0611	0.1251
	Occasionally	26.39	29.79		
	Never	41.67	49.65		
Item 5 "I watch mathematics or science TV shows."	Regularly	37.27	31.43	0.3352	0.0779
	Occasionally	47.73	55.71		
	Never	15.00	12.86		
Item 6 "I read mathematics or science magazines or news articles on mathematics."	Regularly	30.56	27.86	0.6323	0.0507
	Occasionally	47.69	52.86		
	Never	21.76	19.29		
Item 29 "I come to class without a pen or pencil.	Regularly	6.36	5.63	0.7415	0.1360
	Occasionally	12.73	15.49		
	Never	80.91	78.87		

It is clear from Table 5.3.7 that external activities such as participating in a mathematics or science tour, watching mathematics or science television shows or reading mathematics or science magazines or news articles on mathematics have no significant influence on mathematics achievement. It is notable and commendable that fair percentages of students do regularly participate in these activities (around 30% of both HPS and LPS in Items 4, 5 and 6). Item 28 and 29 indicate the level of preparedness for a class situation and again there is no significant difference.

5.3.3 Précis of findings

Learners from high-performing schools are more inclined to the following activities than learners from low-performing schools:

- Attendance of mathematics classes on Saturdays or winter schools.

- Attendance of extra classes.
- Remaining after school doing mathematics.

Learners from low-performing schools are more inclined to the following activities than learners from high-performing schools:

- Coming to class without having done mathematics homework.
- Skipping some mathematics classes.

These findings seem to indicate that learners from high-performing schools have more commitment to their learning tasks in mathematics compared to learners from low-performing schools. The findings also show that learners from low-performing schools feel less serious about their responsibilities to attain success in mathematics.

5.4 CATEGORY C: ATTITUDES AND SELF-CONCEPT

Category C of this study centred on learners' attitudes towards mathematics, their beliefs regarding mathematics and its usefulness as well as their beliefs and perceptions concerning their own success and failure in mathematics. Table 5.4 contains the items that fall into this category.

Table 5.4: Attitudes and self-concept

There is a difference between HPS and LPS with respect to:	***p*-value**	**Significance (5% level)**
Looking forward to mathematics classes (Item 10)	0.0104	Significant
Personal perception of mathematics as being difficult (Item 11)	0.2759	Not significant
Self-discipline in doing mathematics (Item 12)	0.2322	Not significant

Usefulness for future career (Item 13)	0.0681	Not significant
Mathematics as a cause of being nervous and upset. (Item 14)	0.1952	Not significant.
Planning to study tertiary mathematics (Item 15)	0.2944	Not significant
Enjoyment of mathematics (Item 16)	0.2014	Not significant
Importance of studying hard (Item 17)	0.9704	Not significant
Perception of Mathematics as a difficult subject to do (in general (Item 21)	0.0092	Significant
Loss of concentration when solving mathematics problems (Item 33)	0.2299	Not significant

5.4.1 Items with a significant difference

Looking forward to mathematics classes

Results of this item are presented in Table 5.4.1.

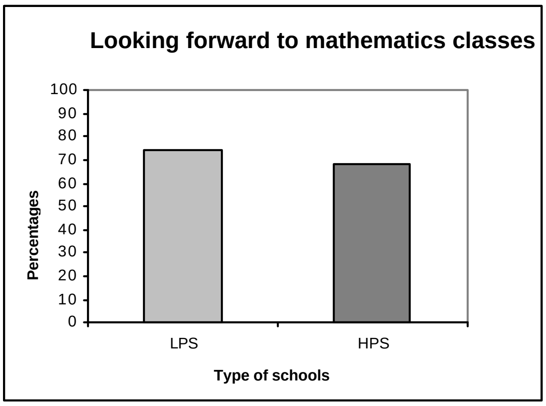
Table 5.4.1: Comparison between HPS and LPS with regard to looking forward to mathematics classes

		LPS	HPS	*p*-value
Item 10 "I look forward to mathematics classes."	Regularly	74.31	68.09	0.0104
	Occasionally	20.18	17.02	
	Never	5.50	14.89	

Effect size: 0.1594 (Small effect size)

In terms of looking forward to mathematics classes, contrary to what could be expected, around 68% of learners from HPS agree that they look forward to mathematics classes whereas a higher percentage of around 74% of learners from LPS agree. The *p* value of *p* = 0.0104 indicates that this difference is significant. An explanation for this result is that learners from HPS see mathematics as a serious subject that requires hard work and devoted attention whereas learners from LPS are less concerned and not fully aware of their predicament. This finding will be expanded on during discussions on other findings in this section. The effect size is small, suggesting that this result has little practical value.

Figure 5.4.1: Percentages of learners of high-performing schools and low-performing schools that agree with the statement



Mathematics is a difficult subject (in general)

Results for this item are presented in Table 5.4.2.

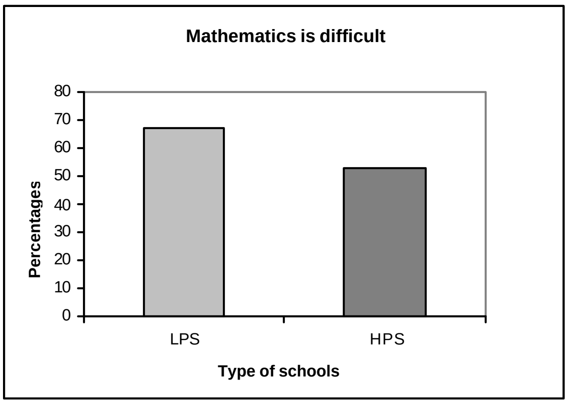
Table 5.4.2: Comparison between HPS and LPS with regard to mathematics being a difficult subject (generally)

		LPS	HPS	*p*-value
Item 21 "I believe mathematics is difficult to do unless you have the brain for it."	Agree	14.61	26.76	0.0092
	Neutral	18.72	20.42	
	Disagree	66.67	52.82	

Effect size : 0.1612 (Small effect size)

The outcome of this item is as unexpected as that of the previously discussed item. Almost twice as many learners from HPS agree that mathematics is a difficult subject than the learners from LPS (around 27% compared to around 15%) and more learners from LPS disagree than learners from HPS (around 66% compared to around 53%). Again, students from HPS seem to be more conscious of the general perception that mathematics is a notoriously difficult subject whereas students from LPS are less concerned. This finding links up with to the previous finding of learners from LPS looking forward more to mathematics classes than learners from HPS. Another angle on this finding is that students from HPS possibly know that a prestige value is often attached to high performance in mathematics and they prefer to think that the reason for their better performance is that they "have the brain for it." The effect size is small, suggesting that this result has little practical value.

Figure 5.4.2: Percentages of learners of high-performing schools and low-performing schools that disagree with the statement



5.4.2 Item for which the difference was almost significant

For one item the difference between learners from LPS and HPS was almost significant ($p < 0,1$). The relevant data are listed in Table 5.4.2.

Mathematics is useful in my future career

Results for this item are presented in Table 5.4.3.

Table 5.4.3: Comparison between HPS and LPS with regard to usefulness in future career

		LPS	HPS	*p*-value
Item 13 "Mathematics is useful in my future career."	Agree	80.82	71.83	0.0681
	Neutral	9.13	9.86	
	Disagree	10.05	18.31	

Effect size: 0.1220 (Small effect size)

In this item the results were that around 72% of the learners from HPS agree with the fact that mathematics is useful for their future career whereas around 81% of learners from low-performing schools agree. Although not significant, the outcome is reminiscent of the general perception that "mathematics is useful". A study by Leitze (1996) concerning attitudes towards mathematics showed that mathematics major students were overwhelmingly convinced that "mathematics is useful". However, they could name at most two professions using mathematics. The statement "mathematics is useful" appeared to be more of an automated response rather than a belief shaped by the students' mathematics experiences. The effect size is small, suggesting that this result has little practical value.

5.4.3 Items for which the difference was not significant

Seven items in this category for which the difference in opinion between learners from HPS and learners from LPS was not significant are listed in Table 5.4.4.

Table 5.4.4: Items for which the different was not significant

		LPS	HPS	*p*-value	*w*-value
Item 11: "Mathematics is difficult for me."	Agree	9.95	45.60	0.2759	0.0843
	Neutral	46.61	43.79		
	Disagree	43.44	40.43		

Item 12: "I have self-discipline in doing Mathematics."	Agree	69.68	71.43	0.2322	0.0899
	Neutral	23.53	17.86		
	Disagree	6.79	10.71		
Item 14: "Doing mathematics makes me nervous or upsets me."	Agree	7.66	11.35	0.1952	0.0949
	Neutral	15.77	20.57		
	Disagree	76.58	68.09		
Item 15: "I will continue with mathematics after Grade 12."	Agree	78.48	72.54	0.2944	0.0819
	Neutral	13.00	14.08		
	Disagree	8.52	13.38		
Item 16: "I enjoy mathematics."	Agree	66.67	71.83	0.2014	0.0942
	Neutral	27.40	19.72		
	Disagree	5.94	8.45		
Item 17: "Studying hard in mathematics is important."	Agree	4.50	5.63	0.8828	0.0262
	Neutral	5.41	5.63		
	Disagree	90.09	88.73		
Item 33: "I lose concentration when solving math problems."	Agree	8.11	13.38	0.2299	0.0899
	Neutral	45.50	40.14		
	Disagree	46.40	46.48		

Although these items do not point to significant differences between HPS and LPS a previously identified and surprising line of thought is strengthened. Almost five times as many students from HPS than from LPS (45.6% versus 9.95%) say that mathematics is difficult for them. In addition more students from HPS than from LPS (around 11% compared to around 7%) say that mathematics makes them nervous or upsets them. What emerges is the notion that students from HPS realise that achievement in mathematics does not come easy. It is a difficult subject that requires hard work and could even make one nervous or upset one. Yet the high performers are willing to do the hard work required. They are fully involved. There is even an indication that they enjoy it more than students from LPS (around 72% compared to around 67%), despite the fact that they find it difficult.

5.4.4 Précis of findings

- Learners from high-performing schools see mathematics as a difficult subject, more so than learners from low-performing schools.
- Learners from HPS do not necessarily look forward to mathematics classes but realise that hard work is required to achieve success.

5.5 CATEGORY D: PERCEPTIONS OF AND INTERACTION WITH PEERS

Category D of this study focused in particular on the role of peers as agents of mathematics socialisation including their beliefs and goals for learners' motivation. We included questions about their interaction with peers after obtaining inputs from students in this regard from the interviews.

Table 5.5: Perceptions of peers

There is a difference between HPS and LPS with respect to:	***p*-value**	**Significance (5% level)**
Friends' interest in mathematics (Item 19)	0.0496	Significant
Performance of close friends in mathematics (Item 20)	0.1488	Not significant
Encouragement from friends (Item 22)	0.0155	Significant

Learners' desire to perform (Item 24)	0.0072	Significant
Respect for mathematics teachers (Item 25)	0.0007	Significant
Collaboration with class mates (Item 31)	0.0737	Not significant
Participation in class discussion (Item 34)	0.0046	Significant

5.5.1 Items with a significant difference

Friends' interest in mathematics

Results for this item are presented in Table 5.5.1.

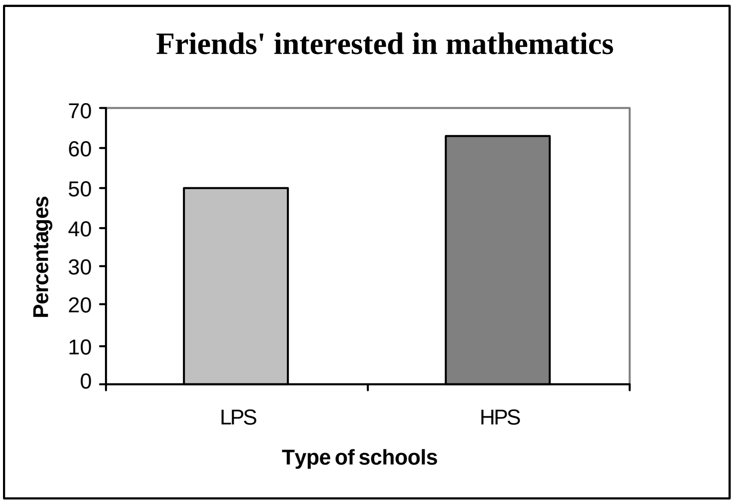
Table 5.5.1: Comparison between HPS and LPS with regard to friends' interest in mathematics

		LPS	HPS	*p*-value
Item 19 "My friends are interested in mathematics."	Agree	49.55	62.68	0.0496
	Neutral	35.45	26.06	
	Disagree	15.00	11.27	

Effect size: 0.1288 (Small effect size)

Students from HPS associate more with friends that show interest in mathematics (around 63% versus around 50%). It is also to be expected that in HPS the community of students interested in mathematics will be larger. The effect size is small, suggesting that this result has little practical value.

Figure 5.5.1: Percentages of learners of high-performing schools and low-performing schools that agree with the statement



Encouragement from friends

Results for this item are presented in Table 5.5.2.

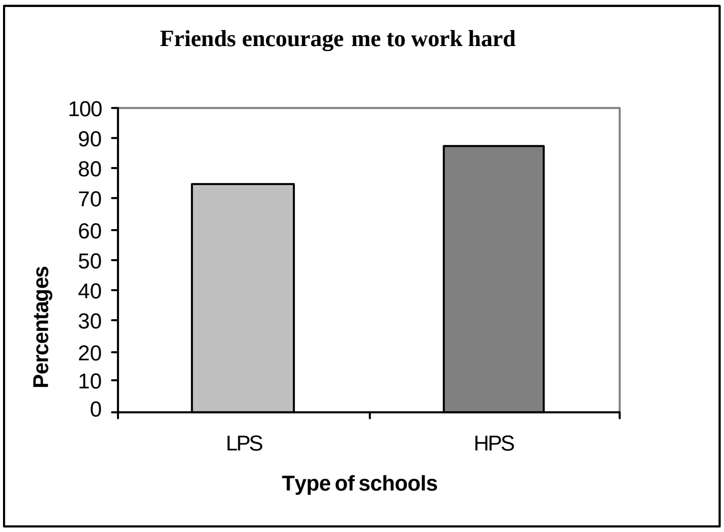
Table 5.5.2: Comparison between HPS and LPS with regard to encouragement from friends

		LPS	HPS	*p*-value
Item 22 "My friends encourage me to work hard."	Agree	75.11	87.32	0.0155
	Neutral	17.19	7.75	
	Disagree	7.69	4.93	

Effect size: 0.1515 (Small effect size)

From Table 5.5.2 we see that around 87% of learners from HPS experience encouragement from their friends versus 75% of learners from LPS. This again points to a community that fosters hard work. These percentages are large (in both cases) compared to small percentages of students that disagree (around 8% and 5%), somewhat surprising for LPS. The effect size is small, suggesting that this result has little practical value.

Figure 5.5.2: Percentages of learners of high-performing schools and low-performing schools that agree with the statement



Learners in my class want to do well

Results for this item are presented in Table 5.5.3.

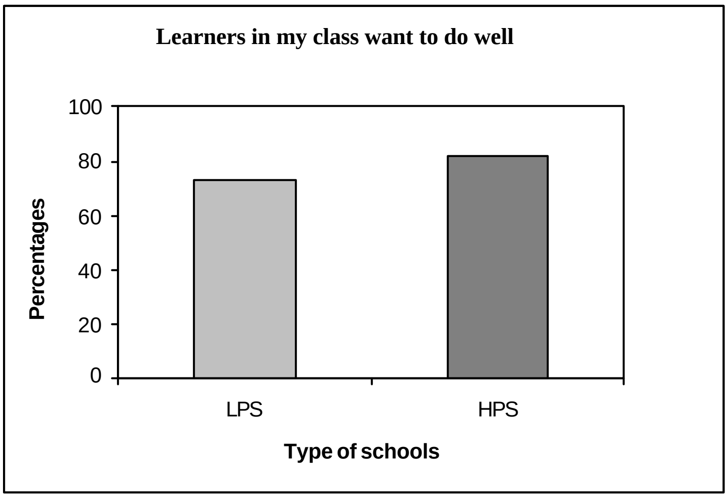
Table 5.5.3: Comparison between HPS and LPS with regard to learners' desire to perform

		LPS	HPS	*p*-value
Item 24 "Learners in my class want to do well."	Agree	72.85	81.69	0.0072
	Neutral	23.53	11.27	
	Disagree	3.62	7.04	

Effect size: 0.1649 (Small effect size)

The results show that around 82% of the learners from HPS agree with the fact that learners in their class want to do well in mathematics whereas around 73% of learners from LPS agree. The communal desire to do well fits in with the emerging image of an environment that stimulates hard work and manifests itself in success. The effect size is small, suggesting that this result has little practical value.

Figure 5.5.3: Percentages of learners of high-performing schools and low-performing schools that agree with the statement



Respect for mathematics teachers

Results for this item are presented in Table 5.5.4.

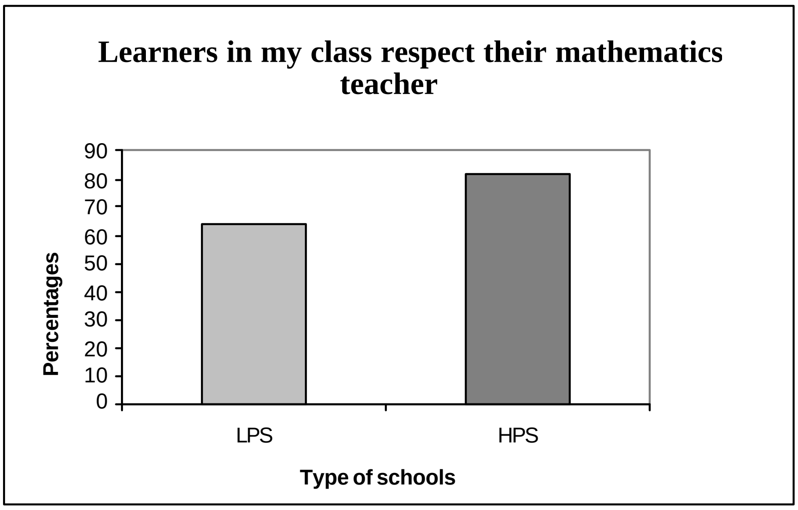
Table 5.5.4: Comparison between HPS and LPS with regard to respect for mathematics teachers

		LPS	HPS	*p*-value
Item 25 "Learners in my class respect math teachers."	Agree	63.06	81.69	0.0007
	Neutral	26.13	13.38	
	Disagree	10.81	4.93	

Effect size: 0.1992 (Small effect size)

The results indicate that around 82% of learners from HPS agree that their classmates respect their mathematics teachers whereas around 63% of the learners from LPS agree. The significant p value ($p = 0.0007$) indicates that learners from HPS believe more that their classmates respect their mathematics teachers than learners from LPS. Respect for a teacher adds to create a scholarly environment. The effect size is small, suggesting that this result has little practical value.

Figure 5.5.4: Percentages of learners of high-performing schools and low-performing schools that agree with the statement



Participation in class discussion

Results for this item are presented in Table 5.5.5.

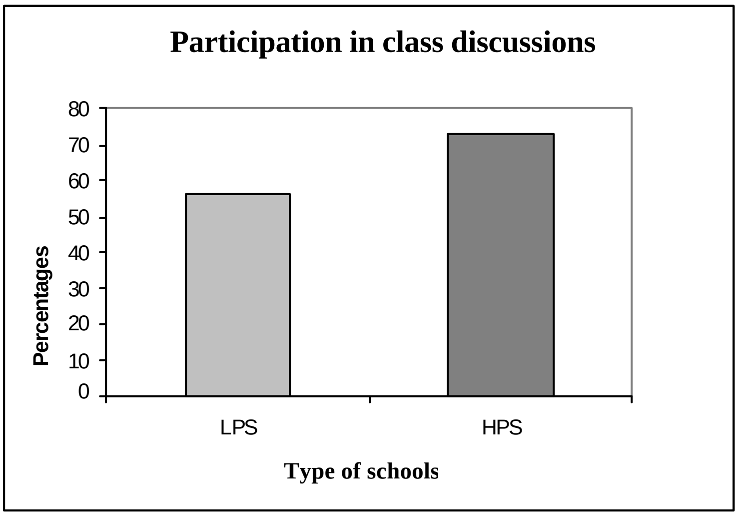
Table 5.5.5: Comparison between HPS and LPS with regard to participation in class discussions

		LPS	HPS	*p*-value
Item 34 "I participate in class discussions."	Regularly	55.45	72.54	0.0046
	Occasionally	37.27	22.54	
	Never	7.27	4.93	

Effect size: 0.1723 (Small effect size)

From the data it is clear that learners from HPS participate in class discussions more regularly than learners from LPS. In this regard around 73% of learners from HPS indicate regular participation in comparison with around 53% of learners from LPS that participate regularly. It is pleasing to see that even for LPS more than half the students regularly participate in class discussions. Very few students, of both groups, never participate in class discussions. There seems to be a culture of class participation overall, but more so in HPS. The effect size is small, suggesting that this result has little practical value.

Figure 5.5.5: Percentages of learners of high-performing schools and low-performing schools that agree with the statement



5.5.2 Item for which the difference was almost significant

Collaboration with classmates

Results for this item are presented in Table 5.5.6.

Table 5.5.6: Comparison between HPS and LPS with regard to working with classmates

		LPS	HPS	*p*-value
Item 31 "I work with classmates in mathematics."	Regularly	66.06	76.60	0.0737
	Occasionally	29.86	19.15	
	Never	4.07	4.26	

Effect size: 0.1200 (Small effect size)

Although the overall difference is not significant for this item, results show that more than 76% of learners from HPS regularly work with classmates in mathematics compared to only 66% of learners from LPS. These percentages are high in both cases but are weighted towards the HPS. The effect size is small, suggesting that this result has little practical value.

5.5.3 Précis of findings

Learners from high-performing schools belong to a scholarly community where they

- Associate with friends who show interest in mathematics.
- Receive encouragement from their friends.
- Have classmates that show a desire to do well.
- Have respect for teachers.
- Participate in class discussions.

5.6 CATEGORYE: PERCEPTIONS OF TEACHERS

There is a difference between HPS and LPS with respect to:	*p*-value	Significance (5% level)
Fear of mathematics teacher (Item 8)	0.0014	Significant
Expectations from teacher (Item 9)	0.3682	Not significant
Encouragement from teacher (Item 18)	0.4117	Not significant
Teacher's treatment of learners (Item 23)	0.4759	Not significant
Recognition by teacher (Item 26)	0.3967	Not significant

5.6.1 Item with a significant difference

Fear of mathematics teacher

Results for this item are presented in Table 5.6.1.

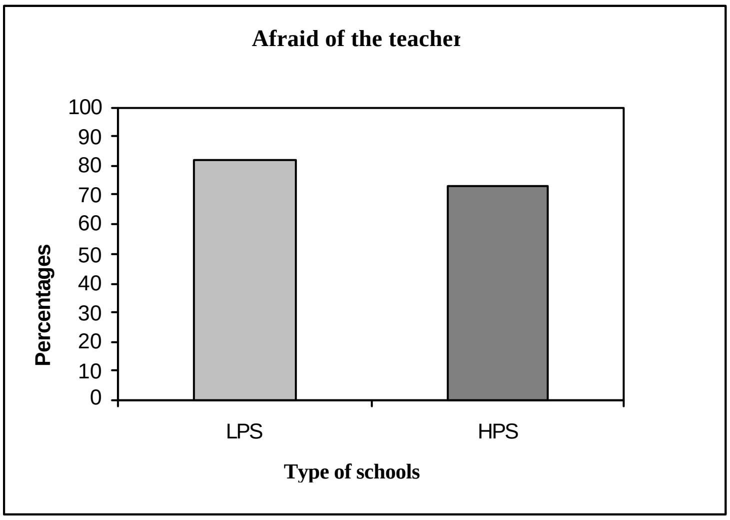
Table 5.6.1: Comparison between HPS and LPS with regard to fear of mathema tics teacher

		LPS	HPS	*p*-value
Item 8 "I am afraid of my mathematics teacher."	Agree	5.43	17.02	0.0014
	Neutral	13.12	9.93	
	Disagree	81.45	73.05	

Effect size: 0.1906 (Small effect size)

A comparison of learners from HPS, and LPS on learners being afraid of their teacher reveals that learners from HPS are more afraid of their teachers than their counterparts. Percentage wise, around 82% of learners from LPS disagree with the fact that they are afraid of their mathematics teacher and around 73% of those learners from HPS disagree. In addition around 17% of learners from HPS feel that they are afraid of their mathematics teacher compared to only about 5% of LPS. This result is perhaps contrary to expectation but fits in with the perception of learners from HPS that mathematics is a difficult subject and that they do not look forward to classes. The image portrayed is that of a strict teacher that obtains results and does not necessarily make life easy for learners. Perhaps this portrayal is somewhat of the old school but one cannot conclude that the HPS teachers' approach is unreasonably authoritarian as we are dealing with learners' perceptions that may be slightly exaggerated. The effect size is small, suggesting that this result has little practical value.

Figure 5.6.1: Percentages of learners of high-performing schools and low-performing schools that disagree with the statement



5.6.2 Items for which the difference was not significant

Four items for which the difference in opinion between learners from HPS and learners from LPS was not significant are listed in Table 5.6.2.

Table 5.6.2: Items for which the difference was not significant

		LPS	HPS	*p*-value	*w*-value
Item 9 "My teacher expects me to do well."	Agree	88.24	85.92	0.3682	0.0742
	Neutral	9.05	8.45		
	Disagree	2.71	5.63		
Item 18 "My teacher always encourages me to work hard."	Agree	93.67	93.66	0.4117	0.0699
	Neutral	3.17	1.41		
	Disagree	3.17	4.93		
Item 23 "My teacher always treats learners with respect."	Agree	77.38	80.99	0.4759	0.0640
	Neutral	16.29	15.49		

	Disagree	6.33	3.52		
Item 26 "Learners' achievement is recognised by the teacher."	Agree	66.97	69.01	0.3967	0.0717
	Neutral	25.23	26.76		
	Disagree	7.80	4.23		

The picture of the teacher as a strict authoritarian figure is further negated by data in the table above. More than 85% of learners from HPS say that the teachers expect them to do well, more than 90% say that the teacher encourages them to do well; more than 80% say that the teachers always treat learners with respect and almost 70% of learners from HPS say that the teacher recognises learners' achievements. These high percentages are not significantly different for LPS. What emerges is the realisation that the blame for poor performance does not lie with the attitude of the teachers. In both cases students testify to the characteristics of encouragement and support from teachers.

5.6.3 Précis of findings

- Learners from high-performing schools are significantly more afraid of their teachers than learners from low-performing schools pointing to a strict classroom environment.
- Yet learners from both high and low-performing schools recognise in their teachers qualities of encouragement, recognition and high expectation.

5.7 CATEGORY F: PERCEIVED CAUSES FOR POOR PERFORMANCE IN MATHEMATICS

Category F of this study was about learners' perceptions on what the causes for general poor mathematics performance are.

Table 5.7: Learners' perceived causes for poor performance in mathematics

There is a difference between learners in HPS and learners in LPS with respect to what they perceive as cause for poor performance in mathematics	***p*-value**	**Significance (5% level)**
Too many learners in a class (Item 40)	< 0.0001	Significant
Not mathematically talented (Item 41)	0.2581	Not significant
Uncertainty about future career (Item 42)	0.4707	Not significant
Uneducated parents (Item 43)	0.0119	Significant
No respect for teachers (Item 44)	0.0890	Not significant
Not attending extra classes (Item 45)	0.2435	Not significant
Under qualified teachers (Item 46)	0.0094	Significant
Not expected to perform well (Item 47)	0.0006	Significant
Not respected by teacher (Item 48)	0.1116	Not significant
No extra support available (Item 49)	0.0332	Significant

No collaboration with class mates (Item 50)	0.0190	Significant
Poor background in mathematics (Item 51)	0.1098	Not significant

5.7.1 Items with a significant difference

Too many learners in the class

Results for this item are presented in Table 5.7.1.

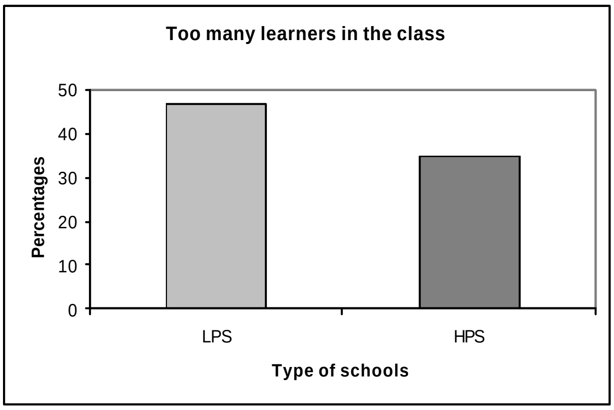
Table 5.7.1: Comparison between HPS and LPS with regard to learners perceiving the number of learners in the class as cause for poor performance

		LPS	HPS	*p*-value
Item 40 "Learners perform badly because there are too many learners in the class".	Agree	9.09	30.00	< 0.0001
	Neutral	43.64	35.00	
	Disagree	47.27	35.00	

Effect size: 0.2705 (Small effect size)

The intention was to find out if learners believe that overcrowded classes affected their performance in mathematics. The class sizes were not the same for HPS and LPS. Some high-performing schools had more learners in one class than low-performing schools and vice versa. In this regard, responses percentage-wise were that around 30% of learners from HPS agree that learners do not perform well in mathematics because the class sizes are too big whereas only around 9% of learners from LPS agree. Learners from HPS clearly experience large classes more as a detriment for performance. The effect size is small, suggesting that this result has little practical value.

Figure 5.7.1: Percentages of learners of high-performing schools and low-performing schools that agree with the statement



Uneducated parents

Results for this item are presented in Table 5.7.2.

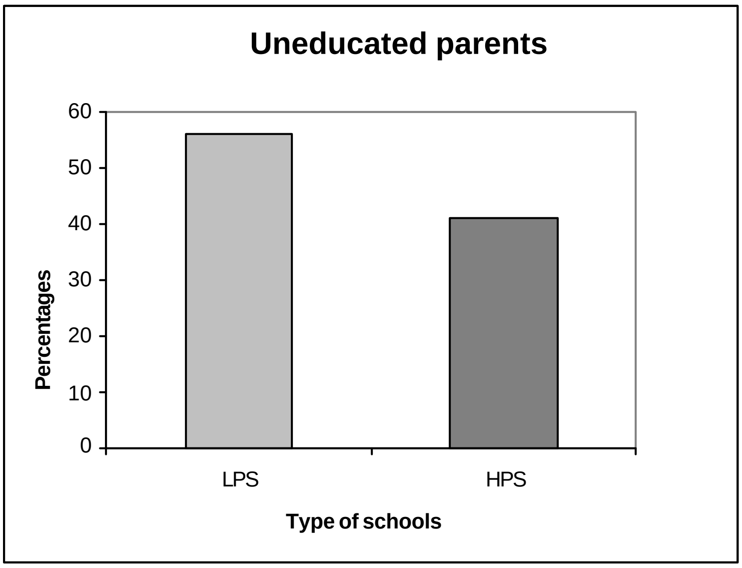
Table 5.7.2: Comparison between HPS and LPS with regard to learners perceiving uneducated parents as cause for poor performance

		LPS	HPS	*p*-value
Item 43 "Learners perform badly because they have uneducated parents."	Agree	8.18	13.57	0.0119
	Neutral	35.45	45.71	
	Disagree	56.36	40.71	

Effect size: 0.1570 (Small effect size)

In both cases, for learners from HPS as well as from LPS, low percentages agree with the statement (around 8% and just over 13%). Larger percentages disagree with the statement (just over 56% and 40% respectively). It is interesting and significant that more learners from LPS put less blame for poor performance on their parents. An explanation could be that learners from HPS realise the value of an educated home environment more because they are serious about their learning. The effect size is small, suggesting that this result has little practical value.

Figure 5.7.2: Percentages of learners of high-performing schools and low-performing schools that disagree with the statement



Under qualified teachers

Results for this item are presented in Table 5.7.3.

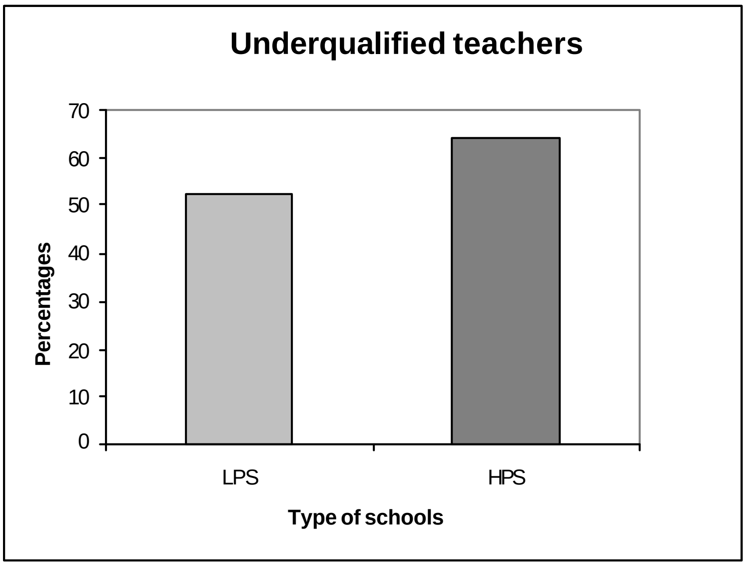
Table 5.7.3: Comparison between HPS and LPS with regard to learners perceiving under qualified teachers as cause for poor performance

		LPS	HPS	*p*-value
Item 46 "Learners perform poorly in mathematics because they have under qualified teachers."	Agree	13.18	15.71	0.0094
	Neutral	35.00	20.00	
	Disagree	51.82	64.29	

Effect size: 0.1610 (Small effect size)

Percentage wise the learners of HPS and of LPS are similar in their agreement with the statement. However, more learners from HPS disagree with the statement than learners from LPS (around 64% compared to around 52%) and both percentages are high. It is clear that learners have confidence in their teachers and do not feel that they are underqualified, and that this is particularly true for learners from HPS. The effect size is small, suggesting that this result has little practical value.

Figure 5.7.3: Percentages of learners of high-performing schools and low-performing schools that disagree with the statement



No expectations from learners

Results for this item are presented in Table 5.7.4.

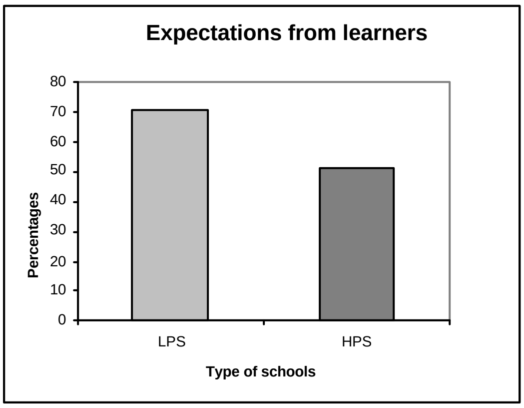
Table 5.7.4: Comparison between HPS and LPS with regard to learners perceiving under qualified teachers as cause for poor performance

		LPS	HPS	*p*-value
Item 47 "Learners perform poorly in mathematics because they are not expected to perform well."	Agree	5.91	12.86	0.0006
	Neutral	23.18	35.71	
	Disagree	70.91	51.43	

Effect size: 0.2022 (Small effect size)

Although more than twice as many learners from HPS agree with the statement that learners perform poorly because they are not expected to perform well, these percentages are on the low side (around 6% and 13% respectively). The majority of students, from both HPS and LPS disagree with the statement, with a significant difference in favour of the LPS (around 71% and 51% respectively). Learners from LPS clearly feel that the reason for poor performance lies elsewhere. They are probably experiencing external pressure for improved performance from the media, perhaps from the school itself although this pressure is clearly not resulting in better performance. This finding supports the belief that external pressure is secondary to internal motivation. The effect size is small, suggesting that this result has little practical value.

Figure 5.7.4: Percentages of learners of high-performing schools and low-performing schools that disagree with the statement



No extra support available

Results for this item are presented in Table 5.7.5.

Table 5.7.5: Comparison between HPS and LPS with regard to learners perceiving no extra support as cause for poor performance

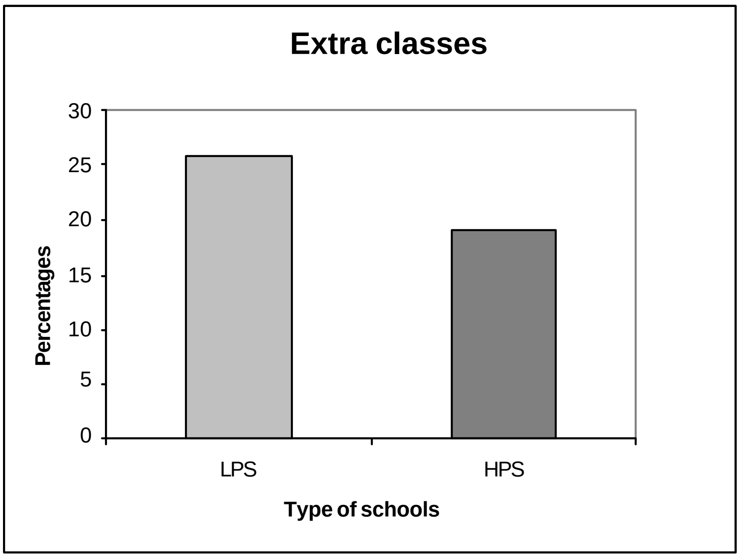
		LPS	HPS	*p*-value
Item 49 "Learners perform poorly in mathematics because they are not provided with extra support when needed."	Agree	25.57	19.29	0.0332
	Neutral	51.14	45.00	
	Disagree	23.29	35.71	

Effect size: 0.1377 (Small effect size)

According to the data around 23% of learners from LPS disagree with the statement whereas around 36% of learners from HPS disagree. Of learners from LPS around 26%

support the statement compared to around 19% of learners from HPS. It appears that learners from LPS are significantly more dependent on extra support. It seems that they want to justify their failure through external reasons, more so than learners from HPS. The effect size is small, suggesting that this result has little practical value.

Figure 5.7.5: Percentages of learners of high-performing schools and low-performing schools that disagree with the statement



Learners do not practise mathematics with their classmates

Results for this item are presented in Table 5.7.6.

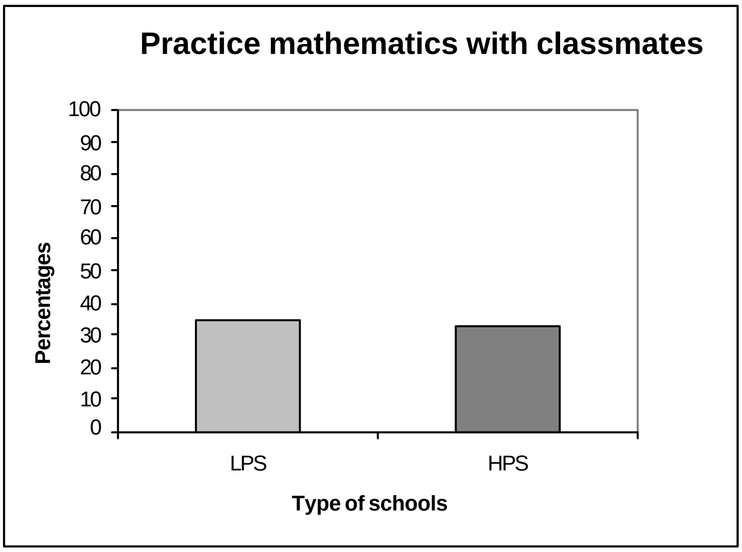
Table 5.7.6: Comparison between HPS and LPS with regard to learners perceiving no practising with classmates as cause for poor performance

		LPS	HPS	*p*-value
Item 50 "Learners perform poorly in mathematics because they do not practise math with their classmates."	Agree	35.32	33.33	0.0190
	Neutral	51.83	42.55	
	Disagree	12.84	24.11	

Effect size: 0.1486 (Small effect size)

The percentages of students from both HPS and LPS that agree with the statement are very similar (around 35% and 33% respectively). The significant difference ($p = 0.0190$) lies in the percentages of students that disagree. Almost twice as many students from HPS than students from LPS disagree with the statement (24% compared to almost 13%). Yet these percentages are not high and it would be rash to make conclusions on grounds of these figures alone. The finding is that about a third of both groups agree that a lack of practising with classmates is a reason for poor performance. The effect size is small, suggesting that this result has little practical value.

Figure 5.7.6: Percentages of learners of high-performing schools and low-performing schools that agree with the statement



5.7.2 Items for which the difference was almost significant

No respect for teachers

For this item the difference between learners from HPS and LPS as almost significant. The details are listed in Table 5.7.6.

Table 5.7.6: Comparison between HPS and LPS with regard to learners perceiving no practising with classmates as cause for poor performance

		LPS	HPS	*p*-value
Item 44 "Learners perform poorly in mathematics because they do not respect their teachers."	Always	14.16	20.00	0.0890
	Sometimes	54.34	42.86	
	Never	31.51	37.14	

Effect size: 0.1161 (Small effect size)

No significant difference could be identified between HPS and LPS. What is of interest is that so few students feel that poor performance is due to disrespect for teachers (around 14% and 20% respectively), a pleasing result. Around a third of both groups of students feel the reason for poor performance lies elsewhere and is not due to lack of respect for teachers. The effect size is small, suggesting that this result has little practical value.

5.7.3 Items for which the difference was not significant

Items for which the difference in opinion between learners from HPS and learners from LPS was not significant are listed in Table 5.7.7.

Table 5.7.7: Items for which the difference was not significant

		LPS	HPS	*p*-value	*w*-value
Item 41 "Learners perform poorly in mathematics because they are not mathematically talented."	Always	10.55	15.71	0.2581	0.0870
	Sometimes	48.17	41.43		
	Never	41.28	42.86		
Item 42 "Learners perform poorly in mathematics because they do not know the career they will follow after Grade 12."	Always	17.81	19.57	0.4707	0.0650
	Sometimes	52.97	46.38		
	Never	29.22	34.06		
Item 45 "Learners perform poorly in mathematics because they do not	Always	29.09	29.79		0.0885

attend extra classes.”	Somet imes	54.09	46.81	0.2435	
	Never	16.82	23.40		
Item 48 “Learners perform poorly in mathematics because they do not feel respected and connected with their teacher.”	Always	20.00	25.00	0.1116	0.1104
	Sometimes	49.09	37.86		
	Never	30.91	37.14		
Item 51 “Learners perform poorly in mathematics because they do not have a strong background in mathematics.”	Always	22.27	28.78	0.1098	0.1109
	Sometimes	52.27	41.01		
	Never	25.45	30.22		

No significant differences were identified for any of these items. What is notable from the results of these items are the low percentages of agreement in general. The highest percentages (around 30%) occurred for the item on attending extra classes, a finding that was noted earlier (Item 30) where learners from LPS felt they did not attend extra classes regularly enough. The highest percentages occur in the Neutral category which is an indication that students do not really know what the reasons for poor performance are, no single reason stands out. The truth is probably that all the possible reasons combine to result in poor performance.

5.7.4 Précis of findings

- Learners from LPS are significantly more dependent on extra support and want to justify their failure through external reasons, more so than learners from HPS.
- Learners from LPS feel that the reason for poor performance lies elsewhere. They are probably experiencing external pressure for improved performance from the media, perhaps from the school itself although this pressure is clearly not resulting in better performance.
- It is clear that learners have confidence in their teachers and this is particularly true for learners from HPS.

- Learners from HPS clearly experience large classes more as a detriment for performance.

5.7.5 Learners' most important cause for poor performance

In this category learners were also asked to indicate the most important reason (from a given list) in their opinion, for poor performance in mathematics. The results are reflected in Table 5.7.8.

Table 5.7.8: Comparison between HPS and LPS with regard to learners' perception as the most important cause for poor performance (given as percentages of the column total)

Item 38 **"Which of the reasons do you regard as the most important cause for poor performance in mathematics?"**	LPS	HPS	Total	Percentage
Too many learners in a class	2.25 (5)	3.57 (5)	10	2.76
Not mathematically talented	5.41 (12)	3.57 (5)	17	4.70
Uncertainty about future career	10.81 (24)	11.43 (16)	40	11.05
Uneducated parents	0 (0)	3.57 (5)	5	1.38
No respect for teachers	6.31 (14)	6.43 (9)	23	6.35
Not attending extra classes	7.66 (17)	10.71 (15)	32	8.84
Underqualified teachers	11.26 (25)	4.29 (6)	31	8.56
Not expected to perform well	0.90 (2)	2.86 (4)	6	1.67
Not respected by the teacher	7.21 (16)	5.00 (7)	23	6.35

No extra support available	7.66 (17)	4.29 (6)	23	6.35
No collaboration with classmates	22.52 (50)	26.43 (37)	87	24.04
Poor background in mathematics	18.02 (40)	17.86 (25)	65	17.96
TOTAL	222	140	362	100

A comparison of high-achieving schools and low-achieving schools in Table 5.7.8 on the most important cause for poor performance in mathematics found that learners from high-achieving schools put more emphasis than those from low-achieving schools on factors directly within their control, such as collaboration with classmates, class attendance, respect for teachers and certainty about their future career whereas learners from low-achieving schools placed more emphasis than high-achieving schools on those factors of which many are polar opposites of those found in HPS and are not under their control, such as extra support, respect by the teachers, mathematical talent, underqualified teachers and mathematical background.

It is therefore interesting that the majority of respondents in this section generally viewed the most significant drawback in doing well in mathematics as lack of collaboration with classmates, the strand that was picked up earlier (Items 31) where learners from both LPS and HPS indicated that they work with classmates regularly. This may signify an underlying uncertainty with regard to mathematics teaching that collaboration with classmates facilitates achievements among learners, whether collaboration method is correctly implemented in the classroom is still a question to be answered.

5.8 SUMMARY ON CHAPTER FINDINGS

In a comparison of high-achieving schools and low-achieving school learners' perceptions, several differences were found. The majority of the learners from both HPS and LPS indicated positive perception of their teachers. What emerges is the realisation that the blame for poor performance does not lie in the attitude of the teachers. However, high percentages of learners from HPS feel that they have to work hard and it is important to do well in mathematics. In this regard the analysis of the questionnaire identified the following factors that facilitate achievement in mathematics as mostly shared among the learners from HPS.

- High learners' achievements, irrespective of education level and parental involvement.
- Peers who motivates other learners for best achievement in mathematics.
- Strong learner accountability in school work.
- A strong and determined attitude among learners that they can and will achieve after hard work.
- High level of mutual respect between teachers and learners and dedication to mathematics work.

The data in this study suggest that even though learners from these ten rural schools were similar in their home and school background, dissimilar factors for success were evident on the following:

- learners' commitment;
- learners' attitudes and self-concept;
- learners' career prospects;
- learners' perceptions of peers and teachers.

In Chapter 6, I will provide, discuss and contextualise the results of the teacher investigation.

CHAPTER 6

ANALYSIS AND INTERPRETATION OF QUANTITATIVE DATA: RESPONSES FROM TEACHERS

6.1 INTRODUCTION

Chapter 5 dealt with analysis and interpretation of quantitative data with respect to responses from learners. Likewise, in this chapter I will present and discuss the information gathered from the teacher questionnaires. The responses were given on a three point Likert scale with a score of 1 (depending on the nature of the question) representing either Regularly, Agree or Always, a score of 2 representing either Occasionally, Neutral or Sometimes and a score of 3 corresponding to either Never or Disagree. The development of the items in the teacher questionnaire was based on classroom observations, focus group interviews and the literature review as reported upon in chapter 4. The statistical information in this chapter was derived from a sample of 26 teachers purposely selected from 26 schools (including the 10 schools used in the quantitative part of the study). These schools include ten schools which were used during qualitative research comprising five high-performing schools and five low-performing schools in mathematics. There were six teachers from high-performing schools and twenty from low-performing schools. No statistical tests were used in this chapter and the analysis of teacher responses is descriptive because of the small sample.

Questions were structured to probe for factors that facilitate achievement in mathematics. The questions were categorised as follows for gaining information under the following headings:

- A Teachers' commitment
- B Teachers' attitude and self-concept
- C Teachers' perceptions of and interaction with learners
- D Teachers' instructional methods
- E Teachers' perceived causes for poor performance in mathematics.

The item numbers that relate to each of the five categories are given in Table 6.1 below.

Table 6.1 Distribution of items into categories

Category	Number of items	Item numbers in the questionnaire
A. Commitment	10	7, 9, 11, 12, 13, 14, 15, 16, 27, 52
B. Attitude and self-concept	7	17, 18, 19, 21, 22, 24, 51
C. Perceptions of and interaction with learners	6	20, 28, 41, 42, 43, 50
D. Instructional methods	8	23, 25, 26, 45, 46, 47, 48, 49
E. Perceived causes for poor performance in mathematics	13	65, 66, 67, 68, 69 ,70 ,71, 72, 73, 74, 75, 76, 77

6.2 TEACHERS' REPONSES TO THE QUESTIONNAIRE

6.2.1 Category A: Teacher commitment

The aim of this section was to establish how committed and serious teachers were in their personal and learners' development in mathematics. Teacher's personal development in mathematics is assumed to improve their efficacy in teaching (Stigler & Hiebert, 1999).

Table 6.2.1 Teacher commitment

	HPS	LPS

Item 7 Attend any college/university course in mathematics	Yes	83.3	55
	No	16.7	45
Item 9 Attend any college/university course on the teaching of mathematics	Yes	66.7	35
	No	33.3	65
Item 11 Observe other teachers teaching mathematics	Yes	50	65
	No	50	35
Item 12 Meet with a local group of teachers to study/discuss mathematics teaching issues	Yes	83.3	85
	No	16.7	15
Item 13 Attend a workshop on mathematics teaching	Yes	100	90
	No	0	10
Item 14 Serve as a mentor and /or peer coach in mathematics teaching for other teachers	Yes	50	52.7
	No	50	47.4
Item 15 Attend any mathematics teacher professional association meetings	Yes	66.7	47.4
	No	33.3	52.6
Item 16 Invite guest speakers or organised field trips relevant to the mathematics taught in class	Yes	33.3	30
	No	66.7	70
Item 27 Involve parents in the mathematics education of their children	Regularly	16.7	5
	Occasionally	66.7	65
	Never	16.7	30
Item 52 Assist learners after normal class	Always	66.7	50
	Sometimes	33.3	50
	Never	0	0

I now analyse and discuss the results for individual items.

Attending courses on mathematics		HPS	LPS
Item 7 Attend any college/university course in mathematics	Yes	83.3	55
	No	16.7	45

From the data it seems that teachers from high-performing schools attend college/university mathematics courses more than teachers from low-performing schools. In this regard around 83% of teachers from high-performing schools indicate attendance in comparison to 55% of teachers from low-performing schools. It is pleasing to see that even for low-performing schools more than half the teachers attend college or university mathematics courses. There seems to be a culture of attending college or university mathematics courses for personal improvement in the subject, to a greater extent in high-performing schools than in low-performing schools. It should be noted that this question could have caused confusion as it may not have been understood as attending courses after their initial training as was the intention.

Attending courses on teaching mathematics		HPS	LPS
Item 9 Attended any college/university course on the teaching of mathematics	Yes	66.7	35
	No	33.3	65

It is also clear that teachers from high-performing schools attend college/university mathematics teaching courses more regularly than teachers from low-performing schools. In this regard around 67% of teachers from high-performing schools indicate regular attendance in comparison to 35% of teachers from low-performing schools. Almost two thirds of teachers from low-performing schools do not attend mathematics teaching courses, denying themselves an opportunity to grow in this regard. An interpretation of this finding is that teachers from high-performing schools are more likely to improve their teaching skills than teachers from low-performing schools.

Observing other teachers teaching mathematics		HPS	LPS
Item 11 Observe other teachers teaching mathematics	Yes	50	65
	No	50	35

When the teachers were asked about whether they observe other teachers teaching mathematics, more teachers from low-performing schools (65%) responded positively compared to only half the teachers from high-performing schools. This is somewhat surprising but could perhaps be interpreted that teachers from high-performing schools consider themselves more competent than their colleagues and that they do not feel the need to observe their colleagues in action. Teachers from low-performing schools clearly experience this need as more important and they seem to realise that they need more exposure to good teaching strategies.

Local group meetings of teachers		HPS	LPS
Item 12 Meet with a local group of teachers to study/discuss mathematics teaching issues	Yes	83.3	85
	No	16.7	15

In this question the percentage difference in the responses was very small. Most teachers from both high-performing and low-performing schools seem to meet with other teachers to discuss mathematics teaching issues on a regular basis. It could be that teachers interpreted this question as asking about attendance of workshops organised by the department in preparation for the new curriculum.

Mentor for other teachers		HPS	LPS
Item 14 Serve as a mentor and / or peer coach in mathematics teaching for other teachers	Yes	50	52.6
	No	50	47.4

There is no noticeable difference between teachers from high or low-performing schools in this regard. This data is interesting as it shows that poor performing schools make no less an effort to provide fellow teachers with advice and coaching. Yet the effort seems to be wasted as the poor performances of these schools indicate.

Attending meetings of a mathematics teacher professional association		HPS	LPS
Item 15 Attend any mathematics teacher professional association meetings	Yes	66.7	47.4
	No	33.3	52.6

A comparison of teachers from high-performing schools and low-performing schools on teachers' attendance of mathematics teacher professional association meetings reveals that teachers from high-performing schools attend such meetings more regularly than their counterparts from low-performing schools. Percentage wise, around 67% of teachers from high-performing schools indicate that they attend meetings of mathematics professional associations compared to around 47% of the teachers from low-performing schools. This data indicates that teachers from high-performing schools feel themselves more part of the bigger community of mathematics teachers.

Inviting guest speakers or organising field trips		HPS	LPS
Item 16 Invite guest speakers or organised field trips relevant to the mathematics taught in class	Yes	33.3	30
	No	66.7	70

In both cases, for teachers from high-performing schools and from low-performing schools, low percentages responded positively with regard to this issue (around 33% and 30%). Again there is no significant difference between responses from high and low-performing schools. There apparently does not exist a culture of inviting guest speakers or organising field trips in either of the two groups, perhaps because most teachers did not know of relevant places to take learners to or did not regard this as being worthwhile.

Involving parents in the mathematics education of their children		HPS	LPS
Item 27 Involve parents in the mathematics education of their children	Regularly	16.7	5
	Occasionally	66.7	65
	Never	16.7	30

It is clear that teachers do not involve parents on a regular basis in the mathematics education of their children in either low-performing schools or high-performing schools. It is notable and commendable that a large percentage of teachers do occasionally involve parents in the education of their parents (around 67% in high-performing schools and 65% in low-performing schools). It is also noticeable that there is no real difference between HPS and LPS in this respect.

Assisting learners after normal class		HPS	LPS
Item 52 Assist learners after normal class	Always	66.7	50
	Sometimes	33.3	50
	Never	0	0

In terms of assisting learners after normal class around 67% of teachers from high-performing schools indicate that they assist learners in this regard whereas a lower percentage of around 50% of teachers from low-performing schools agree. Teachers from high-performing schools seem to put in extra effort to help learners to develop better understanding of the subject.

Précis of findings

In the majority of the items in this section teachers from high-performing schools seem to outperform the teachers from low-performing schools. The data seem to indicate that teachers from high-performing schools put more effort into their teaching than teachers from low-performing schools with respect to the following activities:

- Attendance of meetings of mathematics professional associations
- Attending college/university courses on the teaching of mathematics
- Assisting learners even after normal class
- Attending college/university courses in mathematics.

These findings seem to indicate that teachers from high-performing schools have more commitment to their profession as mathematics teachers compared to teachers from low-performing schools.

6.2.2 Category B: Teacher attitude and self-concept

In these questions teachers were required to indicate their attitudes towards learners and to present mathematics at grade twelve level. The aim of this section was to establish their attitude towards mathematics and their confidence in presenting mathematics at grade twelve level. This section was included because teachers' confidence has been identified as a factor working positively towards mathematics achievement (Stigler & Hiebert, 1999).

Table 6.2.2 Teacher attitude and self-concept

		HPS	LPS
Item 17 I am able to make connections between mathematics and other disciplines	Agree	50	63.2
	Neutral	50	26.3
	Disagree	0	10.5
Item 18 Additional mathematics textbooks as instructional tools are necessary	Agree	66.7	100
	Neutral	33.3	0
	Disagree	0	0
Item 19 I can deal with learners who are not doing well in my class	Agree	83.3	65
	Neutral	16.7	30
	Disagree	0	5
Item 21 I enjoy teaching mathematics	Agree	100	95
	Neutral	0	0
	Disagree	0	5
Item 22 I am able to connect the mathematics I teach with the tertiary mathematics that I studied	Agree	100	85
	Neutral	0	15
	Disagree	0	0
Item 24 I feel confident to teach Grade 12 learners	Agree	83.3	95
	Neutral	16.7	5
	Disagree	0	0

Item 51 I make special provision for learners who are not doing well in my class	Always	33.3	35
	Sometimes	66.7	65
	Never	0	0

I subsequently analyse and discuss the results of individual items.

Ability to make connections between mathematics and other disciplines		HPS	LPS
Item 17 I am able to make connections between mathematics and other disciplines	Agree	50	63.2
	Neutral	50	26.3
	Disagree	0	10.5

In terms of the ability to make connections between mathematics and other disciplines, 50% of teachers from high-performing schools indicated that they were able to make connections between mathematics and other disciplines, while about 63% of respondents from low-performing schools responded positively. This finding is surprising and indicates that teachers from LPS do not feel themselves under equipped for positioning mathematics within a wider frame of knowledge. Yet they do not succeed in using this knowledge for motivating their students for higher performance.

Need for additional mathematics textbooks		HPS	LPS
Item 18 Additional mathematics textbooks as instructional tools are necessary	Agree	66.7	100
	Neutral	33.3	0
	Disagree	0	0

Asked if additional mathematics textbooks as instructional tools are necessary, all teachers from low-performing schools responded positively whereas 67% of teachers from high-performing schools agree. This finding could point to a lack of textbooks in LPS. The fact that there are no teachers who feel neutral about or disagree with this matter shows how strongly teachers from LPS feel about needing more textbooks.

Dealing with learners who are not doing well		HPS	LPS
Item 19 I can deal with learners who are not doing well in my class	Agree	83.3	65
	Neutral	16.7	30
	Disagree	0	5

About 83% of teachers from high-performing schools indicated that they felt themselves able to deal with the problems of learners who were not doing well in their classes compared to only 65% of teachers from low-performing schools. It is interesting that a substantial portion of the respondents from low-performing schools felt themselves incapable of providing for the needs of learners who were not doing well in their classes.

Enjoy teaching mathematics		HPS	LPS
Item 21 I enjoy teaching mathematics	Agree	100	95
	Neutral	0	0
	Disagree	0	5

All the teachers from high-performing schools and 95% of the teachers from the low-performing schools indicated that they enjoyed teaching mathematics. This finding is both surprising and pleasing. Teachers from LPS feel happy with their career choice, despite the low performance of students. These teachers enjoy what they do and the reason for poor performance cannot be ascribed to a lack of enthusiasm by the teachers.

Connecting school mathematics with tertiary mathematics	HPS	LPS

Item 22 I am able to connect the mathematics I teach with the tertiary mathematics that I studied	Agree	100	85
	Neutral	0	15
	Disagree	0	0

All teachers from high-performing schools and 85% of the teachers from low-performing schools seem to agree with the fact that they are able to connect the mathematics they teach with the tertiary mathematics that they studied. Teachers from both groups are confident of their abilities in mathematics and it becomes evident that teachers from LPS feel themselves equipped for the job and that the blame for learners' poor performance cannot be laid at their door.

Confidence		HPS	LPS
Item 24 I feel confident to teach Grade 12 learners	Agree	83.3	95
	Neutral	16.7	5
	Disagree	0	0

A large number of teachers from both HPS and LPS indicated that they feel confident to teach Grade 12 learners. Their responses were around 83% and 95% for HPS and LPS respectively. This finding supports the train of thought developed in the previous paragraph that teachers feel themselves competent to teach and do not accept that the blame for poor performance is due to a lack of competence by them. Yet it remains interesting that only 65% of these teachers from LPS indicated that they were able to deal with learners who were not doing well in their classes (see Item 19 analysis).

Special provision for learners who are not doing well	HPS	LPS

Item 51 I make special provision for learners who are not doing well in my class	Always	33.3	35
	Sometimes	66.7	65
	Never	0	0

In response to this question the majority of teachers from both low and high-performing schools indicated that they only sometimes make special provision for learners who are not doing well in their classes. There is no significant difference between teachers from low and high-performing schools regarding this issue. Making provision for students who are not performing well is perhaps less of an issue in HPS but should be a matter of urgent attention for LPS.

Précis of findings

With regard to attitude and self-concept, teachers from both high-performing and low-performing schools see themselves as competent teachers who can connect their mathematics knowledge to other disciplines and who are confident of their ability to teach grade twelve students. It seems that teachers from LPS do not feel that they are to blame for the poor performance of students.

There is a difference between teachers from HPS and LPS in that teachers from HPS report more strongly on their

- Ability to connect the mathematics they teach with the tertiary mathematics that they studied.
- Ability to deal with learners who are not doing well in their mathematics classes.

A significant finding is that teachers from low-performing schools feel stronger about the need for additional mathematics textbooks as instructional tools.

6.2.3 Category C: Teacher perceptions of learners and interaction with learners

The aim of this section was to explore whether teachers regard learners as capable of learning mathematics and to investigate teachers' relationship with mathematics learners.

Table 6.2.3 Perceptions of learners and interaction with learners

		HPS	LPS
Item 20 Learners learn mathematics best in classes with learners of similar abilities	Agree	66.7	50
	Neutral	16.7	10
	Disagree	16.7	40
Item 28 Advise learners about job opportunities in mathematics, science and technology	Regularly	83.3	70
	Occasionally	16.7	30
	Never	0	0
Item 41 Pose open-ended questions	Always	33.3	42.1
	Sometimes	66.7	47.7
	Never	0	10.5
Item 42 Engage the whole class in discussion	Always	33.3	45
	Sometimes	66.7	55
	Never	0	0
Item 43 Require learners to explain their reasoning	Always	83.3	70
	Sometimes	16.7	30
	Never	0	0
Item 50 Make separate presentations to HG and SG learners	Always	0	30
	Sometimes	50	40
	Never	50	30

I subsequently analyse and discuss the results for individual items.

Classes with learners of similar abilities		HPS	LPS
Item 20 Learners learn mathematics best in classes with learners of similar abilities	Agree	66.7	50
	Neutral	16.7	10
	Disagree	16.7	40

It is clear from the data that more teachers from high-performing schools than teachers from low-performing schools believe that learners learn mathematics best in classes with learners of similar abilities - around 67% of teachers from high-performing schools agreed with this statement compared to 50% of teachers from low-performing schools. The reason for this opinion may be that the majority of learners in high-performing schools are encouraged to register for mathematics at higher grade level rather than at standard grade level. Secondly, in most of the high-performing schools learners are grouped according to their level of academic performance to encourage competition among them, as indicated in Chapter 4.

Advice to learners about job opportunities		HPS	LPS
Item 28 Advise learners about job opportunities in mathematics, science and technology	Regularly	83.3	70
	Occasionally	16.7	30
	Never	0	0

With regard to advising learners about job opportunities in mathematics, science and technology, teachers from high-performing schools seem to do this slightly more often than teachers from low-performing schools (83% compared to 70%). This finding could imply that teachers from low-performing schools need more assistance on mathematics career guidance than the teachers from high-performing schools.

Open-ended questions		HPS	LPS
Item 41 Pose open-ended questions	Always	33.3	42.1
	Sometimes	66.7	47.7
	Never	0	10.5

With regard to posing open-ended questions to learners, teachers from both low and high-performing schools seem to be lacking. The fact that in the low-performing schools this activity seems to be employed more frequently is unexpected. A fairly large (67%) percentage of teachers from high-performing schools employ this way of posing questions only sometimes, but this practice is clearly part of the teaching culture as no one attests to never doing this, whereas this practice does not seem to be quite so ingrained in the LPS.

Class discussion		HPS	LPS
Item 42 Engage the whole class in discussion	Always	33.3	45
	Sometimes	66.7	55
	Never	0	0

Engaging the class in discussion seems to be a reasonably common practice in both LPS and HPS with everyone doing it sometimes or always. This particular question was perhaps not formulated well because involving the *whole* class in discussion can be difficult, especially if the class is large whereas involving one or two individuals in a discussion is easier and more practical. It is clear that there is no difference of note between LPS and HPS.

Explanation of reasoning		HPS	LPS
Item 43 Require learners to explain their reasoning	Always	83.3	70
	Sometimes	16.7	30
	Never	0	0

It seems that teachers from both HPS and LPS put a premium on requiring from learners to explain their reasoning, as 83% and 70%, respectively, testify to doing this always. There is a slight leaning towards HPS doing this more regularly. The notion that teachers from both HPS and LPS feel they do their best to engage and stimulate learners is strengthened by the responses to this question.

Higher and standard grade learners		HPS	LPS
Item 50 Make separate presentations to higher and standard grade learners	Always	0	30
	Sometimes	50	40
	Never	50	30

In this item none of the respondents from high-performing schools indicated that they make separate presentations to higher and standard grade learners. The reason for this might be that in high-performing schools higher and standard grade learners will be in separate classes and consequently separate presentations are not necessary. It is also true that higher performing schools encourage their learners to register for mathematics on higher grade level rather than on standard grade whereas learners from low-performing schools are often encouraged to register for mathematics on standard grade level.

Précis of findings

With respect to teachers' perceptions of learners and teachers' interaction with learners, teachers from high-performing and low-performing schools show some differences.

Teachers from high-performing schools surpass teachers from low-performing schools in the following items:

- Their view that learners learn mathematics best in classes with learners of similar abilities.
- They require learners to explain their reasoning in mathematics classes.
- They advise learners about job opportunities in mathematics, science and technology.
- They encourage learners to register mathematics at the higher rather than standard grade.

6.2.4 Category D: Teachers' instructional methods

The purpose of this section was to find out more about teachers' understanding of how grade twelve learners learn best and how mathematics is taught best. Teachers were required to indicate their skills and preferred method regarding mathematics instruction.

Table 6.2.4 Instructional methods

		HPS	LPS
Item 23 Letting learners criticise / evaluate their own or other learners' homework is advisable	Always	83.3	80
	Sometimes	16.7	15
	Never	0	5
Item 25 Take learners' prior understanding into account when planning a lesson	Always	100	75
	Sometimes	0	20
	Never	0	5
Item 26 Cover all mathematical concepts in the syllabus	Always	83.3	60
	Sometimes	16.7	30
	Never	0	10

Item 45 Ask learners to explain concepts to one another	Always	50	45
	Sometimes	50	50
	Never	0	5
Item 46 Ask learners to seek alternative methods for solutions	Always	66.7	65
	Sometimes	33.3	35
	Never	0	0
Item 47 Assign mathematics homework	Always	83.3	95
	Sometimes	16.7	5
	Never	0	0
Item 48 Encourage learners to work in groups	Always	83.3	75
	Sometimes	16.7	25
	Never	0	0
Item 49 Review homework assignments	Always	83.3	73.7
	Sometimes	16.7	21.1
	Never	0	5.3

I subsequently analyse and discuss the results for individual items.

Learners evaluating their own or other learners' work		HPS	LPS
Item 23 Letting learners criticise /evaluate their own or other learners' homework is advisable	Always	83.3	80
	Sometimes	16.7	15
	Never	0	5

On letting learners criticise /evaluate their own or other learners' homework, the majority of teachers in both categories of schools always seem to allow learners to do it. The reason might be that it reduces the burden of marking learners' assignments. This is particularly helpful when dealing with large classes which are mostly the norm in disadvantaged schools.

Prior understanding		HPS	LPS
Item 25 Take learners' prior understanding into account when planning a lesson	Always	100	75
	Sometimes	0	20
	Never	0	5

All teachers from high-performing schools claim to take learners' prior understanding into account when planning a lesson whereas 75% of teachers from low-performing schools claim to do so. A small percentage of teachers from low-performing schools confess to never taking learners' prior understanding into account, which is a worrying aspect.

Covering the syllabus		HPS	LPS
Item 26 Cover all mathematical concepts in the syllabus	Always	83.3	60
	Sometimes	16.7	30
	Never	0	10

Only 60% of the teachers from low-performing schools always finish the mathematics syllabus whereas around 83% of teachers from high-performing schools cover all mathematical concepts in the syllabus. This would mean most teachers from high-performing schools put more effort into their teaching and make sure that they finish the syllabus in time. It may also mean that some of the topics are experienced as difficult by teachers from low-performing schools and take more time for them to complete.

Learners explaining to one another		HPS	LPS
Item 45 Ask learners to explain concepts to one another	Always	50	45
	Sometimes	50	50
	Never	0	5

With respect to asking learners to explain concepts to one another only about half of the teachers from both high-performing schools and low-performing schools require their learners to do so. It is also interesting to note that, although 83% (HPS) and 75% (LPS) of the teachers acknowledge the importance of group work (see below), only 50% (HPS) and 45% (LPS) ask learners to explain concepts to one another which could be considered as part of group work activities for mathematics.

Alternative solutions		HPS	LPS
Item 46 Ask learners to seek alternative methods for solutions	Always	66.7	65
	Sometimes	33.3	35
	Never	0	0

In terms of asking learners to seek alternative methods for their mathematical solutions around 67% and 65% of teachers from high and low-performing schools, respectively, responded positively with respect to this statement. This does not indicate any significant difference.

Homework		HPS	LPS
Item 47 Assign mathematics homework	Always	83.3	95
	Sometimes	16.7	5
	Never	0	0

Around 83% of teachers from high-performing schools assign mathematics homework to learners whereas 95% of teachers from LPS do. Although the majority of teachers assign homework tasks to learners, and particularly from low-performing schools, it was clear from learner data analysis in Chapter 4 that more learners from low-performing schools do not undertake these tasks.

Group-work		HPS	LPS
Item 48 Encourage learners to work in groups	Always	83.3	75
	Sometimes	16.7	25
	Never	0	0

With respect to encouraging learners to work in groups, teachers from both categories perceived themselves as seemingly competent. This finding is interesting since in the classrooms that I observed (reported in Chapter 4), there were very few opportunities in low-performing schools to work in groups. From this conflicting evidence, it appears as if teachers (in particular for low-performing schools) know what they are supposed to be doing (and claim that they do) but that this does not necessarily realise in the classroom.

Review homework		HPS	LPS
Item 49 Review homework assignments	Always	83.3	73.7
	Sometimes	16.7	21.1
	Never	0	5.3

In terms of reviewing homework assignments there is no significant difference between the groups – teachers from both high and low-performing schools claim that they do review homework assignments most of the time.

Précis of findings

With regard to the teachers' instructional methods, teachers from high-performing and low-performing schools do not show much difference. Teachers from high-performing schools excel in the following items:

- Ability to cover all mathematical concepts in the syllabus.
- Ability to take learners' prior understanding into account when planning a lesson.

On the other hand, teachers from low-performing schools are more active in assigning mathematics homework.

6.2.5 Category E: Perceived causes of poor performance in mathematics

In this category, teachers were asked to indicate the most important reason (from a given list) in their opinion, for poor performance in mathematics. The results are reflected in Table 6.2.5.

Table 6.2.5: Comparison between HPS and LPS with regard to teachers' perception of the most important cause for poor performance (given as percentages of the column total)

"Which of the reasons do you regard as the most important cause for poor performance in mathematics?"	HPS	LPS	Total	Percentage
Too many learners in a class	0.00 (0)	10.00 (2)	2	7.7
Not mathematically talented	0.00 (0)	0.00 (0)	0	0.0
Uncertainty about future career	0.00 (0)	10.00 (2)	2	7.7
Uneducated parents	0.00 (0)	0.00 (0)	0	0.0
No respect for teachers	16.67 (1)	20.00 (4)	5	19.2
Not attending extra classes	0.00 (0)	10.00 (2)	2	7.7
Underqualified teachers	16.67 (1)	5.00 (1)	2	7.7
Not expected to perform well	0.00 (0)	5.00 (1)	1	3.8
Not respected by the teacher	0.00 (0)	0.00 (0)	0	0.0
No extra support available	0.00 (0)	5.00 (1)	1	3.8
No collaboration with classmates	66.67 (4)	25.00 (5)	8	30.8
Poor background in mathematics	16.67 (1)	20.00 (4)	5	19.2
Principal is not supportive	0.00 (0)	5.00 (1)	1	3.8
TOTAL	6	20	26	100

Précis of findings

The three main reasons given for poor performance overall are:

- *No respect for teachers*

  Having no respect for teachers clearly is problematic. Lack of respect as reason for poor performance has not emerged in the study until now. This finding is enlightening.

- *No collaboration between classmates*

  Although teachers overwhelmingly reported that they encourage group work (see section 6.2.4) a different perspective is given here. No collaboration is mentioned as the single most important reason for poor performance. This reason was given by an overwhelming 67% of teachers from high-performing schools and 25% of low-performing schools.

- *Poor background in mathematics*

  Poor background in mathematics is also perceived as problematic, by both high- and low-performing schools. This finding is understandably of importance but not surprising.

6.3 TEACHERS' RESPONSES TO OPEN ENDED QUESTIONS

In items 19, 20, 21 and 22, teachers were asked to respond to the following four questions:

- State the three most important factors that contribute to learners' good performance in mathematics in your opinion.
- State the three most important factors that contribute to learners' poor performance in mathematics in your opinion.
- How do you motivate your learners in mathematics?
- Does the principal support you in your mathematics teaching? Describe briefly.

What follows is a report on teacher responses to the four questions. Their responses were grouped into categories. Since teachers responded with three reasons for each question, the percentages do not ad up to 100%.

6.3.1 Summary of responses on factors contributing to good achievement in mathematics

The responses to the item "State the three most important factors that contribute to learners' good performance in mathematics in your opinion", are reflected in Table 6.3.1.1 and Table 6.3.1.2

Table 6.3.1.1 Summary of responses to factors contributing to good achievement in mathematics in low-performing schools

	Teacher number
• Motivation • More work • Encouragement to practise always	**T1**
• Regular practice • Afternoon classes • Group discussions	**T2**
• Love of the subject • Good attitude • Regular practice	**T3**
• Regular practice • Asking questions when not understanding • Group work	**T4**
• Career influence • Ability and interest in the subject • Encouragement	**T6**
• Group work with classmates • Parental involvement • Competition among learners	**T7**
• Interest in the subject • Career influence • Learner ability and discipline	**T10**
• Group work • Alternative solution to problems • Learner own pace	**T13**
• Enough teaching time • Learner motivation • Facilities	**T14**
• Regular class attendance • Regular homework • Asking questions in class	**T15**
• Love for mathematics(interest) • Always practising procedures • Teacher respect	**T16**

• Regular practice • Class participation • More reference material	**T17**
• Interest in the subject • Regular practice • Teacher respect	**T18**
• Regular practice • Interest in the subject • Asking questions in class	**T20**
• Regular practice • Asking questions in the class • Group work	**T21**
• Hard work and discipline • Learner motivation • Knowing the basics	**T22**
• Regular practice • Attitude to subject and educator • Maths is for the selected few	**T23**
• Regular practice • Practising more problems • Disciplined learners	**T24**
• Attending regularly • Learner motivation • Teacher dedication and extra classes	**T25**
• Regular practice • Buying text books for more practice • Attitude towards the subject and the teacher	**T26**

Table 6.3.1.2 Summary of responses on factors contributing to good achievement in mathematics in high-performing schools

• Motivation • Proper guidance • Regular practice	**T5**
• Regular practice and extra classes • Homework completion • Regular testing	**T8**
• Intrinsic motivation • Career influence • Good and dedicated teachers	**T9**
• Learner motivation • More work and regular practice • Learner encouragement	**T11**
• Group work • Provision for slow learners • Competition among learners	**T12**

• Hard work • Group work • Asking questions in the class	**T19**

Commonalities

Generally all the teachers, both from high and low-performing schools mentioned that they would like learners to be more motivated. Regular work by learners was also mentioned by almost all teachers as a reason for achievement. Yet regular practice was not evident in low-performing schools as teachers from such schools indicated that their learners come to class without having done their mathematics homework (reported on in Chapter 4). Teachers from both high and low-performing schools also mentioned learners' working in groups as a factor contributing to good achievement. Yet again it was clear that in low-performing schools, group work was not generally performed (see Chapter 4).

Differences

Although there does not seem much difference between what teachers from high and teachers from low-performing schools see as factors contributing to good achievement in mathematics, teachers from low-performing schools mention factors that indicate problematic areas. Factors such as an interest and love of mathematics, respect for the teacher, disciplined learners, attitude towards subject and teacher and teacher dedication all seem to point to what these teachers see as lacking in their schools. None of these factors are mentioned in high-performing schools.

6.3.2 Summary of responses to factors contributing to poor achievement in mathematics

The responses to the item, "State the three most important factors that contribute to learners' poor performance in mathematics" are reflected in Table 6.3.2.1 and Table 6.3.2.2

Table 6.3.2.1: Responses to factors contributing to poor performance in low-performing schools

	Teacher number
• Negative attitude • Lack of proper teaching methods • Lazy to do homework and assignments	**T1**
• Poor background in mathematics • Lack of motivation • Truancy	**T2**
• Lazy to practice • Poor background in mathematics • Poor parental involvement	**T3**
• Lack of practice • Negative attitude to the subject and the teacher • Lack of career guidance	**T4**
• Lack of career guidance • Ignorance • Lack of class participation and discussions	**T6**
• Laziness in class • Lack of practice and basics in mathematics • Do not study hard in mathematics	**T7**
• Lack of discipline • Negative attitude and lack of teacher respect • Not working with others	**T10**
• Ill-discipline • Lack of commitment • Teacher state of mind	**T13**
• Laziness • Negative attitude • Not enough practice	**T14**
• Laziness • Fear of mathematics • Low self-esteem	**T15**
• Lazy learners • Poor background in mathematics • Lack of parental involvement	**T16**
• No group work • Do not enjoy mathematics • De-motivation	**T17**
• Lack of practice • Poor background in mathematics • Poor parental involvement	**T18**
• Lazy to do their work • Do not attend classes • Do not have enough time	**T20**

• Peer group off-school activities • Inferiority complex • Lack of discipline even at school	**T21**
• Ignorance • Low self-confidence in mathematics	**T22**
• Lack of resources • Lack of guidance • Poor parental involvement	**T23**
• Lack of motivation • Maths considered as a difficult subject • Lack of practice • Poor teacher preparation • Negative attitude to the subject and homework not controlled • Lack of career guidance	**T24** **T25**
• Homework not controlled regularly • Poor discipline in class • Not giving enough exercises	**T26**

Table 6.3.2.2: Responses to factors contributing to poor performance in high-performing schools

• Undisciplined and lazy learners • Unmotivated learners • Undedicated educators • Teacher negligence of the work • Unqualified teachers in lower grades • Laziness on the part of the teacher	**T5** **T8**
• Lazy to attend classes • Lazy to do class work and homework • Not participating in class and failing to ask questions	**T9**
• Lack of support in extra classes • Lack of learner commitment • Teacher negligence of the work	**T11**
• Negative attitude towards the subject • Lack of practice • Lack of group work	**T12**
• De-motivated learners • Poor teaching methods • Lack of daily practice and career guidance	**T19**

Commonalities

The inferred problem areas are confirmed by responses to this question. Teachers from low and high-performing schools identify a lack of motivation among learners and outright laziness, probably stemming from a lack of motivation, as possible factors contributing to poor performance. It is not to say that learners in high-performing schools suffer from these factors to the same extent as learners from low-performing schools, but both sets of teachers unanimously identify these factors as contributing to poor performance.

Differences

Ill discipline of learners, a lack of resources, poor background in mathematics and poor parental involvement are factors mentioned specifically by teachers from low-performing schools as contributing to poor performance. It is interesting that teacher attitude and behaviour is hardly mentioned at all, almost as if these teachers are reluctant to have the blame come their way. In contrast, teachers from high-performing schools list poor teaching methods, teacher negligence of the work, laziness on the part of the teacher and undedicated educators as definite contributing factors to poor performance. It is important to note that these teachers are in all likelihood not guilty of such conduct and are therefore not afraid to point to these factors as possibly contributing to poor performance.

6.3.3 Summary of responses on how teachers motivate learners in mathematics

The responses to the item "How do you motivate learners in your mathematics class" are reflected in Tables 6.3.3.1 and 6.3.3.2

Table 6.3.3.1 Summary of responses on how educators motivate their learners in mathematics from low-performing schools.

	Teacher number
• Show them that mathematics is easy • Encourage them to be more dedicated • Show them those who made it from their area	**T1**
• Giving prices to learners • Inviting a celebrity from engineering • Having more catch-up programmes	**T2**
• Giving them simple and one complex problem	**T3**
• Show them opportunities requiring mathematics	**T4**

• Showing them the relevance to daily life • Introduce them to role models, former learners who are doing well in mathematics related fields	
• Giving them extra exercises • Career guidance • Helping them after classes	**T6**
• Showing them the benefits of being a mathematician • Encourage them to express him/herself mathematically • By giving them work design from simple to difficult tasks	**T7**
• By telling them about careers • By making them feel special during the lesson • By always being there for them	**T10**
• Making maths practical • Show its importance in careers • Providing mathematics guest speakers	**T13**
• Talk about the value of mathematics in life • Talk about what they are expected to do • Give them rewards for achievements	**T14**
• Organise career orientation for them • Giving them prizes for encouragement • Giving them extra work • Exempting them from doing other work	**T15**
• By telling them about the importance of mathematics • By giving prizes to well-deserving learners • By advising them about job opportunities	**T16**
• Tell them to enjoy mathematics • Practise mathematics regularly • Work in groups	**T17**
• Tell them about the importance of being disciplined • They must learn to be independent • Encouraging them to form groups for discussions	**T18**
• Tell them how to write all steps • Encourage them to work very hard	**T20**
• Presenting my lesson in a non-threatening way • Making them feel confident in the class by not dwelling on their weaknesses • Talk to them about career opportunities in mathematics	**T21**
• Expose them to career opportunities • Take them to different universities to observe • Go an extra mile in helping learners	**T22**
• Giving them guidance before any activity • Giving them projects that involve developed people in mathematics	**T23**
• Talk about the career they want to follow • Discuss job opportunities in mathematics	**T24**
• Showing them the importance of hard work • Mathematics career guidance sessions	**T25**

• Inviting role models in mathematics-related careers for motivation	
• Talk about mathematics as a key to job opportunities • Talk about mathematicians and how wise they were	**T26**

Table 6.3.3.2 Summary of responses on how educators motivate their learners in mathematics from high-performing schools

• Encourage them to ask questions regularly • Talk about advantages of passing mathematics • Best achievers are rewarded	**T5**
• Talk about the many careers available in mathematics • By awarding prizes to best achievers • Supporting learners when they encounter problems	**T8**
• Explain to them about job opportunities • Praise when they do things right • Give gifts to high performers	**T9**
• Show them the importance of mathematics • Tell them about the relevance of mathematics to job opportunities • honouring good work in classes	**T11**
• Tell them to work hard • Tell them about the vast career opportunities in the field of mathematics • Mentioning names of successful people from their community, those who pursued the field of mathematics and are from the same school.	**T12**
• Encourage competition among learners • Show relevancy of mathematics in real life • Invite role models in mathematics-related careers and show them how possible to get solutions to problems	**T19**

Commonalities

In response to a question on motivation strategies, most of the teachers indicated that they introduced their learners to other high achievers in their communities in mathematics. Furthermore they organise career orientation for them and give them extra work and show them the importance of hard work.

Other common factors include:

- Invite role models of people who are successful in mathematics and science careers who graduated from the same schools.
- Praise and award learners
- Engage their learners in conversation about school work
- Encourage learners to study hard and in some cases made arrangements for them to visit institutions of higher learning.

- Talk about mathematics as a key to job opportunities
- Emphasise career guidance in mathematics-related fields.

Differences

The significant observation in this section is that there are no clear differences between responses from teachers of high- and low-performing schools on how to motivate learners.

6.3.4 The principal's contribution to learners' achievement in mathematics

Teachers were asked the question "Does the principal support you in your mathematics teaching? Describe briefly". By posing this question I wanted to determine the role played by the principal in learner's mathematics achievement. In this regard teachers related a number of the principal's supportive actions and problems that impacted on learners' achievement in mathematics. Responses to this question are reflected in Table 6.3.4.1 and Table 6.3.4.2.

Table 6.3.4:1 Principal's contribution to learners' mathematical achievement in low-performing schools

	Teacher number
• Supports partially • Informs us about courses in mathematics • Does not buy material on time	**T1**
• Provides stationary • Helps subsidise field excursion • Provides venue for catch up programmes	**T2**
• No help, he does not know mathematics	**T3**
• Initiates cooperation with other schools • Does not welcome initiatives from the teacher • Arranges additional classes without involving the teacher	**T4**
• Helps with career guidance • Helps with subject choices • Encourages learners to do mathematics	**T6**
• Helps in organising Saturday classes • Invites subject specialist • Encourages exchange programmes with neighbouring schools	**T7**
• Motivates learners regularly • Supportive during field trips	**T10**

• Provides teaching materials	
• Supports partially • Informs us about courses in mathematics • Does not buy material on time	**T13**
• Provides stationary • Helps subsidise field excursion • Provides venue for catch up programmes	**T14**
• No help he does not know mathematics	**T15**
• Initiate cooperation with other schools • Does not welcome initiatives from the teacher • Arranges additional classes without involving the teacher • Supports fanatically for excursion • Helps in organising extra classes • Provides stationary for teaching	**T16** **T17**
• Helps with career guidance • Helps with subject choices • Encourages learners to do mathematics	**T18**
• Helps in disciplining the ill-disciplined learners • Encourages the interaction among maths teachers within the school • Always ready to buy learner support material	**T20**
• Helps in learner motivation • Encourages learners to attend regularly • Makes textbooks available	**T21**
• Motivates learners regularly • Supportive during field trips • Provides teaching materials	**T22**
• Instils discipline in school • Provides learning materials needed • Helps in planning extra classes	**T23**
• Supports partially • Informs us about courses in mathematics • Does not buy material on time; encourages the teachers to attend workshops and courses	**T24**
• Encourages the teachers to attend workshops and courses • Supports educational excursions and extra classes arrangements • Provides teaching and learning materials	**T25**
• Provides stationery • Helps subsidise field excursion • Provides venue for catch-up programmes	**T26**

Table 6.3.4.2 Principal's contribution in learners' mathematical achievement high-performing schools

• Supports fanatically for excursion • Helps in organising extra classes • Provides stationery for teaching	**T5**

• Helps disciplining the ill-disciplined learners • Encourage the interaction among maths teachers within the school • Always ready to buy learner support material	**T8**
• Help in learner motivation • Encourage learners to attend regularly and maintain discipline • Make textbooks available	**T9**
• Instil discipline in school • Provide learning materials needed • Help in planning extra classes	**T11**
• Encourage the teachers to attend workshops and courses • Support educational excursions • Provide teaching and learning materials	**T12**
• Help in organising Saturday classes • Invite subject specialist • Encourage exchange programmes with neighbouring schools	**T19**

Commonalities

There are a number of commonalities between responses of teachers from high and low-performing schools. Principals' encouragement of learners and teachers are valued, as is making textbooks, stationery and other learning materials available. The principal's role in organising extra classes was also mentioned a number of times by both groups of teachers.

Differences

The analysis of this item recognises the fact that the majority of the principals from high-performing schools seem to be highly supportive of the teachers and assist in organising extra classes programmes. Principals through their leadership created a school climate and set practices that promote successful teaching and learning for mathematics. Teachers from high-performing schools considered the principal as the person who plays a vital role in mathematics achievement. The type of support offered by the principal mentioned includes providing books and materials for learning, disciplining learners, encouraging improvement of teacher's qualifications, and organizing extra lessons to give learners remedial assistance. Teachers from poor performing schools are more critical towards the principal. It is believed that the principal does not welcome initiative from the teacher, does not buy material on time and arranges additional classes without involvement from the teacher. Among these factors, the principal's involvement in managing learner discipline was often mentioned as being especially important in high-achieving schools whereas in the case of low-performing schools the principal's role of providing books and material for learning was mostly mentioned.

6.4 SUMMARY ON CHAPTER FINDINGS

Although teachers from both high and low-performing schools agree on several factors, there are some factors which vary. From these teachers' responses the factors that appear to contribute to achievement in mathematics are those that are indicated by teachers from high-performing schools which include:

- Attendance of mathematics professional associations.
- Attending college/university course on the teaching of mathematics.
- Assisting learners after normal classes.
- Attending college/university mathematics course for their personal development.
- Cooperative learning (group work and class discussions).

Factors mentioned by teachers from low-achieving schools include:

- Low teacher confidence, in terms of dealing with learners who are not performing well in mathematics.
- Limited special teacher involvement in own professional development.
- Limited access to knowledge of mathematics career opportunities in order to assist learners.
- Prevalent attitude by the teachers that learners will fail because of their poor background in mathematics.

In chapter 7 I will summarise and interpret the findings from the literature study, from both the qualitative and quantitative part of the data collection, namely classroom observation, focus group interviews and questionnaires.

CHAPTER 7

CONCLUSIONS AND RECOMMENDATIONS

7.1 INTRODUCTION

This study was prompted by the current trend in South African education that learners from historically disadvantaged schools do not perform well in mathematics. In view of the importance of mathematics in society, there is serious concern amongst educators and policy makers that disadvantaged learners are not performing well in mathematics and constitute the majority of high school mathematics learners in South Africa (Arnott, Kubeka, Rice & Hall, 1997; Maree, 1999).

The literature review in Chapter 2 revealed that high school learners, who graduate with low achievement in science and mathematics and continued their education after high school, are less likely than other learners to register for science and mathematics-oriented fields at university (Peng & Hill, 1995). Furthermore research by Visser (1989) indicates that achievement in secondary school mathematics is one of the best predictors of tertiary success. It is due to this and other related problems that the study investigated factors that facilitate achievement in mathematics in historically disadvantaged schools.

This chapter commences by providing an overview of the study in section 7.2. In section 7.3 the research questions are addressed. In section 7.4 recommendations and suggestions for future research are made. Section 7.5 the limitations of the study are discussed and in section 7.6 some suggestions for further investigation are made.

7.2 OVERVIEW OF THE STUDY

In order to investigate factors that facilitate achievement in mathematics, a large body of literature was studied and reviewed in Chapter 2. In the literature review the main aim was to examine variables that seem to influence learners' performance and achievement in mathematics, as well as those that may affect underachievement. Secondly the aim was to provide background information to the investigation, and serve as basis for classroom observation, focus group interviews and questionnaire construction. No matter how mathematics achievement and persistence are measured, most learners from disadvantaged communities still lag behind their peers. Instances of success can be found, but disproportional poor matric (final year high school) results in mathematics remain the norm despite significant advances in mathematics education research. Since mathematics is a requirement for science, computer technology and engineering courses as well as for advanced mathematics courses, it has in fact become a barrier preventing many of these learners from pursuing careers related to these areas at tertiary institutions (universities or universities of technology). At the same time, there are examples of disadvantaged schools achieving excellent results in mathematics.

Chapter 2 also noted some of the causes for low achievement in mathematics nationally and internationally. For instance, researchers (Attwood, 2001, Brodie, 2004, Maree, 1997, Malcolm, Keane, Hoohlo, Kgaka & Ovens, 2000, Murray, 1997) have found that achievement in mathematics in secondary schools is influenced by a number of factors such as:

- Learning environment, school and class size, culture, effectiveness of schools, teaching and learning approaches.
- Career choice, enjoyment and ability, peer pressure and support, learner motivation, learners' academic involvement.
- Effort and recognition, self-esteem, mathematics anxiety and interest.
- Teacher attitudes and beliefs concerning mathematics, learners' attitudes and beliefs concerning mathematics, and teacher quality.
- Parental involvement.

Chapter 3 covered the research design of the study. This study was conducted using both a qualitative and a quantitative research approach. These two approaches were used because they complement each other and produce balanced results (Borland, 2001:5). In this regard, three phases were followed involving qualitative and quantitative data in the form of:

- Six weeks of classroom observations and interviews with teachers (**Phase 1; qualitative data).**
- Focus group interview sessions with learners (**Phase 2; qualitative data**).
- Questionnaires for both teachers and learners (**Phase 3; quantitative data**).

Chapter 4 contains the results for the qualitative phase (classroom observations and focus group interviews) whereas Chapter 5 (learner results) and six (teacher results) contains the quantitative results on factors that facilitate achievement in mathematics.

7.3 ADDRESSING THE RESEARCH QUESTIONS

The information gathered from learners and teachers in high-performing schools and low-performing schools highlight some of the factors that facilitate achievement in mathematics from historically disadvantaged schools. Returning to the questions addressed by this study:

7.3.1 Research Question 1

What are the attitudes and competencies of mathematics teachers in high-performing and in under- performing schools?

The teacher interviewees often mentioned issues related to the learners' characteristics as factors that facilitate achievement in mathematics. Teachers from both high-performing and low-performing schools were unanimous in mentioning learners' mathematical background and discipline as the reason for success in mathematics. In the case of low-performing schools, teachers confirmed that low expectations were the norm in their schools. They also blamed the learners for poor performance in mathematics. Many teachers from low-performing schools do not seem to see themselves as part of the problem and as such have no power to effect the positive change in their mathematics teaching. In contrast, teachers from high-performing schools did their best to improve learners' academic self-concept and mathematics understanding even if it meant organizing extra classes for those who were not performing well. In this study we found that teacher expectations, encouragement, and attitudes are often the primary factors that facilitate achievement in mathematics, similar to a finding of Nieto (1992), and it is notable that learners from high-performing schools witnessed attitudes that foster their achievement and self-efficacy in mathematics from their teachers. Teacher encouragement from high-performing schools and motivation seemingly increased learners' self-concept and belief that mathematics is possible.

From the qualitative part of the study I learned that most teachers from high-performing school made arrangements for their learners to visit some companies relevant to their studies for motivational purposes. From interviews with both teachers and learners mostly from high-performing schools it transpired that motivation was the main factor in facilitating achievement in mathematics. Often motivation for studying a subject stems from its perceived usefulness (Du Preez, 2004). Teachers from high-performing schools indicated that they showed the importance of mathematics and its usefulness to their learners. In this regard most learners from high-performing schools focused on their plans to register with tertiary institutions, and on what the required scores were in the subjects required for acceptance into their chosen careers. Similar to research by Hrabowski *et al.* (1998), I found that learners of teachers that set high expectations for academic achievement are more likely to have high achievement and academic success. Findings of Malcolm, *et al.* (2000) indicate that learners achieve academically when high expectations are set and maintained by their teachers. In this study, teachers from high-achieving schools were active participants in discussions on mathematics concepts with their learners and engage and encourage learners to study hard in mathematics.

In the majority of the items in the questionnaire completed by teachers in Chapter 6, teachers from high-performing schools seem to outperform the teachers from low-performing schools in several aspects. It would appear that teachers from high-performing schools put more effort into their teaching than teachers from low-performing schools with regard to the following activities

- Attendance of meeting of mathematics professional associations.
- Attending college/university courses on the teaching of mathematics.
- Assisting learners in mathematics even after normal class.
- Attending college/university courses in mathematics.

With regard to attitude and self-concept, teachers from both high- and low-performing schools see themselves as competent teachers who can connect their mathematics knowledge to other disciplines and who are confident in their ability to teach grade twelve students. It seems that teachers from low-performing schools do not feel that they are to blame for the poor performance of students.

There is a difference between teachers from high-performing schools and low-performing schools in that teachers from high-performing schools report more thoroughly on their

- ability to connect the mathematics they teach with the tertiary mathematics that they studied;
- ability to deal with learners who are not doing well in their mathematics classes.

From interviews with teachers during classroom observation it transpired that teachers from high-performing schools:

- were motivated,
- had a lower teaching load in many instances,
- were better qualified; even those who teach in grades other than Grade 12,
- invited speakers from outside to encourage learners,
- used some modern teaching technique in their presentation,
- encouraged learners to associate with serious learners in mathematics.

There is a culture in the high-performing schools of learners willing to learn on their own. Teachers from high-performing schools indicated that they were able to deal with learners who were not performing well in mathematics, better than teachers from low-performing schools. In this regard, teachers from high-performing schools have significant contact with the learners. Their learners have extended contact with them and these teachers get to know their learners and their individual abilities in mathematics.

Teachers from high-performing schools display more positive perception than teachers from low-performing schools in the following aspects:

- They feel that learners learn mathematics best in classes with learners of similar abilities.
- They require learners to explain their reasoning in mathematics classes.
- They advise learners on job opportunities in mathematics, science and technology.
- They encourage learners to register for mathematics rather in the higher grade than the standard grade.

The teachers in high-performing schools were convinced that all learners were expected to excel academically. All their learners were encouraged to register for higher grade mathematics rather than standard grade mathematics in order to be admitted to the study programme of their choice at tertiary institutions. Similar research by Fisher and Padmawidjaja (1999) and Hrabowiski and Maton (1995) indicates that teacher encouragement and expectations had the most significant impact on learners' decisions regarding careers in mathematics and science as well as on their academic success. The positive relationship between learners and teachers also influenced the academic efforts of the learners in this study.

7.3.2 Research Question 2

What are the learners' attitudes towards mathematics and their perceptions of their successes and /or failures in mathematics?

In general, learners from high-performing schools expressed positive perceptions of their teachers and peers. A majority of the learners interviewed feel they are expected to work hard, that they try to obtain good grades in tests, respect their teachers, and have a good self-image, and believe that it is important to do well in mathematics. They were also intrinsically motivation.

When comparing high-achieving schools and low-achieving school learners' perceptions, several differences were found. Learners from high-achieving schools put more emphasis than those learners from low-achieving schools on factors directly within their control, such as class attendance, active participation and homework exercise completion, whereas learners from low-achieving schools placed more importance than high-achieving schools on the instructional methods and teacher personality. Both learners from high-achieving and low-achieving schools put the emphasis on study and teaching methods as a more influential factor in mathematics achievement than adequate mathematics background knowledge.

With regard to commitment, in Chapter 5, learners from high-performing schools were more inclined to engage in the following activities than learners from low-performing schools:

- Attendance of mathematics Saturdays or winter schools.
- Attendance of extra mathematics classes.
- Remaining after school doing mathematics.

It was also clear from this study that many learners from low-performing schools do not place emphasis on learning mathematics and grade competition as in high-performing schools. In this regard, teachers from low-performing schools indicated that learners often come to class without having done their mathematics homework.

Learners from high-performing schools show a strong peer and school support group to encourage them to work hard and succeed in mathematics as has been illustrated in the quantitative part of this study.

Learners from high-performing schools were mostly satisfied with their school and the majority of their teachers. These learners consistently acknowledged the importance of mathematics with respect to their future careers. They particularly appreciated teachers who cared about them and encouraged them to do well in mathematics. According to Cheung (1988) self-confidence correlated most highly with achievement, followed by the belief that mathematics was useful to their future careers.

Learners from low-performing schools had a low opinion of their mathematics classes and their teachers. Furthermore they lacked support from their mathematics teachers and mentioned poor use and organisation of Saturday and winter classes. In addition learners from low-performing schools had little belief that they would make it in mathematics. This is similar to the observation made by Costello (1991) who states that there is common and reasonable belief that a positive attitude, a particular liking for, and interest in mathematics leads to greater effort and in turn to higher achievement.

Learners from both high-achieving and low-achieving schools put the emphasis on study and teaching methods as a more influential factor in mathematics achievement than adequate mathematics background knowledge. This finding supports research findings which suggest that in the case of many learners poor performance is largely due to ignorance of the study methods required, or the inability to apply these methods appropriately, rather than lack of ability (Manalo, Wong-Toi & Henning, 1996). Learners from high-performing schools also placed greater emphasis than learners from low-performing schools on those factors related to teaching and working with a classmate. In this regard, learners' responses from high-performing schools demonstrate the significant impact that career choices had on persistence in mathematics achievement. Learners seemed to have also kept a positive attitude despite the challenge posed by mathematics, which in turn gave them the determination to persevere in this subject. Research by Moody (1997) suggests that positive attitudes and determination to succeed resulted in learners' achievement.

Learners from high-performing schools are more inclined to the following activities than learners from low-performing schools:

- Attendance of mathematics Saturdays or winter schools.
- Attendance of extra classes.
- Remaining after school doing mathematics.
- Associate with friends who show interest in mathematics.
- Receive encouragement from their friends.
- Have classmates that show a desire to do well.
- Have respect for teachers.
- Participate in class discussions.
- View mathematics as a difficult subject.

- Do not necessarily look forward to mathematics classes but realise that that hard work is required to achieve success.

In contrast learners from low-performing schools were more inclined to the following activities than learners from high-performing schools:

- Coming to class without having done mathematics homework.
- Skipping some mathematics classes.
- Feeling that the reason for poor performance lies elsewhere not resulting in hard work and better performance.

7.3.3 Research Question 3

What factors facilitate successful classroom practices in mathematics in Grade 12 schools?

Observation of low-performing schools shows that teachers are under-qualified and lack interest in their subject. In the same vein teaching methods in mathematics should change to a situation in which the learners are encouraged to develop their own strategies for mathematical learning. In this respect, teachers from low-performing schools never show an attempt to exercise these strategies. In contrast, teachers from high-performing schools encouraged their learners, explained the importance of mathematics, advised regular class attendance, gave extra lessons and also encouraged the learners to practise mathematics regularly.

Teachers from high-performing schools also seem to use some of the modern teaching techniques in mathematics, learners are given enough time for practice, application topics and problem-solving are emphasized and learners are assessed frequently. The most common conclusion is that many teachers from low-performing schools need further training to conduct better teaching practices in mathematics. Many of the teachers from low-performing schools do not posses a deep, broad, and thorough understanding of the content they teach. This was evident during classroom observation.

The environment in low-performing schools is less conducive to learning mathematics and learners receive fewer positive learning opportunities in mathematics. For instance, many of the low-performing schools learners are not encouraged to register for higher grade mathematics.

Data from the interviews indicated clearly that the school environment significantly influences learners' persistence and success in high school mathematics. Principals and teachers' influence and encouragement in high-performing schools play an important role in learners' achievement. Although teachers encouraged their learners positively, learners from high-performing schools indicated that they were more afraid of their teachers than learners from low-performing schools, an indication that there was strictness in terms of work ethics. The present research compares with works by Mboya (1995), who delineated how learners achieve academic success through the support of caring educators.

Some other factors that seem to facilitate achievement in mathematics according to this study are discipline, class attendance and homework completion. The quantitative part of this study has indicated that more than twice as many learners from low-performing schools claim that they occasionally skip classes than learners from high-performing schools. The most dominant role for the principal in high-performing school indicated was maintaining discipline among learners.

These findings support the conclusion by researchers such as Edmonds (1979), Maree, (1997), Chall (2000) and Malcolm *et al.* (2000). Their findings are summarised below as follows:

- High learners' achievement is the foremost priority of the school, and the school is organised around this goal as evidenced by principals and mathematics teachers who demonstrate high expectations for learners' achievement and make learners aware of and understand these expectations.

- Learner's peers and parents being aware of the basic objective of the school understand and support those basic objectives and believe they have an important role in contributing to learning.
- Strong leadership is provided by a principal who works with the staff, provides reliable support for staff, and meets with teachers and other members of the staff frequently to discuss classroom practices.

During classroom observation there were a number of factors that were common and some that differed for low and high-performing schools. Firstly, the four schools (two high-performing schools and two low-performing schools) that I observed and reported on in Chapter 4 had similar patterns in their sequence of activities. Most of the time was used for the teacher's presentation on the chalk board. The teachers worked out examples on the chalkboard with the whole class. Except for the observation that teachers from low-performing schools did not appear to have time to summarise the main points of the lesson because of spending more time on subject presentation, the routine in these schools was similar to those documented for other mathematics classrooms. My findings adds to some of Maree (1997) and effective school research conducted by Malcolm, *et al.* (2000) and Bempechat (1998).

In the high-performing school classrooms the following was observed:

- Adherence to homework completion
- Well-disciplined learners with principal intervention
- A clear demonstrated positive expectation from teachers and peers
- Support and encouragement from peers and teachers
- School environment that stressed academic success
- An affinity for mathematics
- A focus on future career

Most learners from high-performing schools were taught in homogeneous groups of similar levels of mastery of the subject. According to my observation, this allowed the cross-class grouping of learners at the same level of competence who are taught together. From the quantitative study teachers from high-performing schools indicated that it was easier for them to teach learners with similar levels of mastery of the subject. Teachers were able to organise extra tutorial classes for struggling learners. Around 63% of learners from high-performing schools compared to around 48% of learners from low-performing schools reported that they attend extra classes, a significant difference. In some high-performing schools groupings of learners in mathematics classes were revised after every major test based on the assessment of the learners' performance

With regard to the teachers' instructional methods, teachers from high-performing and low-performing schools do not show much difference. Teachers from high-performing schools seem to have better:

- ability to cover all mathematical concepts in the syllabus;
- ability to take learners' prior understanding into account when planning a lesson

Another observation was that the teaching and learning in low-achieving schools were characterised by doggedly using the prescribed textbook throughout the lesson. This is similar to the observation by Wood, Cobb and Yackel (1992) that teachers rely heavily on the textbook as a source of their classroom activities. The teachers that I interviewed from low-performing schools admitted that teaching would be effective if they used other textbooks for learners' activities, but they did not do it. The reasons provided were that they needed to use the textbooks that the learners had access to and that were provided by the department of education.

7.4 CONCLUSION

The conclusion of the study is simple: The success of high-achieving schools lies in the application of sound teaching and learning principles and in the creation of a stimulating teaching environment. There is no instant or extraordinary recipe for success.

7.5 RECOMMENDATIONS

The research results of this study are essential for both teachers and learners from disadvantaged schools and also tertiary institutions. Therefore, the following recommendations stemming from this study may contribute to the increase of learners' success in mathematics:

7.5.1 Recommendation 1: Influence of learners' career prospects

Learners from high-performing schools were very clear about the fact that their career prospect served as motivation to work hard in mathematics. In this regard, it is important to present information to learners about mathematics careers. Universities should work with school districts to develop comprehensive mathematics and science career guidance and information-sharing programmes designed to educate disadvantaged learners and their parents or guardians in mathematics and science career options and post-secondary education opportunities. Our evidence suggests that presenting such information to learners changes learners' notions about the usefulness of mathematics. Few of the learners from low-performing schools had such information from their schools. Knowledge of such information motivates learners to do more in the subject. Disadvantaged learners often lack the information about where and how to apply or how to obtain finance for their tertiary learning - to be able to turn their tertiary ambitions, if any, into reality. Many of the learners and teachers from both high and low-performing schools demonstrated a need for assistance in understanding career options as a tool for motivation for good performance. Well-trained school guidance teachers may play a particularly important role in reducing the mathematics and science career information gap.

7.5.2 Recommendation 2: Improving learners' mathematics attitudes and self-concept

From this study it was clear that learners and teachers from high-performing schools have positive attitudes towards mathematics. In this regard, area school district managers, principals of schools, universities and universities of technologies should coordinate efforts to increase interest in educational achievement in mathematics and encourage learners to engage in mathematics and science educational activities. Parents, peers, schoolteachers, and guidance teachers need to provide more convincing evidence that there is an economic payoff, when one follows mathematics-related careers at tertiary institutions.

7.5.3 Recommendation 3: Improving mathematics study and learning methods

Teachers from low-performing schools indicated that they were not able to deal with learners who are not doing well in their classes. Therefore, special programmes should be devised for learners to support after the normal class lessons as early as Grades 10 and 11.

7.5.4 Recommendation 4: Improving order and discipline in mathematics classrooms

With reference to keeping order and discipline at school teachers from high-performing schools indicated that the principal's role was mostly one of disciplining learners. Learners from high-performing schools also indicated respect for their teachers more frequently than those from low-performing schools. Consequently the issue of discipline should be given priority in schools for good achievement in mathematics.

7.5.5 Recommendation 5: Encourage ongoing teacher development in mathematics

Teachers from high-performing schools indicated that they continue with their professional development in mathematics and most of them were members of professional organisations. It is therefore important for teachers to be encouraged to continue with development in mathematics as long as they still teach.

7.6 CONSTRAINTS AND LIMITATIONS OF THE STUDY

During the process of the study, certain limitations were inherent and they will be discussed as follows:

7.6.1 Limitations regarding participants in the study

- Participation for the focus group discussions comprised learners from high-achieving schools and low-achieving schools. Interview respondents consisted of teachers from four schools in which two were high-achieving and two low-achieving. The views of principals and parents from the participating schools might have enriched the findings of this study.
- Interviews for the study focused on teachers from schools where classroom observations were conducted. The study might have yielded valuable findings if principals and parents had been included.
- Interviews with school governing bodies and other relevant stake holders might have indicated alternative ideas in this regard.
- The teacher sample in the qualitative study was small and not equal in terms of representation. The numbers of educators from high-performing schools were smaller than teachers from low-performing schools.
- Some of the teachers were known to me before the study, and this may have influenced their responses. As stated earlier, I had previously worked with some of the teachers while visiting their schools to evaluate pre-service college students.

7.6.2 Limitations related to the method used for collecting data

- Classroom observation might have interfered with the day-to-day activities in the class. I could be wrong to assume that what happens in the classroom during my presence was typical.
- The sample size for teachers was relatively small, so the results could not necessarily be generalised to the entire set of South African schools.
- Conducting focus group interviews and structured interviews on a sensitive topic such as why some schools are performing well, give rise to ethical questions regarding confidentiality of information. Although respondents of this study were assured of the confidential nature of the research, talking about the weaknesses of your school is sensitive.

- The results of the focus group are generally not statistically significant, and De Vos (1998) states that the main limitation of using this data collection method is that data obtained cannot be generalised to the entire population.
- Although the questionnaire respondents were very clearly asked to answer each item as honestly as possible, there may have been other respondents who were not entirely truthful with themselves and answered the item in a politically correct way.
- The focus group interviews were difficult to organise as finding a time and venue that suited all respondents invited was not possible and these led to some respondents not being available.
- The sample group belonged to only one district of Limpopo Province. Results may differ when respondents from other districts are involved in the study.

7.7 SUGGESTION FOR FURTHER STUDY

Further research could be conducted to explore teaching methods involved in classrooms and used by both learners and teachers to encourage learners' autonomous learning behaviour. Secondly researchers or investigators could replicate the study by using samples of learners who are being prepared for mathematics-related careers at tertiary institutions. These learners should be randomly selected from peers with a common educational level and age. This sample would avoid a situation in which some participants had a chance of graduating from well resourced high schools and good socio-economic backgrounds. Finally, the study could be conducted by means of a qualitative approach only in which the researcher spends more time immersed in learners' real lives.

BIBLIOGRAPHY

Abrami, P.C., & Chambers, B.D., Apolonia, S., & Farrel, M. (1992). Gro up outcomes: The relationship between group learning outcomes, attributional style, academic achievement & self-concept. *Contemporary Educational Psychology*, 17(3): 201-210.

Alderman, M.K. (1990). Motivation for at-risk students. *Educational Leadership*, 48(1): 27-30.

Alderman, M.K. (1999). *Motivation for achievement: possibilities for teaching and learning*. Mahwah, New Jersey: Lawrence Erlbaum associates, Inc.

Ames, C., & Archer, J. (1988). Achievement goals in the classroom: Students' learning strategies and motivation processes. *Journal of Educational Psychology*, 80: 260-270

Anderson, L.W., & Burns, R.B. (1989). *Research in classrooms: The study of teachers, teaching, and instruction*. Oxford: Pergamon Press.

Arnott, A., Kubeka, Z., Rice, M., & Hall, G. (1997). *Mathematics and Science teachers: Demand, Utilization, Supply and Training in South Africa*. Craighall: Edusource 97/01.

Attwood, N. (2001). Relationships between Mathematics aggregate, socio-economic status and gender of grade 8 learners in a school situated in an economically depressed area of the Cape Flats. *Pythagoras*, (55): 42-48.

Ashton, P.T., & Webb, R.B. (1986). *Making a difference: Teachers' sense of efficacy and students achievement*. New York: Longman.

Babbie, E., & Mouton, J. (2001). *The practice of social research*. Cape Town: Oxford University Press.

Backhouse, J., Haggarty, L., Pirie, S., & Stratton, J. (1992). *Children, teachers and learning: improving the learning of mathematics*. London: Cassell.

Balacheff, N. (1990). Towards a problematique for research on mathematics teaching. *Journal for Research in Mathematics Education*, 21: 258-278.

Ball, S. (1982). Motivation. In Mitzel, J.H.B. & Rabinowits, W, (Eds.). *Encyclopedia of educational research*, 1256-1263. New York: Free Press.

Beggs, A. (1995). Collaboration: Co-operation or colonisation. In Hunting, R.P., Fitzsimons, G.E., Clarkson, P.C., & Bishop A.J. (Eds.). Regional Collaboration in Mathematics Education. Melbourne: Monash University (Proceedings of the Conference on Mathematics Education, ICMI, Melbourne, Australia), 97-106.

Bempechat, J. (1998). *Against the odds: How "At-Risk" children exceed expectations*. San Francisco: Jossey-Bass Inc.

Berliner, D. (1990). Creating the right environment for learning. *Instructor*, 99: 16-17.

Best, J.W., & Kahn, J.V. (1998). *Research in education*. Boston: Allyn and Bacon.

Betz, N.E. (1978). Prevalence, distribution and correlates of math anxiety in college students. *Journal for Counseling Psychology*, 25: 441-448

Bigge, M.L., & Shermis, S.S. (1999). *Learning theories for teachers*. (6th edition). New York: Addison Wesley Longman, Inc.

Biggs, J.B., & Telfer, R. (1987). *The process of learning*. (2nd edition.). Sydney: Prentice-Hall of Australia.

Bless, C., & Higson-Smith, C. (1995). *Fundamental of social research methods: An African perspective*. (2nd edition). Cape Town: Juta & Co.

Bloor, M., Frankland, J., Thomas, M., & Robson, K. (2001). *Focus groups in social research*. Thousand Oaks, CA: Sage.

Borich, G. (1996). *Effective teaching methods*. (3rd edition). New York: Macmillan.

Borland, K.W. (2001). Qualitative and quantitative research: A complementary balance. *New Directions for Institutional Research,* 112: 5-13.

Brahier, D. (2000). *Teaching secondary and middle school mathematics*. Boston: Allyn & Bacon.

Brink, H.I.L. (1991). Validity and reliability in qualitative research. *Curationis* 16(2): 35-38.

Brink, H.I. (1999). *Fundamentals of research methodology for health care professionals*. 2nd edition. Cape Town: Juta.

Brodie, K. (2004). Re-thinking teachers' mathematical knowledge: a focus on thinking practice. *Perspective in education, 22(1), 65-80]*.

Bruffee, K.A. (1999). *Collaborative learning: Higher education, interdependent, and the authority of knowledge*. Baltimore: Johns Hopkins University Press.

Burns, N., & Grove, S.K. (2001). *The practice of nursing research: conduct, critique and utilization*. (4th edition). Philadelphia: WB Saunders.

Bush, T. (2002). Authenticity-reliability, validity and triangulation. In Coleman & Briggs, A.R.J. (Ed.). *Research methods in educational leadership and management*. (89-102). London: Thousand Oaks, Sage publications.

Campbell, P.J., and Ginstein, L.S. (Eds.). (1988). *Mathematics education in secondary schools and two year colleges.* New York: Garland Publishing, Inc.

Castello, R.B. (1992). *Random house Webster's college dictionary.* New York: Random House.

Carlson, M.P. (1999). The mathematical behaviour of six successful mathematics graduate students: influences leading to mathematical success. *Educational Studies in Mathematics* (40): 237-258.

Chall, J.S. (2000). *The academic achievement challenge: What really works in the classrooms?* New York: The Guilford Press.

Charles, R., & Lester, F. (1982). *Teaching problem solving: What, why and how?* California: Dale Seymour.

Chen,Y., Clark, T.B., & Schaffer, E.C. (1988). Teaching variables and mathematics achievement in the context of six-grade classroom in Taiwan. *International Review of Education*, 34(1): 115-124.

Cheung, K.C. (1988). Outcomes of schooling: Mathematics achievement and attitudes towards mathematics learning in Hong Kong. *Educational studies in mathematics, 19(2): 209-219.*

Mkhabela, M. (2004). Failure rate for black students horrifying. *City Press*, 25.

Cohen, L., & Manion, L (1997). *Research methods in education.* London: Routledge.

Cohen, L., Manion, L. & Morrison, K. (2000). *Research methods in education.* 5th edition. London: Routledge.

Coker, A.D. (2003). African American female adult learners: Motivation, challenges and coping strategies. *Journal of black studies*, 33(5): 654-674.

Coleman, M., & Briggs, A.R. (Eds.). (2003). *Research methods in educational leardership and management*. London: Thousand Oaks, Sage publications.

Cooper, H. (1989). Synthesis of research on homework. *Educational Leadership*, 47(3), 85-91.

Cooper, H. (1994). Homework research and policy. A review of literature. *Research/ Practice*, 2(2). Retrieved September 8, 2003, from http:// education.umn.edu/ CAREI/Reports/Rpractice/Summer94/default.html.

Cormack, D.F.S. (1996). *The research process in nursing*. (3rd edition). London: Blackwell Science.

Costello, J. (1991). *Teaching and learning mathematics 11-16.* London: Routledge.

Creswell, J.W. (1998). *Qualitative inquiry and research design: choosing among five traditions*. London: Sage.

Creswell, J.W. (1994). *Research design: qualitative and quantitative approaches*. London: Sage.

Davidson, N. (1990). *Cooperative learning in mathematics: A handbook for teachers*. Menlo Park: Addison-Wesley Publishing Co.

Department of Education (DoE). (1997). *Education White Paper: A programme for the transformation of Higher Education.* Pretoria: Government Publishers.

Department of Education (DoE). (2002). *Revised national curriculum statement grades R-9*. Pretoria: Government Publishers.

Department of Education and Science (DES). (1985). *Mathematics from 5 to 16*. Curriculum matters 3. An HMI Series. London: Her Majesty's Stationary Office.

De Vaus, D. (2001). *Research design in social research*. London: Sage.

De Vos, A.S. (Ed.). (2001). *Research at grassroots: A primer for the caring professions*. Pretoria: J.L. van Schaik Publishers.

Deutsch, F.M. (2003). Low-cost ways to shrink high-school class size. *Education Digest*, 69(2): 47.

Dlamini, C. (2008). Policies for enhancing success or failure? A glimpse into the language policy dilemma of one bilingual African state, *Pythagoras*, 67, 5-1.3.

Dossel, S. (1993). Math anxiety. *Australian Mathematics Teacher*, 49(1): 4-8.

Dossey, J., McCrone, S., Giordano, F. & Weird, M. (2002). *Mathematics methods and modelling for today's mathematics classroom: A contemporary approach to teaching grade 7-12*. (56-58). Pacific Grove, CA: Brooks/Cole.

Dreckmeyr, T.(1994). *Towards Christ-centred education*. Pretoria: CcE Books.

Duda, J.L., & Nicholls, J.D. (1992). Dimensions of achievement motivation in schoolwork and sport. *Journal of Educational Psychology*, 84: 249-299.

Dungan, J.F., & Thurlow, G.R. (1989). Students' attitudes to mathematics: A review of the literature. *Australian Mathematics Teacher,* 45(3): 8-11.

Du Preez, A.E (2004). *Format and long-term effect of a technique mastering programme in teaching calculus*. MSc thesis. Pretoria: University of Pretoria.

Eccles, J.S., & Jacobs, J.E. (1986). Social forces shape math attitudes and performance. *Journal of women in culture and society*, (11): 367-380.

Ellis, S.M., & Steyn, H.S. (2003). Practical significance (effect sizes) versus or in combination with statistical significance (p-values). *Management Dynamics*, 12(4):51-53.

Entwistle, N.J., & Ramsden, P. (1983). *Understanding student learning*. London: Croom Helm.

Erickson, F. (1986). Qualitative methods in research on teaching. In Wittrock, M.C. (Ed.). *Handbook of research on teaching*. (3rd edition). New York: Macmillan, 119-161.

Ernest, P. (1999). Forms of knowledge in mathematics and mathematics education: philosophical and rhetorical perspective. *Educational Studies in Mathematics*, 38: 67-83.

Ethington, C.A. (1990). Differences among women intending to major in quantitative field of study. *Journal of Education Re search*, 81: 353-359.

Evans, W., Flower, J., & Holton, D. (2001). Peer tutoring in first year undergraduate mathematics. *International Journal of Mathematical Education in Science and Technology*, 32(2): 161-173.

Ewen, L. (2002). *Mathematics motivation: An annotated bibliography*. Retrieved February 12, 2004 from http://mathforum.org/~sara/discussion.sessions/biblio.motivation.html.

Fantini, M.D., & Weinstein, G. (1968). *The disadvantaged: Challenge to education*. New York: Harper and Row.

Fennema, E., & Franke, M. (1992). Teacher's knowledge and its impact. In Grouws D. (Eds.). *Handbook of research on mathematics teaching and learning.* (147-164). New York: Macmillan Publishers.

Fennema, E., & Romberg, T. (1999). *Mathematics classrooms that promote understanding.* New Jersey: Lawrence Erlbaum Associates, Publishers.

Fennema, E., & Sherman, J. (1978). Sex-related difference in mathematics achievement and related factors: a further study. *Journal for Research in Mathematics Education,* 9: 189-203.

Fiore, G. (1999). Math-abused students: Are we prepared to teach them? *The Mathematics Teacher*, 92(5): 403-406.

Fisher, T. A., & Padmawidjaja, I. (1999). Parental influences on career development perceived by African American and Mexican American college students. *Journal of Multicultural Counseling and Development,* 27: 136–152

Fuller, B. (1987). "What School Factors Raise Achievement in the Third World?" *Review of Educational Research,* 57: 255-292.

Gadanidis, G. (1991). Deconstructing constructivism. *Mathematics Teacher*, 87(2): 91-94.

Georgewill, J.W. (1990). Causes of poor achievement in West African schools certificate examinations in River State secondary schools, Nigeria. *International Journal of Mathematics Education in Science and Technology*, 21(3): 81-87.

Goddard, W., & Melville, S. (2001). *Research methodology: an introduction*. (2nd edition). Lansdowne: Juta & Co, Ltd.

Good, T.L., & Biddle, B.J. (1988). Research and the improvement of mathematics instruction: the need for observational resources in Grouws, D.A. & Jones, D. (eds.). Perspectives on Research on *Effective mathematics teaching*. (122-134). Reston, VA: NCTM.

Good, T.L., & Brophy, J.E. (1997). *Looking into classrooms*. (7th edition). New York: Longman, 114 – 142.

Goods, M., & Galbraith, P. (1996). Do it this way! metacognitive strategies in collaborative mathematical problem-solving. *Educational Studies in Mathematics*, 30:229-260.

Gordon, S.P. (2004). *Professional development for school improvement: Empowering learning communities*. Boston: Allyn and Bacon.

Grouws, D. (2001). Homework. In L.S. Grinstein, & S.I. Lipsey (Eds.). *Encyclopaedia of mathematics education*. New York: Routledge Falmer, 330-331

Hanushek, E.A. (1989). The impact of differential expenditures on school performance. *Educational Researcher*, 18(4): 45-65.

Hadfield, O.D., & McNeil, K. (1994). The relationship between Myers-Briggs personality type and mathematics anxiety among pre-service elementary teachers. *Journal of Instructional Psychology*, 25: 34-47.

Hall, D., & Hall, I. (1996). *Practical social research: project work in the community.* Basingstoke: Macmillan.

Harris, S.H. (1995). Cultural concerns in the assessment of non-white students' needs. In Stab, S.D., & Harris, S.H, (Eds.). *Multicultural needs assessment for college and university student populations.* Springfield: Thomas, 17-49

Hembree, R. (1990). The nature, effects and relief of mathematics anxiety. *Journal for Research in Mathematics Education*, 22(1): 33-46.

Henning, E., Smith, B., & Van Rensburg, W. (2004). *Finding your way in qualitative research*. Pretoria: Van Schaik Publishers.

Henson, K.T., Eller, B.F. (1999). *Educational psychology for effective teaching.* Belmont: Wadsworth Publishing Company.

Hiebert, J., & Stigler, J.W. (1992). *The teaching gap: Best ideas from the world's teachers for improving education in the classroom*. New York: Simon & Schuster, Inc.

Hill, P.W. (1995). *School Effectiveness and Improvement: Present Realities and Future Possibilities*. Inaugural lecture as Professor of Education, Melbourne University, unpublished.

Hilliard, A.G. (1988). Public support for successful instructional practices for at-risk students. In Council of Chief State Officers (Eds.). *School success for students at-risk.* Chicago: Harcourt Brace Jovanovich.

Howie, S.J. (1998). TIMSS in South Africa: The value of international comparative studies for a developing country. In J.Adler (Ed.). *Proceedings of the National Seminar on TIMSS and Related Mathematical Assessment in South Africa*. Johannesburg: Wits University, 22-40.

Howie, S.J. (2001). *Mathematics and science performance in grade 8 in South Africa 1998/1999-TIMSS-R.* South Africa. Pretoria: Human Sciences Research Council.

Hoffer, T.B., & Gamoran, A. (1993). *Effects of instructional differences among ability groups on students' achievement in middle school science and mathematics.* Report center on organization and restructuring of schools. Madison: University of Wisconsin (56-67).

Hughes, M.F. (1999). Similar students - dissimilar opportunities for success, high and low achieving elementary schools in rural, high poverty areas of West Virginia. *Journal of Research in Rural Education*, 15(1): 47-58.

Hrabowski, F.A., & Maton, K.I. (1995). Enhancing the success of African American students in the sciences: Freshman year outcomes. *School Science and Mathematics*, 95: 19-27.

Hrabowski, F.A., Maton, K.I., Grief, G.L.,& Green, M. (1998). *Beating the odds: Raising academically successful African American males.* New York: Oxford University Press.

Jaworski, B. (1994). *Investigating mathematics teaching: A constructive enquiry*. London: The Falmer Press.

Johnson, M.L. (1994). Blacks in mathematics: a status report. *Journal for Research in Mathematics Education*, 15(2): 145-153.

Kahn, M.J. (2001). Changing science and mathematics achievement: Reflection on policy and planning. *Perspectives in Education*, 19(3): 169-176.

Kaphesi, E. (2004). The influence of language policy in education on mathematics classroom discourse in Malawi: The teachers' perspective. *Teacher Development*, 7: 265-285.

Kerr, D. R., & Lester, F.K. (1982). A new look at the professional training of secondary school mathematics teachers. *Educational Studies in Mathematics*, (13): 431-441.

Kimchi, J., Polivka, B., & Stevenson, J.S. (1991). Triangulation operational definition. *Nursing Research*, 4(6): 364-366.

Lee, V.E., Smith, J.B., Croninger, R.G. (1997). How high school organization influences the equitable distribution of learning of mathematics and science. *Sociology of Education*, 70: 128-150.

Leitze, A.R. (1996). To major or not major in mathematics? Affective factors in the choice-of-major decision. *CBMS Issues in Mathematics Education*, 6, 83Y99

Levine, G. (1995). Closing the gap: focus on mathematics anxiety. *Contemporary Education*, 67(1): 42-45.

Lockheed, M.E., & Komenan, A. (1989). Teaching quality and student achievement in Africa: The case of Nigeria and Swaziland. *Teaching and Teacher Education*, 5(2): 318-325.

Lubinski, C.A. (1994). The influence of teachers' beliefs and knowledge on learning environments. *Arithmetic Teacher*, 41(8): 476-479.

Ma, L. (1999). *Knowing and teaching elementary mathematics*. Mahwah, N.J: Lawrence Erlb.

Ma, X. (1997). The effect of informal oral testing frequency upon mathematics learning of high school students in China. *Journal of Classroom Interaction*, 30(1): 17-20.

Malcolm, C., Keane M., Hoohlo, L., Kgaka, M., & Ovens, J. (2000). *People working together: a study of successful schools.* Johannesburg: University of Witwatersrand.

Manalo, E., Wong-Toi, G., & Henning, M. (1996). Effectiveness of an intensive skills course for university students on restricted enrolment. *Higher Education Research and Development*, 15:189-199.

Maqsud, M., & Khalique, C.M. (1991). Relationships of some socio-personal factors to mathematics achievement of secondary school and university students in Bophuthatswana. *Educational Studies in Mathematics,* 22(4): 377-390.

Maree, J.G. (1997). *The development and evaluation of a study orientation questionnaire in mathematics*. PhD thesis. Pretoria: University of Pretoria.

Maree, J.G. (1999). Difference in orientation towards the study of mathemathics of South African high school learners: developing a study orientation questionnaire in mathematics. *Psychological Reports,* 84: 467 - 476

Martin, D.B. (2000). *Mathematics success and failure among African-American youth: The roles of socio-historical context, community forces, school influence and individual agency.* New Jersey: Mahwah.

Mboya, M.M. (1995). Perceived teachers' behaviours and dimensions of adolescent self-concepts. *Educational Psychology,* 15(4), 491-499.

McLeod, D.A. (1992). Research on affect in mathematics education: A re-conceptualization. In Grouws, D.A (Eds.). *Handbook of research on mathematics teaching and learning.* (575-596). New York: Macmillan.

McMillan, J.H., & Schumacher, S. (2001). *Research in education: A conceptual introduction*. (5^{th} Edition). New York: Longman, Inc.

Meyer, M.R., & Kloehler, M.S. (1990). Internal influence on gender differences in mathematics. In Fennema, E., & Leder, G.C. (Eds.). *Mathematics and Gender*. (60-95). New York: Teachers College Press.

Michell, J.M., James, L., Essig, B., & Shipp, K. (2003). SOAR2 College. *Educational Leadership*, 61(1): 78-81.

Miller, L.D., & Mitchell, C.E. (1994). Mathematics anxiety and alternative methods of evaluation. *Journal of Instructional Psychology*, 21(4): 353-358.

Molepo, J.M. (1997). *The role of mathematics in developing rural and tribal communities in South Africa*. PhD thesis. Pretoria: University of Pretoria.

Moody, V. (1997). *Giving a voice to African American who have been successful with school mathematics*. Unpublished doctoral dissertation. Athens, GA. University of Georgia.

Moyana, H.J. (1996). *Factors related to mathematics achievement of secondary school pupils*. M.Ed thesis. Pretoria: University of South Africa.

Moyles, J. (2003). Observation as a research tool. In Coleman, M., & Briggs, A.R. (Eds.). *Research methods in educational leadership and management*. London: Thousand oaks, Sage publications.

Mouton, J. (1996). *Understanding social research*. Pretoria: J.L. van Schaik Publishers.

Mudeliar, K.M. (1987). *Factors affecting pupils' choice of and progress in mathematics at secondary school*. M.Ed thesis. Johannesburg: University of Witwatersrand.

Mullis, I.V.S. (1991). *The state of mathematics achievement: NAEP' s 1990 assessment of the nation and trial assessment of the states.* Washington: GPO.

Murray, G. (1997). Opportunity-to-learn issues common to South Africa and the United States. *The Journal of Negro Education*, 66(4): 376-382.

Mwamwenda, T.S., & Mwamwenda, B.B. (1987). Self-concept and academic achievement in Botwana Primary School Leaving Examinations. *Perceptual and Motor Skills*, 65: 71-75.

Nakamura, J. (1988). *Optimal experience and the uses of talent*. In M. Csikszentmihalyi & I. S. Csikszentmihalyi (Eds.). Optimal experience: Psychological studies of flow in consciousness. (319-326). New York: Cambridge University Press.

National Commission on Higher Education. (1996). *NCHE discussion document: A framework for transformation.* Pretoria: Government Publishers.

National Commission on Education. (1996). *Success against the odds*. London: Routledge.

National Council of Teachers of Mathematics (NCTM). (1995). Commission on Standards for School Mathematics. *Assessment Standards for School Mathematics.* Reston, VA: NCTM.

National Council of Teachers of Mathematics (NCTM). (1989). *Curriculum and Evaluation Standards for School Mathematics.* Reston, VA: NCTM.

National Department of Education and Training. (2000). *Norms and Standards for Educators.* Pretoria: DOE.

Nelson, K.C., & Prindle, N. (1992). Gifted teacher's competencies: Ratings by rural principals and teachers compared. *Journal for the Education of the Gifted*, 15(40): 357-69.

Newman, R.S., & Schwager, M.T. (1993). Students' perceptions of the teacher and classmates in relation to reported help seeking in math class. *The Elementary School Journal*, 94: 3-17.

Neuman, W.L (1994). *Social research methods: Qualitative and quantitative approaches*. (2nd Edition). Boston: Allyn & Bacon.

Niemi, D. (1999). *Assessment models for aligning standards and classroom practice*. UCLA Graduate School of Education and Information studies. Centre for the Study of Evaluation. National Centre for research on Evaluation, Standards and Students Testing.

Nieto,S. (1992). *Affirming diversity: The sociopolitical context of multicultural education*. White Plains. New York: Longman

Nimer, F.B. (1990). Mathematics anxiety, mathematics achievement, gender and socio-economic status among Arab secondary students in Israel. *International Journal of Mathematical Education in Science and Technology*, 21: 319-324.

Norman, C. (1988). Math education: A mixed picture. *Science*, 241(4864): 408-409.

Oaks, J. (1989). School context and organization. In Shavelson, L., (Ed). *Indicators for Monitoring Mathematics and Science Education: A Sourcebook*. Santa Monica: Rand Corporation.

O'Laughlin, M. (1990). *Teachers' ways of knowing: A journal study of learning in dialogical and constructivist learning environments*. Paper presented at the 1990 annual meeting of the Association of Teacher Education. Boston, MA.

Orton, A. (1992). *Learning mathematics: Issues, theory and classroom practice.* London: Cassell.

Owens, J.E. (1995). Cooperative learning in secondary schools: research and theories. In Pedersen, J.E., & Digby, A.D. (Eds.). *Secondary schools and cooperative learning: theories, models and strategies.* New York: Garland Publishing, Inc., 153-183.

Pallas, A.M., Natriello, G., & McDill, E. L. (1989). The changing nature of the disadvantaged: Current dimensions and future trends. *Educational Researcher,* 18(5): 16-22.

Peng, S.S., & Hill, T.H. (1995). *Understanding racial-ethnic differences in secondary school science and mathematics achievement*. Washington DC: National Centre for Education Statistics.

Perdenrsen, K., Elmore, P.B., & Bleyer, D. (1986). Parent attitudes and student career interest in junior high school. *Journal for research in mathematics education*, 17: 49-59.

Perrot, E. (1982). Using questions in classroom discussions. In A. Pollard, (ed.).Reading for reflective teaching, 252-255. New York: Continuum.

Pezdek, K., Berry, T., & Renno, P. (2002). Children' mathematics achievement: The role of parents' perceptions and their involvement in homework. *Journal of Educational Psychology,* 94(4): 771.

Pinar, W.F., Reynolds, W.M., Slattey, P., & Taubman, P.M. (1995). *Understanding Curriculum.* New York: Peter Lang Publishing, Inc.

Poggenpoel, M. (1998). Data analysis in qualitative research. In De Vos, A.S. (Eds.). *Research at grassroots: A primer for the caring professions*. (348-351). Pretoria: J.L. van Schaik Publishers.

Polya, G. (1971). *How to solve it*. Princeton: Princeton University Press.

Polit, D.F., & Hungler, B.P. (1991). *Nursing research: methods, appraisal and utalisation*. (4th edition). Philadelphia: JB Lippincott.

Reddy, V. (1997). The Status of Provision of Physical Science in KZN. In Reddy, V. (Ed.). *Analysis of planning and policy priorities for physical science in KwaZulu-Natal*. Durban: UDW.

Reyes, L. (1990). Attitudes and mathematics. In M. Montgomery Lindquist (Eds.). *Selected issues in mathematics education*. (161-182). Berkley, CA: McCutchan Publishing Corporation.

Robitaille, D.F., & Garden, R.A. (1989). *The IEA study of mathematics II: contexts and outcomes of school mathematics*. New York: Pergamon Press.

Reynolds, A.J., & Walberg H.J. (1992). A process model of mathematics achievement and attitude. *Journal for Research in Mathematics Education,* 23: 306-328.

Ross, K.N., Farish, S., & Plunkett, M. (1988). *Indicators of socio-economic disadvantage for Australian schools*. Deakin University Victoria: Deakin Institute for Studies in Education.

Russell, B. (1999). Experience-based learning theories. In The Informal Learning Review. Retrieved February 23,2004 from http://www.Informallearning.com/archive/1999-0304-a.htm

Rutter, M. (1983). Stress, coping and development: Some issues and some questions. In Garmezy, N., & Rutter, M. (Eds.). *Stress, coping and development in children*. (107-134). New York: McGraw-Hill.

Sadker, M.P., & Sadker, D.M. (1991). *Teachers, schools and society.* (2nd Edition). New York: McGraw-Hill.

Sarason, S. (1993). *The case for change.* San Francisco: Jossey-Bass, Inc.

Schiefele, U., Krapp, A., & Winteler, A. (1992). Interest as a predictor of academic achievement: A meta-analysis of research. In Renninger, K.A., Hidi, S., & Krapp, A. (Eds.). *The role of interest and development*. (183-212). Hillsdale, NJ: Erlbaum.

Schmidt, W.H., McKnight, C.C., & Raizen, S.A. (1999). *A splintered vision: an investigation of U.S. science and mathematics education*. Boston: Kluwer Academic Publishers.

Schmitt, N. (1999). Fairness in employment selection. In Smith, M., & Robertson, I.T. (Eds.). *Advances in selection and assessment*. Chichester: John Wiley & Sons, Ltd.

Schoenfeld, A. (1989). Exploration of student's mathematical beliefs and behaviour. *Journal for Research in Mathematics Education*, 20 (4): 338-355.

Schoenfeld, M. (1995). *Mathematical problem solving*. Orlando: Academic Press

Schroeder, T.L., & Lester, F.K. (1989). Developing understanding in mathematics via problem solving. In Trafton, P.R., & Shulte, A.P. (Eds.). *New directions for elementary school mathematics*. (31- 42). 1989 yearbook. Reston, VA: NCTM.

Schromer, M., Calvert, C., Gariglietti, G., & Bajaj, A. (1997). The development of epistemological beliefs among secondary students: A longitudinal study. *Journal of Educational Psychology*, 89: 37-40.

Shavelson, R.J., McDonnell, L.M., & Oakes, J. (1989). *Indicators for Monitoring Mathematics and Science Education. A sourcebook* . Santa Monica: The Rand Publication Series, 66-95.

Shulman, L. (1987). Knowledge and teaching: Foundations of the new reform. *Harvard Educational Review*, (57): 1-22.

Silverman, D. (1989). *Interpreting Qualitative data: Methods of Analysis, Talk, Text and Interaction*. London: Sage.

Simon, J.S. (1999). *Conducting successful focus groups*. Saint Paul, MN:Amhest H. Wilder Foundation.

Singh, K., Granville, M., & Dika, S. (2002). Mathematics and Science Achievement: Effect of Motivation, Interest, and Academic Engagement. *The Journal of Educational Research*, 95 (6): 323-331.

Slavish, R., & Karweit, N. (1984). *Mathematics achievement effects of three levels of individualisation: whole class, ability grouped and individualised instruction*. Centre for Social Organisation of Schools, John Hopkins University, ED 242 559.

Smith, M.S. (1998). *Mastering mathematics: How to be a great math student*. (3rd edition). California: Brooks/ Cole Publishing Company.

Steen, L.A. (1989). Mathematics for a new century. *Australian Mathematics Teacher*, 45(2): 19-23.

Stephen, K., & Reys, R. (1980). *Problem solving in school mathematics*. Reston, Virginia: The National Council of Teachers of Mathematics.

Steyn, T.M. (2003). *A learning facilitation strategy for mathematics in a support course for first year engineering students at the University of Pretoria*. PhD thesis. Pretoria: University of Pretoria.

Stevenson, H.W., & Stigler, J.W. (1992). *The learning gap: Why our schools are failing and what we can learn from Japanese and Chinese education*. New York: Simon and Schuster.

Stigler, J.W., & Hiebert, J. (1999). *The teaching gap: best ideas from the world's teachers for improving education in the classroom*. New York: Simon & Schuster.

Stuart, V. (2000). Mathematics curse or math anxiety? *Teaching Children Mathematics,* 6(5), 330-335.

Strauss, A., & Corbin, J. (1998). *Basics of qualitative research: Techniques and procedures for developing grounded theory*. (2nd Edition). London: Sage Publications.

Strauss, A., & Corbin, J. (1994). Grounded Theory Methodology. In Denzin, N.K., & Lincoln, Y.S (Eds.). *Handbook of Qualitative Research*. London: Sage. 273-285.

Straus, J.P., Van der Linde, H.J., & Plekker, S.J. (1999). *Education and Manpower Development, 19.* Bloemfontein: University of Orange Free State, Research Institute for Education Planning.

Thomas, A. (1992). Teachers' beliefs and conceptions: A synthesis of research In D. Grouws (Ed.). *Handbook of research on mathematics teaching and learning.* New York: Macmillan Publishers, 127-146.

Thompson, D.R. (1992). Teachers' beliefs and conceptions: a synthesis of the research. In Grouws, D.A. (Eds.). *Handbook of research on mathematics teaching and learning,* . New York: Macmillan, 127-148.

Tinzmann, M.B., Jones, B.F., Fennimore, T.F., Bakker, J., Fine, C., & Pierce, J. (1990). *What is the collaborative classroom?* Retrieved 12 February 2003 from http://www.ncrel.org/sdrs/areas/rpl_esys/collab.htm

Tobias, S., & Weissbrod, C. (1980). Anxiety and mathematics: An update. *Harvard Educational Review*, (50): 95-104.

Torn, A., & McNichol, E. (1998). A qualitative study utilizing a focus group to explore the role and concepts of the nurse practitioner. *Journal of Advanced Nursing,* (27): 1202-1211.

Trochim, W.M.K. (2002). *Qualitative methods*. Retrieved on 10 September 2003 from http://trochim.human.cornell.edu/kb/qualmeth.htm

Trusty, J. (2002). Effects of high school course-taking and other variables on choice of science and mathematics college majors. *Journal of Counselling and Development,* 80(4): 464-474.

Trusty, J., & Ng, K. (2000). Longitudinal effects of achievement perceptions on choice of post-secondary major. *Journal of Vocational Behaviour*, (57): 127-135.

U.S. Department of Education. (2000). *Learning without limits: an agenda for the office of postsecondary education.* Washington: DC.

Valverde, L.A. (1984). Under-achievement and under-representation of Hispanics in mathematics and mathematics-related careers. *Journal for Research in Mathematics Education*, (15): 123-133.

Vaughn, S., Schumm, J., & Sinagub, J.(1996). *Focus group interviews in education and psychology* . Thousand Oaks: Sage.

Vatter, T. (1992). Teaching mathematics to the at-risk secondary school students. *Mathematics Teacher*, 85(4): 292-294.

Vygotsky, L. (1978). *Mind in society*. Cambridge: Harvard University Press.

Visser, D. (1989). Mathematics-the critical occupational filter for women. *South African Journal of Science*, 85(4): 212-214.

Ware, N., & Lee, V. (1988). Sex differences in choice of college science majors. *American Educational Research Journal*, (25): 593-614.

Watling, R. (2003). The analysis of qualitative data. In Coleman, M., & Briggs, A.R. (Eds.). *Research methods in educational leadership and management*. London: Sage publications, 262-278.

Weinstein, C. E., & Mayer, R. E. (1986). The teaching of learning strategies. In Wittrock, M. C. (Eds.). *Handbook of Research on Teaching*. New York, MacMillan Publishing, 315-327

Wilen, W., Bosse., M.I., Hutchison, J., & Kinsvatter, R. (2004). *Dynamics of effective secondary teaching*. (5th edition). Boston: Pearson Education.

Wilkinson, S. (2004). Focus group research. In Silverman, D. (Eds.). *Qualitative research: Theory Method and Practice*, (2nd edition). London: Sage publications.

Woolf, H.B. (1977). *Webster's new collegiate dictionary*. Springfield: G.&C. Merriam Company.

Wong, H. (2003). *There is only one way to improve student achievement*. Retrieved February 12, 2004 at http:// www.newteacher.com/pdf/only1way.pdf.

Wong, N. (1992). The relationship among mathematics achievement, affective variables and home background. *Mathematics Education Research Journal*, 14(3): 32-42.

Wood, T., Cobb, P., & Yackel, E. (1992). A constructivist alternative to the representational view of mind. *Journal for Research in Mathematics Education*, 23(1): 2-33.

Woolnough, B.E. (1994). *Effective Science Teaching.* Buckingham: Open University Press.

Wu, H. (1997). The mathematics education reform: Why you should be concern and What you can do. *Mathematical Association of America*. Washington D.C.

Zaaiman, H. (1998). *Selecting students for mathematics and science: The challenge facing higher education in South Africa.* Pretoria: HSRC Publishers.

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APPENDIX A

1. FFAM[3] GRADE 12 LEARNERS QUESTIONNAIRE SURVEY INSTRUMENT

2. FFAM TEACHERS QUESTIONNAIRE SURVEY INSTRUMENT

[3] FFAM: Factors facilitating achievement in mathematics.

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FFAM GRADE 12 LEARNERS QUESTIONNAIRE

The purpose of this questionnaire is to trace some factors that facilitate achievement in mathematics in traditionally disadvantaged secondary schools. Most of the statements instruct you to mark one option with a **cross (X)** from a list of options. Use a pencil or black or blue pen to complete this questionnaire. Please be completely honest. Your answers will be regarded as strictly confidential. There are no **wrong** answers.

THANK YOU IN ADVANCE FOR YOUR CO-OPERATION.

L

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Respondent number:	V1 | | | | 1-3
Name:	

Please mark with a cross (X):

(1) What is your father/male guardian's highest educational level? (**Only one option**)

Lower than Grade 8	
Grade 8	
Grade 10	
Grade 12	
Technical Qualification	
Bachelors degree	
Honours degree	
Masters degree	
Doctorate	
Other (specify)	

V2 \[\] \[\] 5

(2) What is your mother/female guardian's highest educational level? (**Only one option**)

Lower than Grade 8	
Grade 8	
Grade 10	
Grade 12	
Technical Qualification	
Bachelors degree	
Honours degree	
Masters degree	
Doctorate	
Other (specify)	

V3 \[\] \[\] 7

(3) Have you engaged in any of the following activities during the past 3 years? (**For each question, mark only one option with a cross (X)**)

	REGULARLY	OCCASIONALLY	NEVER		
3.1 Participated in a mathematics or science tour/excursion?				V4	8
3.2 Watched mathematics or science TV shows				V5	9
3.3 Read mathematics or science magazines or news articles on mathematics				V6	10
3.4 Attended any mathematics Saturdays or Winter schools				V7	11

(4) To what extent do you agree with each of the following statements? **For each question, mark only one option with a cross (X))**

	AGREE	NEUTRAL	DISAGREE		
				V8	12
4.1 I am afraid of my maths teacher				V9	13
4.2 My teacher expects me to do well				V10	14
4.3 I look forward to mathematics classes				V11	15
4.4 Mathematics is difficult for me				V12	16
4.5 I have self-discipline in doing mathematics				V13	17
4.6 Mathematics is useful in my future career				V14	18
4.7 Doing mathematics makes me nervous or upset					19

Me				V15		
4.8 I will continue with mathematics after Grade 12				V16		20
4.9 I enjoy mathematics				V17		21
4.10 Studying hard in maths is not important				V18		22
4.11 My teacher always encourages us to work hard				V19		23
4.12 My friends are interested in mathematics				V20		24
4.13 My best friend does well in mathematics				V21		25
4.14 I believe mathematics is difficult to do unless you have the brains for it				V22		26
4.15 My friends encourage me to work hard				V23		27
4.16 My teacher treats learners with respect				V24		28
4.17 Learners in my class want to do well				V25		29
4.18 Learners in my class respect their maths teacher				V26		30
4.19 Learners' achievement is recognized by the Teacher						

(5) How often do you do the following in mathematics? **For each question, mark only one option with a cross (X))**

	REGULARLY	OCCASIONALLY	NEVER			
				V27		31
5.1 Skip maths classes				V28		32
5.2 Come to class without a pen or pencil				V29		33
5.3 Try to solve math problems before seeking help				V30		34
5.4 Attend extra classes				V31		35
5.5 Work with classmates in mathematics				V32		36
5.6 Remain after school doing maths				V33		37
5.7 Lose concentration when solving maths problems				V34		38
5.8 Participate in class discussion				V35		39
5.9 Come to class without having done my homework				V36		40
5.10 Get assistance from family (brother, sister etc)						

(6) What marks do you usually get in mathematics tests or exams? (**Mark only one option with a cross (X)**)

Mostly As (around 80-100)		V37		41
Mostly Bs (around 70-79)				
Mostly Cs (around 60-69)				
Mostly Ds (around 50-59)				
Mostly Es (around 35-49)				
Mostly Fs (below 35)				

(7) How much effort do you usually put into your mathematics work? (Mark only one option with a **cross (X))**

I do not try at all	
I do just enough to get by	
I give an average amount of effort	
I try very hard, but not as hard as I could	
I work as hard as I can	

V38 ☐ 42

V39 ☐ 43

(8)Which grade HG or SG? ☐

(9) In your own experience, learners perform poorly in mathematics because: **(For each question, mark only one option with a cross (X))**

	ALWAYS	**SOMETIMES**	**NEVER**
01. They are too many in the class			
02. They are not mathematically talented			
03. They do not know the career they will follow after Grade 12			
04. They have uneducated parents			
05. They do not respect their teachers			
06. They do not attend extra classes			
07. They have underqualified teachers			
08. They are not expected to perform highly			
09. They do not feel respected and connected with their teacher			
10. They are not provided with extra support when needed			
11. They do not practice maths with their classmates			

V40	☐	44
V41	☐	45
V42	☐	46
V43	☐	47
V44	☐	48
V45	☐	49
V46	☐	50
V47	☐	51
V48	☐	52
V49	☐	53
V50	☐	54
V51	☐	57

12. They do not have a strong background in mathematics				

(10) Which of the above reasons do you regard as the most important one? V52 59

Give only the number V53 62

(11) S.N V54 65

(12) C.N

STOP HERE: MAKE SURE THAT YOU HAVE ANSWERED ALL THE QUESTIONS.

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T

FFAM TEACHERS QUESTIONNAIRE

The purpose of this questionnaire is to trace some factors that facilitate achievement in mathematics in traditionally disadvantaged secondary schools. Most of the statements instruct you to mark one option with a **cross (X)** from a list of options. Use a pencil or black or blue pen to complete this questionnaire. Please be completely honest. Your answers will be regarded as strictly confidential. There are no **wrong** answers.

THANK YOU IN ADVANCE FOR YOUR CO-OPERATION.

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Respondent number — V1 [ ] 1-4

SECTION A

Please mark with a cross (X)

(1) Indicate your gender

Male	
Female	

V2 [ ] 5

(2) Years of experience in teaching Grade 12 mathematics

Fill in the number [ ]

V3 [ ] 6- 7

(3) What is the total number of standard grade (SG) learners in your mathematics class (es)?

Fill in the number [ ]

V4 [ ] 8- 10

(4) What is the total number of higher grade (HG) learners in your mathematics class (es)?

Fill in the number [ ]

V5 [ ] 11- 13

(5) What is your highest qualification in mathematics?

Grade 12
JSTC
STD
Bachelors degree
Honours degree
Masters degree

V6 [ ] 14

Doctorate	
Other (specify)	

SECTION B

In the past 5 years, have you participated in any of the following activities related to mathematics or teaching of mathematics?

(6) Attended any college/university mathematics course.

Yes	No

V7 ☐ 15

If **Yes** give details:

V8 ☐☐ 16- 17

(7) Attended any college/university course on the teaching of mathematics.

Yes	No

V9 ☐ 18

If **Yes** give details:

V10 ☐☐ 19- 20

(8) Observed other teachers teaching mathematics

Yes	No

V11 ☐ 21

(9) Met with a local group of teachers to study/discuss mathematics teaching issues.

Yes	No

V12 ☐ 22

(10) Attended a workshop on mathematics teaching?

Yes	No

V13 ☐ 23

(11) Served as a mentor and /or peer coach in mathematics teaching for other teachers.

Yes	No

V14 ☐ 24

(12) Attended any mathematics teacher association meeting.

Yes	No

V15 ☐ 25

(13) Invited guest speakers or organised field trips relevant to the mathematics taught in class.

Yes	No

V16 ☐ 26

SECTION C

(14) Please indicate to what extent you agree or disagree with the following statements:

	AGREE	NEUTRAL	DISAGREE			
14.1 I am able to make connections between mathematics and other disciplines				V17	☐	27
14.2 Additional mathematics textbooks as instructional tools are necessary				V18	☐	28
14.3 I can deal with learners who are not doing well in my class				V19	☐	29
14.4 Learners learn mathematics best in classes with learners of similar abilities				V20	☐	30
14.5 I enjoy teaching mathematics				V21	☐	31
14.6 I am able to connect the mathematics I teach with the tertiary mathematics that I studied				V22	☐	32
14.7 Letting learners criticise /evaluate their own or other learners' homework is advisable				V23	☐	33
14.8 I feel confident to teach Grade 12 learners				V24	☐	34

(15) How often do you do the following: (Mark with a cross (X))

	REGULARLY	OCCASIONALLY	NEVER			
15.1 Take learners' prior understanding into account when planning a lesson				V25		35
15.2 Cover all mathematical concepts in the syllabus				V26		36
15.3 Involve parents in the mathematics education of their children				V27		37
15.4 Advise learners about job opportunities in mathematics, science and technology				V28		38

(16) In which of the following topics would you like in-service training? (Think about content mastery and instructional strategies).

	YES	NO			
16.1 Linear programming			V29		39
16.2 Exponents and logarithms			V30		40
16.3 Euclidean geometry			V31		41
16.4 Trigonometry			V32		42
16.5 Inequalities			V33		43
16.6 Remainder and factor theorem			V34		44
16.7 Analytic geometry			V35		45
16.8 Differential calculus			V36		46
16.9 Arithmetic and geometric progression			V37		47

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16.10 Graphs of functions			V38		48
16.11 Other (specify)			V39		49

(17) Which of the above do you regard as the most important one?

Give only the number ☐ V40 ☐☐ 50- 51

SECTION D

(18) How often do you do the following in your mathematics instruction?

	ALWAYS	SOMETIMES	NEVER			
18.1 Pose open-ended questions				V41		52
18.2 Engage the whole class in discussion				V42		53
18.3 Require learners to explain their reasoning				V43		54
18.4 Allow learners to work at their own pace				V44		55
18.5 Ask learners to explain concepts to one another				V45		56
18.6 Ask learners to seek alternative methods for solutions				V46		57
18.7 Assign mathematics homework				V47		58
18.8 Encourage learners to work in groups				V48		59
18.9 Review homework assignments				V49		60
18.10 Make separate presentations to HG and SG learners				V50		61
18.11 Make special provision for learners who are not doing well in your class				V51		62

18.12 Assist learners after normal class	V52	63
SECTION E		
(19) Give the three most important factors that contribute to learners' good performance in mathematics in your opinion.		
(a)--	V53	64- 65
(b)--	V54	66- 67
(c)--	V55	68- 69
(20) Give the three most important factors that contribute to learners' poor performance in mathematics in your opinion.		
(a)--	V56	70- 71
(b)--	V57	72- 73
(c)--	V58	74- 75
(21) How do you motivate your learners in mathematics?		
(a)--	V59	76- 77
(b)--	V60	78- 79
(c)--	V61	80- 81
(22) Does the principal support you in your mathematics teaching? Describe briefly.		
(a)--	V62	82
(b)--	V63	83
(c)--	V64	84

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(23). In your own experience, learners perform poorly in mathematics because: (For each question, only mark one option with a **cross (X)**)

	ALWAYS	SOMETIMES	NEVER			
01. They are too many in the class				V65		85
02. They are not mathematically talented				V66		86
03. They do not know the career they will follow after Grade 12				V67		87
04. They have uneducated parents				V68		88
05. They do not respect their teachers				V69		89
06. They do not attend extra classes				V70		90
07. They have underqualified teachers				V71		91
08. They are not expected to perform highly				V72		92
09. They do not feel respected and connected with their teacher				V73		93
10. They are not provided with extra support when needed				V74		94
11. They do not practise maths with their classmates				V75		95
12. They do not have a strong background in mathematics				V76		96
13. The principal is not supportive				V77		97

(24) Which of the above reasons do you regard as the most important one? Give only the number ☐ **STOP HERE: MAKE SURE THAT YOU HAVE ANSWERED ALL THE QUESTIONS**.	78 ☐ 98

APPENDIX B

1. THE LETTER REQUESTING PERMISSION TO CONDUCT RESEARCH IN LIMPOPO PROVINCE SCHOOLS

2. LETTER OF APPROVAL TO CARRY OUT RESEARCH

3. LETTER REQUESTING PARTICIPANTS TO COMPLETE THE RESEARCH SURVEY FROM LEARNERS OR PARENTS OF LEARNERS

4. THE LETTER REQUESTING PERMISSION TO CONDUCT RESEARCH FROM TEACHERS AND PRINCIPAL OF SCHOOLS

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

University of Venda for Science and Technology
School of Mathematics and Natural Sciences
Department of Mathematics
P/Bag X5050
Thohoyandou
0950

The Superintendent-General
Department of Education, Arts, Culture and Sports
POLOKWANE 0700

Dear Sir/Madam

RE: REQUEST FOR CONDUCTING RESEARCH IN THE NORTHERN PROVINCE SCHOOLS

The matter above refers.

I am a lecturer at the University of Venda and a degree-seeking student at the University of Pretoria. I intend to find relevant information regarding factors that facilitate achievement in mathematics in traditionally disadvantaged secondary schools.

The information obtained would constitute part of my research and is essential. May I therefore seek written permission for use when I visit schools that I would choose.

Thanking you sincerely.

Respectfully

A.R. Tsanwani
[RESEARCHER]

Northern Province

DEPARTMENT OF EDUCATION
NORTHERN REGION

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SIBASA
VENDA
0970
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REGIONAL OFFICE
DEPARTMENT OF EDUCATION, ARTS, CULTURE & SPORTS
REGION 3
-2
PRIVATE BAG X 2250
0970 SIBASA
NORTHERN PROVINCE

Ref: No. 8/3/1
Enq: Makgahlela S.M

Mr A.R. Tsanwani
P/Bag x 5050
THOHOYANDOU
0950

REQUEST FOR CONDUCTING RESEACH IN OUR SCHOOLS: YOURSELF

1. We acknowledge the receipt of your letter dated 1.8.2001 regarding the matter supra.

2. The region grants you permission to conduct the reseach in the schools under its jurisdiction of Soutpansberg and Vuwani Districts.

3. You are required to report at these two districts so that they arrange with the schools you are targetting.

Good luck in your reseach.

REGIONAL DIRECTOR FOR EDUCATION
/mm

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

University of Venda for Science and Technology
School of Mathematics and Natural Sciences
Department of Mathematics
P/Bag X5050
Thohoyandou
0950

Dear Educator

Your learners have been selected to take part in a PhD research project. The purpose of this research is to trace some factors that facilitate achievement in mathematics in traditionally disadvantaged secondary schools. I have been granted permission to conduct research in your school by the Regional Education Department (Limpopo).

One questionnaire will be administered and it will take approximately 30 minutes to complete (**FFAM Grade 12 learners questionnaire). Please note:**

1. When a learner cannot answer a question or respond to a statement because he has not actually experienced the situation, or if s/he does not understand a certain statement or term, he should ask the researcher to explain it to him or her.
2. Most of the statements instruct the learner to mark one option with a **cross (X)** from a list of options.
3. Your learner's answers will be regarded as **strictly** confidential and I intend to use the data obtained for research **only.**
4. There is no known risk involved in the research. Possible benefits include the fact that participation will probably help your learner to improve in the study of mathematics.
5. There are no costs involved.
6. The learner should remember that there are no **right** or **wrong** answers.

Should you have any queries or comments, you are welcome to contact me.

A.R. Tsanwani

CONSENT

In terms of the ethical requirements of the University of Pretoria, you are requested to complete the following section:

I____, have read this letter and understand the terms involved.

On condition that the information provided by my learners is treated as confidential at all times, I hereby (MARK the appropriate section)

	Give consent
	Do not give consent

Signature: ____________________
Date: ____________________

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University of Venda for Science and Technology
School of Mathematics and Natural Sciences
Department of Mathematics
P/Bag X5050
Thohoyandou
0950

Dear Parent/Guardian

Your child has been selected to take part in a PhD research project. The purpose of this research is to trace some factors that facilitate achievement in mathematics in traditionally disadvantaged secondary schools. I have been granted permission to conduct research in the school that your child is currently attending by the Regional Education Department (Limpopo).

One questionnaire will be administered and it will take approximately 30 minutes to complete (**FFAM Grade 12 learners questionnaire). Please note:**

1. When a learner cannot answer a question or respond to a statement because he has not actually experienced the situation, or if s/he does not understand a certain statement or term, he should ask the researcher to explain it to him or her.
2. Most of the statements instruct the learner to mark one option with a **cross (X)** from a list of options.
3. Your child's answers will be regarded as **strictly** confidential and I intend to use the data obtained for research **only.**
4. There is no known risk involved in the research. Possible benefits include the fact that participation will probably help your child to improve in the study of mathematics.
5. There are no costs involved.
6. The learner should remember that there are no **right** or **wrong** answers

Should you have any queries or comments, you are welcome to contact me.

A.R. Tsanwani

CONSENT

In terms of the ethical requirements of the University of Pretoria, you are requested to complete the following section:

I____, have read this letter and understand the terms involved.

On condition that the information provided by my child is treated as confidential at all times, I hereby (MARK the appropriate section)

	Give consent
	Do not give consent

Signature: ____________________

Date: ____________________