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.