MOKOKA, M C

THE USE OF SOUTH AFRICAN COMPUTER-ASSISTED MATHEMATICS PROGRAMS IN THE BRITS DISTRICT OF THE NORTH WEST PROVINCE

MEd (Computer-Assisted Education) UP 1998

The use of South African computer-assisted Mathematics programs in the Brits District of the North West Province

An essay by

Mmamotlele Christinah Mokoka

Submitted in partial fulfilment of the requirements of the degree

Magister Educationis

in

Computer-Assisted Education

in the Department of Didactics

of the Faculty of Education

University of Pretoria

Supervisor: Prof C.A. Hodgkinson

November 1998

ACKNOWLEDGEMENTS

I would like to express my sincere gratitude to my supervisor, Prof. Cheryl Ann Hodgkinson for her tireless guidance, patience, support and encouragement to this study.

My sincere gratitude to

- Prof. J. Cronjé
- Prof. J. van Staden
- Prof. M. Braun
- Prof. J. Engelbrecht
- Mr J. Fouche
- Dr D. Gray
- Mrs A. Strehler

For their contribution towards the success of this project.

- Prof. R. A. Gray, for editing this project.

My sincere appreciation to:

- Headmasters, Mathematics and Computer Science teachers at the schools: Hoërskool Brits, Hoërskool Hartebeespoort, Hoërskool Wagpos, Micha Kgasi and Tsogo High Schools and Morekolodi Primary School-without their cooperation this project would have not been possible.
- My colleagues at Brits District Subject Advisory Services for their contribution.
- The North West Education Department.

Many thanks to my mother, brothers and sister for their support throughout.

Special thanks to my husband and children, Phetogo and Oleboge for having endured my divided attention.

SAMEVATTING

Die gebruik van Suid-Afrikaanse rekenaar-gesteunde Wiskunde programme in die Brits distrik van die Noord-Wes Provinsie

'n Verhandeling deur

Mmamotlele Christinah Mokoka

Leier	:	**Prof. Cheryl Ann Hodgkinson**
Departement	:	**Didaktiek**
Graad	:	**M.Ed. (RGO)**

Hierdie navorsingsproject was gemik daarop om vas te stel tot watter mate rekenaar-gesteunde Wiskundeprogramme in skole in die Brits Distrik (Noord-Wes Provinsie) gebruik word en hoe nuttig kan sulke programme vir Wiskunde-onderwysers en vir -leerlinge wees. 'n Lys van Suid-Afrikaanse Wiskundeprogramme wat vir huidige skoolsillabusse ontwikkel is, is opgestel.

Die resultate van 'n vraelys wat aan skole gestuur is, het getoon dat slegs 1% van 112 laerskole en 14% van 28 hoërskole die bruikbaarheid van Wiskundeprogramme ondersoek het. Die resultate suggereer dat daar wel skole is wat Wiskunde-onderrig wil uitbou en meer as die minimum onderrigmoonlikhede wil gebruik. Skole ondervind sleutelprobleme soos finasiële beperkings en rooster beperkings. Die tyd toegelaat vir Wiskunde-onderrig laat nóg onderwysers nóg leerlinge toe om sulke hulpbronne ten volle te gebruik.

Die navorsing is nie alomvattend nie, aangesien nie al die Wiskundeprogramverkopers die vraelys beantwoord het nie.

The use of South African computer-assisted Mathematics programs in the Brits District of the North West Province

Supervisor	:	**Prof. Cheryl Ann Hodgkinson**
Department	:	**Didactics**
Degree	:	**M.Ed. (CAE)**

This research project aimed to establish the what extent computer-assisted Mathematics programs are used in schools in the Brits District (North West Province), and how useful these programs can be for teachers and learners. A list of South African Mathematics programs developed for the current school syllabi in Mathematics, was compiled.

The results of a questionnaire sent to schools show that only 1% of the 112 primary schools and 14% of 28 high schools are exploring the usefulness of Mathematics programs. These results suggest that some schools are prepared to enhance Mathematics teaching and go beyond minimum requirements for teaching the subject. The key problems experienced by the schools are financial constraints and timetable constraints. The time allocated to Mathematics teaching does not permit the teachers and learners to utilize such resources to the fullest.

The research is not exhaustive, because not all Mathematics program vendors responded to the questionnaire.

TABLE OF CONTENTS

CHAPTER ONE INTRODUCTION

CHAPTER TWO LITERATURE REVIEW

CHAPTER 3 RESEARCH METHODOLOGY

CHAPTER FOUR FINDINGS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

LIST OF ABBREVIATIONS

ANC	African National Congress
CAI	Computer-assisted instruction
CAE	Computer-assisted education
HSRC	Human Science Research Council
IT	Information Technology
NEPI	National Education Policy Investigation
NQF	National Qualification Framework
RIEP	Research Institute for Education Planning
SA	South Africa
TIMMS	The Third International Mathematics and Science Study
UK	United Kingdom
UOVS	University of Orange Free State
USA	United States of America
UWC	University of the Western Cape

CHAPTER ONE

INTRODUCTION

"Studies in science, technology and mathematics are part of our educational entitlement, a part of culture, which empowers individuals and opens up a range of scientific and technological careers."

(African National Congress, 1995, 87).

CHAPTER ONE

INTRODUCTION

1.1 Introduction

The performance of learners in Grade 12 Mathematics is below acceptable standards for scientific and technological careers. Statistics show that about 13,8% and 13,4% of black matriculants pass higher and standard grade Mathematics respectively (SA Science and Technology Indicators, 1990). Subsequently, a very small percentage of higher education students pursue degrees and diplomas in Engineering, Physical and Mathematical sciences (ANC, 1995). The factors that seem to contribute to the drift away from the sciences include a shortage of qualified teachers in these fields, poor training background for teachers and inadequate funding for tertiary Science and Technology (de Lange, 1981; NEPI, 1992; Lamont, 1993; ANC, 1995). Metrowich (1991) observed factors such as time management and teachers' qualifications as contributory to this state of affairs.

EduSource (1997: 71) has outlined the problems of poor Mathematics performance as follows:

- different curricula for Mathematics in colleges of education;
- lack of links with universities and the isolation of Black teacher education from developments in Mathematics;
- stereotype examination questions;
- English as a medium of instruction; and
- lack of school experience by some college lecturers resulting in 'a noticeable divide between theory and practice'.

The question that one should ask is how the problems that have been identified could be addressed so that more students are able to follow scientific and technological careers.

The ANC led government declared 1998 as the year of Science and Technology. ('Science' is taken to include natural, mathematical and life science at all levels). The focus of this exercise is to promote a sustainable network of Science and Technology. The process of learning in schools should include conscientising learners about the importance of Science and Technology in improving the quality of life. The educators should make an effort to improve the popularity of Mathematics and Science so that the number of learners taking these subjects increases.

Another challenge within the education system of South Africa in 1998 is the implementation of 'Curriculum 2005' in Grade 1. An outcomes-based approach that aims at developing skills, critical thinking, attitudes and understanding is being introduced in the schools. In this system, education and training are brought together and are no longer separate as in the past. All forms of learning (formal or informal) are to be recognized so that learning should become an on-going process. Learners should be able to build on what they learn as they move from one learning situation to another. The system aims at involving all parties, learners and educators in the process of learning. The traditional perceptions of learning that include ideas that learners should be good listeners, memorize facts and reproduce such facts are to give way to more meaningful strategies of learning. The National Qualification Framework (NQF) is the pivot around which the new education system revolves.

These government initiatives allow Science educators an opportunity to pause and reflect on the status of Science in the schools and tertiary institutions. The problems that have been identified as the major factors that inhibit progress in Mathematics education need to be revisited. Mathematics should be taught as a subject which has an important role in everyday life and in future occupations.

The vision for Science and Technology year is that Science, Engineering and Technology are interesting, exciting and integral to our daily lives. In order to achieve these objectives, educators should plan and implement programmes that will address shortcomings in Mathematics education. The programmes should be targeted at all teachers: pre-service and in-service.

According to Metrowich (1991) the lack of suitable qualifications and poor training background compel teachers to adhere to rigid teaching methods and to depend almost entirely on text books. Traditional didactical methods, which involve explanation of how to solve problems step by step, are most commonly used. Learners are expected to follow similar steps when they work on their own. The real worth of Mathematics is seldom explained to the learners. The result is that the subject becomes unpopular and it is perceived to be difficult.

Teachers should be able to explain the real worth of Mathematics to learners. This will improve the attitude of learners towards the subject and subsequently improve the chances of the popularity. Consequently, traditional methods of teaching should be improved and augmented where these are lacking. Computer-assisted instruction is one such alternative method.

Weichers (1982), suggests that computer-assisted instruction (CAI) may be applied in two situations, *viz.*

- in normal teaching where the teacher is underqualified; and
- for remedial teaching, to support normal teaching.

It is recommended that if computers are integrated into the curriculum, traditional methods can be improved and enriched (Funkhouser, 1992). Computers also have a potential of fostering flexible learning environments that can improve motivation and encourage responsibility for learning (Underwood & Underwood, 1990; Funkhouser, 1992). Computers can forster cooperation between teachers and learners, develop creativity and skills of analysis and problem-solving (Underwood & Underwood, 1990; Funkhouser, 1992).

Computer-assisted learning made its educational debut in first world countries in the 1960s (Hartley, 1987). In the United States of America for example, by 1975, about 60% of the schools had already implemented computers (Kansky, 1982). In South Africa computer-assisted education is relatively new. It started around the 1980s in universities: the University of the Western Cape (UWC), Rhodes and Pretoria (Francis, 1993; Lippert, 1993).

This study is an attempt to explore the potential that computers, in particular, computer-assisted instruction software in Mathematics, may have in schools around the Brits District in the North West Province. The study will further make a compilation of Mathematics computer programs developed for the current syllabi in SA and names of schools where the programs are being used. This exercise is intended to assist, in particular, disadvantaged schools which have not used computers and Mathematics programs previously, but are now considering the use of computers in their teaching.

1.2 Research problem

1.2.1 Purpose of the research

The purpose of this study is to establish the potential usefulness to teachers of Mathematics computer programs. Questions have been prepared for interviews with teachers who currently have such programs in their schools. These questions are not specific to a particular program and will therefore be used for any of the schools that are currently using a program in their teaching or remedial classes for Mathematics.

1.2.2 Aim of the research

The aim of this study is twofold, *viz.*:

- to investigate whether Mathematics computer programs can be useful to Mathematics education in schools, especially, high schools; and
- to establish what SA Mathematics computer programs are available on the market in order to provide teachers from disadvantaged schools with information about some of the resources for computer-assisted instruction which may be used for the learning and teaching of Mathematics.

1.2.3 Research question

The main research questions which this study attempts to answer are as follows:

Which computer-assisted instruction software for Mathematics developed in South Africa is implemented in schools around Brits District and what plans and policies for CAI are provided by the Department of Education in the North West Province?

In order to obtain answers to these questions, subsidiary questions were posed to:

- Mathematics teachers currently using the CAI programs;
- a North West Education Representative; and
- vendors of South African Mathematics CAI programs.

1.2.4 Related research in South Africa

A review by the Human Science Research Council's NAVO database conducted in September 1997 reflects 9 related studies. Table 1.1 provides a list of such studies. It is evident from the table that this topic is relatively new, but will hopefully contribute to the on-going research in this field.

Table 1.1 Summary of research in South Africa

Researcher	Topic	Year	Purpose
Hattingh JM	Computer aided Mathematics teaching at Black High Schools	1987	MEd
Marsh TA	The computer in secondary school mathematics: An analysis and classification of possible modes of application, with suggested implications for mathematics curriculum in South Africa	1991	PhD
Funnell L	A classroom-based investigation into the potential of computer spreadsheet as a learning tool within the secondary school mathematics curriculum	1992	MEd
Stoker J	Mathematics Education: The design and evaluation of computer software for the development of a socio-constructivist approach to the teaching of primary mathematics	1992	PhD

Table 1.1 (cont.)

Researcher	Topic	Year	Purpose
Murray JC	Computer programming as learning mode for Mathematics	1993	Non-degree
Kuhn L	A comparison between computer-supported and conventional examination of junior secondary mathematics pupils	1993	MEd
Toni T	Relationship between computer programming and performance in mathematics for students at high school level	1994	MSc
Jakovljevic M	The design, development and implementation of computer supported instructional programs for teaching mathematical thinking skills at secondary level	1995	MEd

1.3 Research methodology

The quantative survey approach was adopted in this study in order to establish which schools in the Brits District of North West have computers and which Mathematics programs are available. Appendix A is a letter that was sent to the schools. Further information was obtained from the report of North West Province School/College Register of Needs Survey compiled by the Department of Education, HSRC and the Education Foundation and RIEP (UOVS, 1996).

Two methods, *viz.*, structured telephonic interviews and written questionnaires obtained the information that relates to South African Mathematics computer programs. Unstructured telephonic interviews were intended to request the vendors to complete questionnaires that would be mailed to them. Subsequent to telephonic interviews covering letters (Appendix D1) which explain the purpose of research and questionnaires (Appendix D) were mailed to the vendors.

The participants in this survey were drawn from a population of headmasters and Mathematics teachers in the schools within the Brits District. A North West Education representative was consulted in connection with initiatives taken by the Department to improve Mathematics teaching in the schools and to establish as to whether there are any plans for computer-assisted instruction in Mathematics. Information about South African Mathematics programs was elicited from local vendors and educationists in the fields of Mathematics and CAI.

1.3.1 Data collection methods

The research is qualitative and therefore data needs to be triangulated to ensure validity of results. Methodological and investigator triangulation was used in this research. According to Cohen and Manion (1994), methodological triangulation is characterized by a multi-method approach while in investigator triangulation the researcher uses more than one participant. The methods here include structured telephonic interviews, interview schedules and questionnaires.

The participants in this research are headmasters of schools, Mathematics teachers, a North West Education representative, academicians and/or practitioners who are involved with computer-assisted instruction in institutions, consultants and vendors.

1.3.2 Data collection plan

Table 1.2 summarizes research questions and the data collection instruments that were used.

Table 1.2 Research questions, instruments and participants

Respondents	Data collection instruments	
	Questionnaire	**Structured Interview Schedule**
Mathematics teachers currently using programs	Appendix A	Appendix B
North West Education Representatives	Appendix C1 Appendix C2 Appendix C	Appendix C
Vendors of South African Mathematics CAI programs	Appendix D1 Appendix D	

1.4 Overview of the research report

An outline of this research report is as follows:

Chapter 1 Gives the introduction and background of the study

Chapter 2 Provides a literature review of computers in education as well as CAE in Mathematics

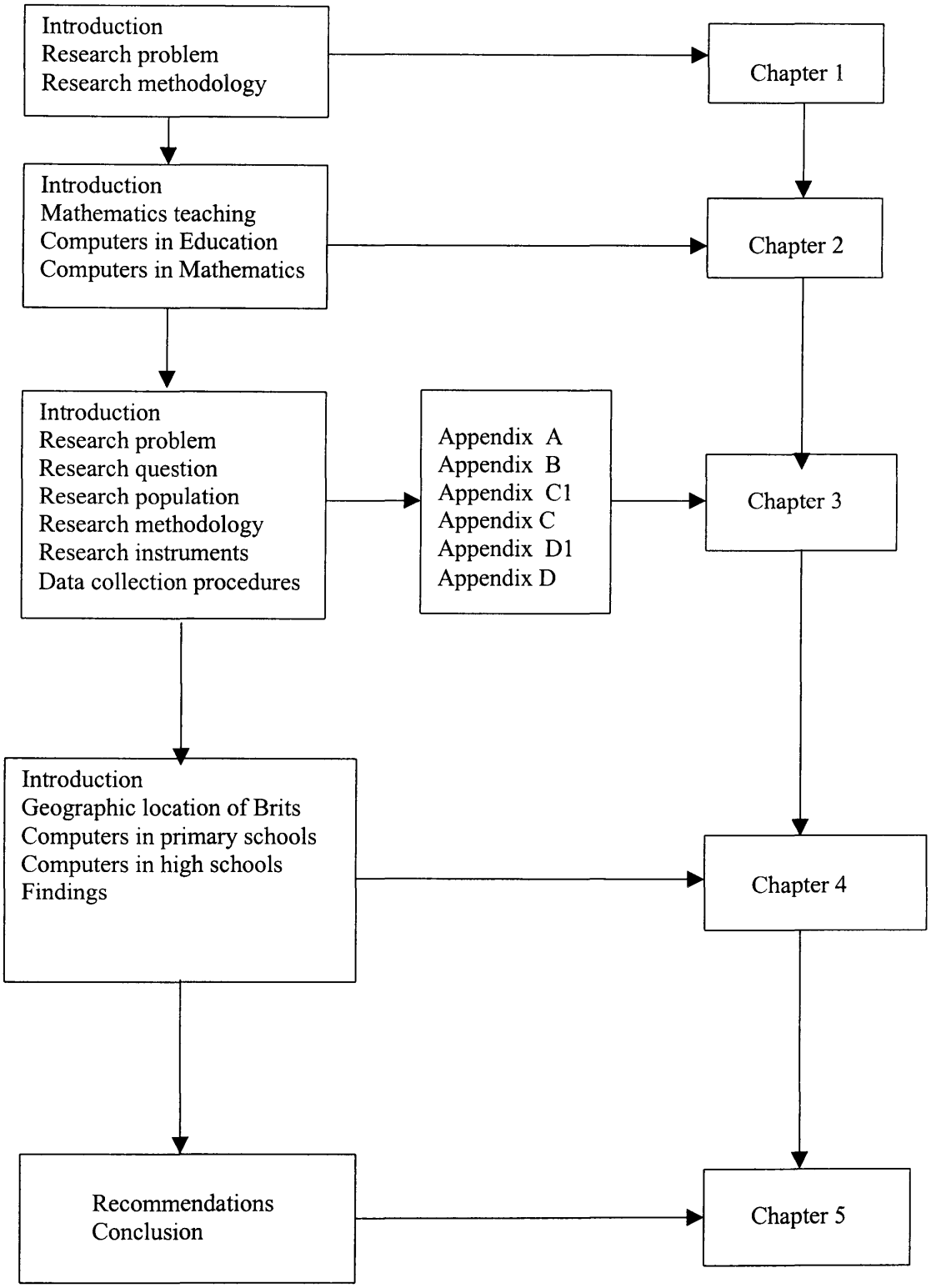
Chapter 3 Outlines research methods

Chapter 4 Provides research findings of the study

Chapter 5 Summarizes the findings and provides recommendations and conclusion

The overview of the research report is represented in Figure 1.1.

Figure 1.1 Overview of the research report



CHAPTER TWO

LITERATURE REVIEW

"Knowledge of mathematics is essential for all members of our society.
To participate fully in our democratic process and to be
unrestricted to career choice and advancement,
people must be able to understand and apply mathematical
ideas"

(Reyes & Stanic, 1988, 26).

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

In this chapter various viewpoints about the use of computers and computer-assisted education in Mathematics instruction are discussed. This chapter attempts to provide a background to Mathematics teaching and learning in South African schools. The first section of the chapter deals with Mathematics teaching and learning in schools while the second part outlines the general use of computers in education. The last part focuses on computers in Mathematics education.

2.2 Mathematics teaching and learning in South Africa

South Africa faces many challenges, one of which is that of redressing the imbalances created by apartheid education. Apartheid has denied black people access to science based careers (South Africa's Green Paper on Science & Technology, 1996).

According to Gray (1997), the South African education system generates large numbers of professionals in the Humanities but does not supply the needs for scientifically and technologically trained manpower. Moulder (1991) suggests that liberal universities produce more black graduates in the Humanities. Pouris (1991) also acknowledges the fact that South African universities produce more arts graduates than science and engineering graduates. The result is that the private sector cannot employ all these graduates. Moulder (1991) goes on to say that these universities do not produce as many black graduates as the professions require. The South African education system also fails to train scientists and technicians that the nation requires (Gray, 1997).

The question which arises is whether or not the South African education system is adequate.

Oldert and Barras-Baker (1992) suggest that an adequate education system should produce individuals who:

- are literate;
- have basic skills for productivity;
- are able to operate in the technological milieu in which they live; and
- are able to carry on learning when formal education stops.

However, the South African education system does not meet the above objectives (Oldert & Barras-Baker, 1992; Moulder, 1991; Pouris, 1991; Gray, 1997).

De Lange (1981), Metrowich (1991), National Education Policy Investigation (1992), and Lamont (1993) identify the factors, which contribute to the South African education system generating only large numbers of professionals in Humanities to include:

- low enrolments by students in Mathematics and Science;
- unsuitable Mathematics and Science curricula;
- unsuitable teaching methods;
- underqualified and unqualified teachers; and
- underperformance by students in Science and Mathematics.

Clearly, Mathematics is critical in training professionals in the Science and Technology fields. As Moulder (1991: 10) comments:

> The problem is that mathematics is the royal road to the professions, as well as to many other jobs in an information-driven economy.

Engelbrecht (1997) maintains that a sound mathematical foundation is required by a large number of other subjects.

The aims of Mathematics instruction suggest that Mathematics is essential for careers in Science and Technology. Dinkheller, Gaffney and Vockell (1989) identify the aims of Mathematics instruction as follows:

- to equip the child with the skills necessary for daily life in society;
- to provide a satisfactory foundation for advanced study of Mathematics; and

- to prepare students for careers in fields involving Science, Engineering and Technology.

The factors that seem to contribute to a shortage of trained manpower in Mathematics related careers are discussed under four sub-headings; *viz.*:

- enrolments in Mathematics;
- Mathematics curriculum;
- students' performance; and
- teachers' qualifications.

2.2.1 Enrolments in Mathematics

Mathematics and other Science subjects are regarded as being "killer" subjects and therefore unpopular to learners in Grades 10-12 (Gray, 1997). According to Costello (1991), surveys show that learners acknowledge the usefulness of Mathematics. However, the learners' attitude towards the subject remains negative. The learners maintain that Mathematics is "hard" and they tend to dislike it (Costello, 1991).

Many students do not prefer Mathematics to other subject fields because often they are badly taught by either unqualified or under-qualified teachers (Lamont, 1993). Although Mathematics is compulsory in the first nine years of schooling, the number of learners doing Mathematics in Grades 10 – 12 continues to decline (Gray, 1997). The problem is exacerbated by poor matriculation results. A chain reaction of events occurs. Falling numbers of successful matriculants in Mathematics and Science lead to tertiary institutions experiencing falling numbers of such students and subsequently falling numbers of graduates in these subjects.

Table 2.1 shows Grade 12 enrolments, pass and fail percentages in Mathematics in 1997. These statistics exclude Western Cape Province. From the table it can be seen that only 45 out of every 100 Grade 12 candidates wrote Mathematics (EduSource Data News, 1998).

Table 2.1 Enrolments in Mathematics

	Total full-time candidates	Number who wrote Mathematics	% of all candidates	Number who passed Mathematics	% of all candidates	Passrate of a percentage of those who wrote Mathematics
Male	225 503	108 717	48	53740	24	49
Female	292 567	122 595	42	48 732	17	40
Total	518 070	231 312	45	102 472	20	44

Source: (EduSource Data News, 1998, 4).

2.2.2 Mathematics curriculum

The second factor that may contribute to negative attitudes towards Mathematics is its curriculum.

The ANC (1995) describes Science, Mathematics and Technology education as outmoded. The curricula are said to be 'academic, outmoded and overloaded'(ANC, 1995, 87).

Hodgson (1995: 30) describes Mathematics curriculum as follows:

> Our children are taught to do mathematics in ways that are very largely outmoded, with at least 80% of the curriculum time wasted on trying, more or less successfully, to develop fluency in skills.

Hoffman (cited in Bruder, Buchsbaum, Hill & Orlando, 1994: 20), goes on to say:

> ... most elementary students spend the majority of their daily 40 minute in maths class learning computational skills needed by 1940s shopkeepers.

Glencross and Fridjhon (1990: 307) also highlight the problem in Mathematics curriculum by saying:

the mathematics that will be taught in our schools *tomorrow* is being decided *today* largely on the basis of what was taught yesterday.

2.2.3 Students' performance

The third factor that seems to contribute towards the declining numbers of students who are able to follow Mathematics related careers is the poor performance in the subject.

Research has shown that achievement relates directly to the length of the school year and effective hours of instruction and learning. Costello (1991) attributes greater effort and higher achievement to affective factors like enjoyment, liking for, interest, *et cetera.*

Time management in schools appears to be a problem (Metrowich, 1991; Gray, 1997). Teachers are involved in many school activities and this hinders progress in terms of curricula for different standards (Metrowich, 1991; Lamont, 1993; Gray, 1997). Consequently, there is an overlap of topics from syllabi from one level to the next. The Grade 12 teachers face a major problem of having to teach all outstanding topics.

The problem of time management is compounded by **school disruptions** through stay-aways, go-slows, chalk-downs, *et cetera.* (Gray, 1997). Generally schools have, once a week, half a day reserved for sporting activities (Metrowich, 1991; Lamont, 1993 and Gray, 1997). Another problem, that the researcher has observed, is unique to rural schools relates to **travelling long distances.** Teachers and learners arrive late and this results in late starts for first periods.

Of great concern is also the time allocated on the **timetable** for Mathematics. This varies from two to four hours per week (Gray, 1997). The researcher has also observed a similar problem during visits to schools. South Africa only allocates **one and a half** to **two** hours per week for Mathematics, while other countries have Mathematics periods ranging from **four** to **six** hours per week (Gray, 1997).

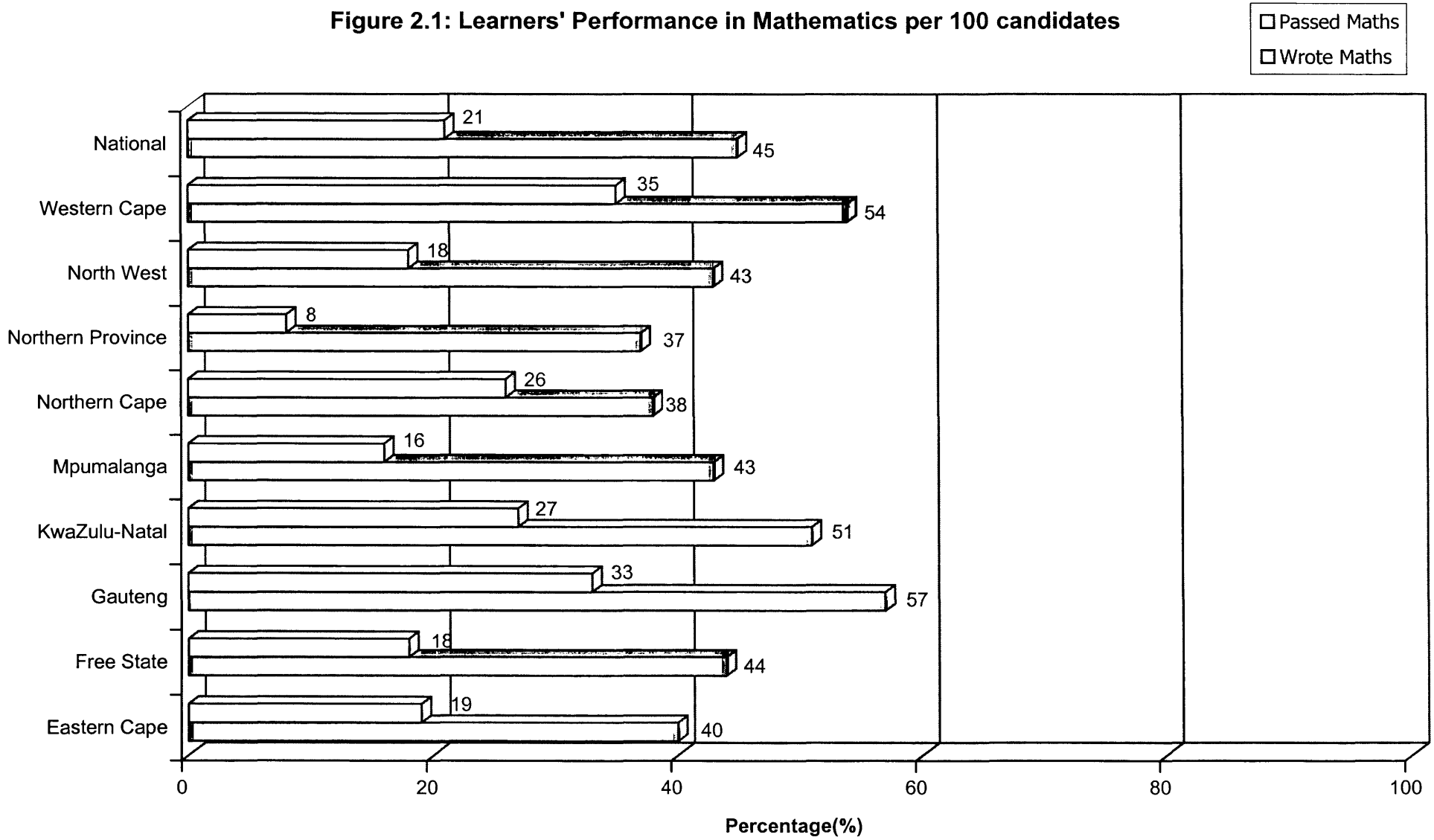
Gray (1997) conducted research in which South African learners in Grades 7 – 9 took part in the Third International Mathematics and Science Study (TIMMS). Results from this study indicate shortcomings in the South African education system to include

pedagogical, language, as well as environmental factors (Gray, 1997). Forty-two countries completed the study and South African learners' performance is rated at the bottom of the class in all test categories (Gray, 1997). It should be noted that SA was the only African country that participated in TIMMS (Gray, 1997).

Figure 2.1 indicates the performance in Mathematics of learners in Grade 12 at the end of 1997. The results show the following:

- for every **100** candidates only **45** wrote Mathematics; and
- of these, only **46%** passed Mathematics (EduSource Data News, 1998, 3).

Figure 2.1: Learners' Performance in Mathematics per 100 candidates



Source : (EduSource Data News No. 20/March, 1998, 5)

Prepared by: HSRC GIS Centre

2.2.4 Teachers' qualifications

Many teachers offering Mathematics are either unqualified or under-qualified, as already stated (ANC, 1995). Metrowich (1991) observed these shortcomings in primary school teachers. It is also said that Science and Mathematics were taught at close to 'matric' level to diploma students in many Black colleges of education (ANC, 1995), making them ill prepared for teaching. Lack of suitable qualifications and poor training background seem therefore to be the principal factors that compel teachers to adhere to rigid teaching methods and to entirely depend on text books (Metrowich, 1991; Lamont, 1993; Gray, 1997), as noted in the introduction of this study.

Excessive reliance on text books results in teaching methods which focus heavily on rote learning and neglect concept formation and problem solving skills (Gray, 1997). As a result, poorly prepared teachers produce poorly prepared students and the vicious circle continues. However, the quality of teachers varies between different race groups with a more serious crisis occurring among Black teachers who have been directly affected by the Bantu education system of the apartheid system (SA Science and Technology Indicators, 1990).

According to South African Science and Technology Indicators (1990), 65% of teachers teaching Mathematics at the critical level of Standard 6 and 7 (Grades 8 and 9) are under-qualified. Again the situation varies within different race groups.

The study entitled South African Science and Technology Indicators (1990: 21) further describes the appalling situation for teachers as follows:

> All our analyses indicate that the quality of teachers (as it is manifested in qualifications) deteriorates as we move from Whites to Asians and Coloureds and reaches crisis proportions in the Black educational system. Examination of the qualifications of teachers teaching physical science, mathematics and biology reveals an even worse picture.

Table 2.2 gives statistics for teachers' qualifications in Mathematics. The table reveals that only 50% of teachers are even partially qualified.

Table 2.2 Subject Qualification in Mathematics Across Seven Provinces

Subject Qualification	**Teachers Qualified in Mathematics**	**% of Total Mathematics Teachers**
Three or more university courses	1401	9%
Two-year university course	633	4%
One-year university course	893	6%
Higher Diploma in (Mathematics)	576	4%
Secondary Teacher's Diploma (Mathematics)	4 284	27%
Total Qualified	**7 787**	**50%**

Source: (EduSource, 1997, 32).

Professor Kieska Mynhardt of the Department of Mathematics, Applied Mathematics and Astronomy at Unisa advocates better ways of training Science and Mathematics teachers.

> They don't need to just train teachers in science and mathematics, they need to train them differently... You need more teachers who have more than a first degree in science (Pretoria News, 26 November 1996).

Within the South African context, Mathematics education in schools faces the problem of a shortage of qualified teachers who have the ability to promote the subject. The methods adopted in the teaching of Mathematics inhibit the learning process. The circumstances described result in lack of interest by and motivation in learners in high schools to take Mathematics.

The next section describes in general the use of computers in education.

2.3 Computers in education

The use of computers in education needs to be seriously considered as a alternative way of providing education (Oldert & Barras-Baker, 1992). Various education specialists in education acknowledge that a computer is a possible means to diversify, develop and improve teaching an learning process (Hebenstreit, 1992; Perlman, 1994; Duchâteau, 1995; Johnson, 1995; Schofield, 1995).

Information technology (IT), which refers to developments that combine computers and communications, is effecting rapid changes in all sectors of the economy (Hawkridge, Jaworski & McMahon, 1990). Developed countries use IT as a major source of power to exert control over competitors as well as developing countries (Hawkridge *et al.*, 1990).

Developing countries need IT for the following reasons:

- for survival in economic terms;
- to be in electronic communication with developed countries for trade purposes;
- to avoid regressing towards effective colonial status once again;
- to modernise their infrastructures; and
- to compete internationally (Hawkridge *et al.*, 1990).

Hawkridge *et al.*(1990) maintain that if third world countries neglect IT, the technological gap between these countries will continue to widen. Third world countries like Ghana, Tanzania and Uganda acknowledge that IT is essential and further regret not having participated in the industrial revolution of the late 18th century (Hawkridge *et al.*, 1990).

South Africa is no exception to the developments that take place globally.

> Technological change waits for no one. We are part of the information age and must change accordingly (SA Green Paper on Science and Technology, 1996, 17).

> South Africa's economic future, in terms of its present educational standards and output, will not be a bright one unless urgent steps are taken to redress deficiencies in the management of education (Gray, 1997, 318).

2.3.1 Importance of IT in schools

Hawkridge *et al.* (1990) describe four rationales of computers in education, *viz.*: the Social, Vocational, Pedagogical and Catalytic Rationales.

The Social Rationale involves conscientising students about the importance of computer literacy and how computers work. Computers pervade the society and therefore students should know how to use them and not have a fear of them (Hawkridge *et al.*, 1990).

The Vocational Rationale: The essence here is the role that computers can play in learners' careers. Students who are taught programming may develop skills that may be useful in their jobs (Hawkridge *et al.*, 1990).

The Pedagogical Rationale is a justification of the use of computers in learning other subjects. Computer-assisted learning may be used if it offers advantages over other methods of learning (Hawkridge *et al.*, 1990).

The Catalytic Rationale: the introduction of computers in schools can be catalytic i.e. changing teaching, administrative and managerial efficiency for the better. Some of the benefits from using computers include:

- enabling learners to engage in interactive learning processes;
- helping students to become less dependent on the teacher; and
- requiring students to do less information memorization of facts and less information handling and problem solving (Hawkridge *et al.*, 1990).

All four rationales may form a basis for a suitable and adequate education system described by Oldert and Barras-Baker (1992).

Schools need computers for various reasons. Pelgrum and Plomp (1991) summarizes the use of computers in schools as follows:

- the need for students to experience computers for future use;
- computers make school more interesting and attract more students;
- computers improve students' achievement; and
- computers promote individualized and co-operative learning.

Hebenstreit (1992) supports the use of computers in schools because:

- computers, contrary to teachers, are available all the time and at any time the learner wishes to learn; and
- computers are never 'tired' and never 'lose their temper'.

Computers are said to have unique characteristics such as speed, patience, individualization, interesting displays of graphics, immediate feedback and allow for self pacing which can be harnessed to make learning more interesting and ease the teachers' responsibility in the classroom (Underwood & Underwood, 1990; Alessi & Trollip, 1991; Jarvis, 1993; Francis, 1994).

> Technology tools have allowed teachers to teach and learners to learn in significantly different ways than what is [sic] "normally" found within secondary classroom (O'Connor, 1994, 27).

Benting (1995) maintains that computer-assisted education (CAE) has definite benefits to the users provided the medium is correctly applied and the material is delivered within a well-managed system.

According to Weichers (1982) computer-assisted instruction (CAI) is useful in two situations, *viz.*:

- for normal teaching if there is a shortage of qualified teachers; and
- for remedial teaching, to reinforce and supplement normal teaching.

Given the current situation in education especially in Mathematics education, it is imperative that alternative methods and resources should be explored for improvement.

Metrowich (1991) suggests that computer-based education may offer a partial solution to existing problems in Mathematics. Marsh (1990) suggests that computers may form

powerful tools for augmenting and enriching conventional problem-solving activities. According to Marsh (1990), calculators became accepted in Mathematics for augmenting numerical calculations. The benefit of using calculators is that the learners can become involved in creative and more meaningful problem solving.

Mathematics software packages are available that could be explored to tackle problems in real situations. Marsh (1990) maintains that often parameters of problems are made artificially simple to reduce the complexity of calculations. According to Marsh (1990), muMATH may be used to tackle problems relating to real situations which often are avoided because of their complexity.

Perlman (1994) recommends Computer Based Tutorial (CBT) from Cliff's StudyWare as an alternative instruction medium, which could provide a solution to this education. The CBT range contains various disciplines including Calculus targeted towards high school from Grade 11 to first year calculus at university level (Perlman, 1994). This CBT

> ...has introduced a new dimension to the South African education system (Perlman, 1994, 68).

Perlman (1994) suggests that alternative instruction media enable learners to be exposed to teaching methods in which knowledge is acquired at their own pace and at a level they can cope with.

Within the South African context, Mathematics education in schools faces the problem of a shortage of qualified teachers who have the ability to promote the subject. The problems are set out in the first section of this chapter. The methods adopted in the teaching of Mathematics inhibit the learning process. The circumstances described result in lack interest and motivation in learning the subject.

Various researchers assert that computers and CAE have great potential for improving Mathematics education (Marsh, 1990; Metrowich, 1991; Perlman, 1994; Johnson, 1995; Laridon, 1995; Schofield, 1995).

2.4 Computers and CAE in Mathematics instruction

Computers and CAE have various facilities which can provide alternative approaches to doing Mathematics as well as to teaching and learning the subject (Costello, 1991).

Computer-assisted education has been used in various developed and developing countries. Successes and failures have been reported. These successes and failures should form a foundation for the development of programmes suitable to the needs of individual countries.

2.4.1 Computer-assisted education in developed countries

A number of studies using CAE in Mathematics in developed countries exist (Johnson, 1995; Schofield, 1995). To illustrate potential benefits of using CAE in Mathematics, two examples are briefly described.

2.4.1.1 The UK ImpactT Study

According to Johnson (1995), the purpose of this study was to evaluate the impact of IT on children's achievement in primary and secondary schools. The study was conducted from January 1989 to December 1991.

The results from this study show that CAE succeeds in:

- improving motivation and increasing interest and enjoyment of learning. This has a positive effect on the status of a subject;
- improving learners' concentration because learners focus on the work at hand; and
- providing opportunities to work in an open-ended way. This enables learners to become involved in more complex and challenging learning situations.

Mathematics is a subject that has a potential to 'engender unhelpful characteristics such as anxiety, helplessness and apathy' (Costello, 1991, 123). CAE may alleviate some of the fears that learners seem to experience.

There were difficulties that were encountered through the ImpacT Study. Learners and some teachers were unable to use certain software packages (Johnson, 1995). The use of general-purpose software, for example, spreadsheets and databases placed additional demand on the teachers (Johnson, 1995).

2.4.1.2 The GPTutor

Another study used GPTutor and also reported satisfactory results.

Mathematics teachers in schools will agree that geometry teaching tends to be a 'nightmare'. However, geometry classes at Whitmore using GPTutor are less frustrating (Schofield, 1995).

The GPTutor is designed to teach students how to do proofs in geometry (Schofield, 1995). The teachers and students at Whitmore benefited in various ways, *viz.*;

- Teachers started giving more attention to slow learners;
- The average and lower than average students with less confidence in maths improved because of increased opportunity for direct and extended interaction with their teachers;
- Students' involvement in the classroom increased in terms of time-on-task and the level of effort in the face of difficulty;
- Students competed in positive and productive ways; and
- Student were able to express their frustration without embarrassment and their fear was reduced (Schofield, 1995).

2.4.2 Computer-assisted education in South Africa

In South Africa computer-assisted education is about 15 years old (Lippert, 1993). Lack of funds delayed large-scale implementation of computer-assisted education in schools (Metrowich, 1991; Lippert, 1993). Another factor that led to the slow implementation of CAE is lack of knowledge about the potential of computers for learning and teaching (Lippert, 1993). Despite these shortcomings, Mehl suggests that CBT may play an important role of 'equalizing educational opportunities in SA' (1991, 11).

Some of the reported studies to date are briefly discussed below.

2.4.2.1 UWC Outreach Programme

The Outreach Programme (OP) at UWC started the beginning of 1983 (Francis, 1994). Standard 9 and 10 (Grades 11 and 12) pupils of eight high schools in the immediate vicinity of UWC took part in this project during the afternoons. They had an opportunity to work for an average of 60 hours per year. Pupils were able to access Plato via a terminal and worked on tutorial, drill-and-practice lessons and tests (Francis, 1994).

The benefits from OP include improved achievement in Mathematics and Science in 1990 and even better achievement in 1991 (Francis, 1993). Pupils were reported to have enjoyed learning with the aid of a computer (Francis, 1993).

The average percentages in Mathematics and Science for Outreach pupils exceeded those at national level (Francis, 1993).

Table 2.3. Average percentages for Mathematics and Science in 1990

Subject		DET schools	Outreach	DEC Schools	Outreach
Mathematics	HG	18	26	46	62
	SG	14	21	40	50
Science	HG	30	33	50	50
	SG	26	27	45	49

Source: (Francis, 1993, 20).

'The pioneering utilization of the computer in addressing the learning problems of disadvantaged students at University of Western Cape (UWC) is unique'. (Mehl, 1991, 12). Mehl (1991) maintains that this attempt has caused other institutions to imitate what UWC is doing.

2.4.2.2 SERGO Project

Laridon (1995) conducted a research project which involved a classical pre-test and post-test of experimental and control groups. The purpose of this research was to allow Grade 12 learners to revise the calculus they had learned in school through a computer-aided package of SERGO.

The entire matriculation class of a school in Ulundi formed the experimental group while the control group consisted of the entire matriculation class of a school in Umlazi township in Durban.

Both groups wrote the same pre-test on calculus with questions set from past matriculation papers. Two forms of intervention were set for each group. For the experimental group, intervention entailed 6 hours of on-line exercises while paper-based exercises from SERGO for study purposes for the same length of time were used.

The results of this research show that an improvement from both HG and SG matriculation learners was recorded for both experimental and control groups. The improvement of experimental group was significantly better than that of the control group showing that the use of SERGO was helpful (Laridon, 1995). The pass rate increased from 18% to 42% for HG pupils and from 5% to 35% for SG pupils (Laridon, 1995).

Laridon (1995) also observed shortcomings in the use of SERGO. According to Laridon (1995), it appears that the gains from CAE are short-term and related to mechanical applications rather than to a more lasting understanding of concepts. Laridon (1995) asserts that CAE in Mathematics requires more refined courseware that could support high school Mathematics students to increase their proficiency.

2.4.2.3 TOAM Project

The TOAM computer-assisted instruction was used in this study. The Mathematics program was developed in U.S.A. The courseware was improved to cater for DET syllabi for the primary schools in SA (Metrowich, 1991).

The results of HSRC tests used to determine mathematical knowledge of primary school Mathematics teachers indicated that the teachers' understanding of certain concepts like fractions, sets, multiplication and others was very poor (Metrowich, 1991).

The research by Metrowich (1991) is the result of a need to upgrade the subject knowledge and teaching skills of black primary school teachers. The purpose of this study was to develop a model for in-service teachers that could be used nationally to upgrade the primary school Mathematics teachers. The model developed would assist the educationally disadvantaged Black teachers in the classroom (Metrowich, 1991). It should be noted that these teachers only had an academic background of either Standards 6 or 8 (Grades 8 and 10) Mathematics. Although there were teachers who had passed Standard 10 (Grade 12), not one of them had taken Mathematics at that level (Metrowich, 1991).

According to Metrowich (1991), the aspects considered for developing the model include:

- Knowledge and understanding of Mathematics;
- Attitude towards Mathematics and computers;
- Teaching methods used in the classroom;
- Classroom management skills;
- The teachers' skills for remedial lessons; and
- General education levels and teaching experience in Mathematics.

The research consisted of experimental and control group of schools in Soweto. Teachers from both groups underwent the same pre-test which consisted of:

- TOAM diagnosis;
- Initial evaluation tests by HSRC;
- HSRC diagnostic tests;
- An attitude questionnaire and interview;
- A demographic questionnaire; and
- Classroom observation.

Intervention strategies:

Table 2.4 indicates the treatment for both experimental and control groups

Table 2.4 Intervention Strategies

	Experimental group		**Control group**
Treatment	Immersion Courses TOAM diagnosis Afternoon training In-school visits		Conventional in-services courses by Inspector Inspection at school
Classroom Practice	Worksheets TOAM diagnosis Group work Remediation	Worksheets Own diagnosis Groupwork Remediation	Text books No formal diagnosis Traditional Frontal teaching No Remediation
Post-test	TOAM system diagnosis Initial evaluation tests (HSRC) Attitude questionnaire Achievement tests based on Std 5 Mathematics Classroom observation		
	Ability to use TOAM printout for Diagnosis Use of groupwork in class		

Source: (Metrowich, 1991: 169).

The results and the main purpose of the research are summarized below.

According to Metrowich (1991), the following results were achieved.

1. The model improved the teachers' mathematical content in the experimental group.

2. Teachers improved their teaching skills. This was observed from the teachers' willingness to use additional strategies in their teaching including group work and using teaching aids in geometry.
3. Teachers were willing to do remedial work with the learners.
4. Teachers improved performance in specific areas and this increased their confidence.
5. A positive attitude developed because teachers became more aware of their shortcomings and were willing to seek assistance from other people.

The research by Metrowich (1991) is another example showing that CAI has the potential to improve the teaching and learning of Mathematics in the schools.

2.4.2.4 Computer technology with unqualified teachers

Fourie and Henning (1995) conducted research about an encounter with computer technology with a group of unqualified teachers in an informal settlement outside Johannesburg. The software that was used was not identified. The findings of this research were exciting. The teachers confirmed that computers raised their level of motivation (Fourie & Henning, 1995). This is evident from the teachers' comments:

> "Although I was very tired after a busy day, the computer lesson interested [sic!] and I felt like never leaving the computer lab" (Fourie & Henning, 1995, 81).

> "Before I was scared to use the computer, but now I am Happy" (Fourie & Henning, 1995, 81).

2.5 Summary

This chapter has outlined the problems in Mathematics instruction in South Africa. Furthermore, an outline is provided for the use of computers in education. Some examples of successful applications of computers in other countries have been discussed. Finally, South African attempts have been briefly discussed.

The next chapter discusses the research methods and instruments.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

The purpose of this study is to determine which computer-assisted Mathematics programs developed in South Africa are being implemented in schools in the Brits District of the North West Province. The study further investigates whether or not plans and policies for CAI are provided by the North West Education Department.

The aim in this chapter is to discuss the research methodology and instruments used to collect information about:

- Which programs developed for the South African Mathematics curriculum are available; how much they cost and where they can be obtained;
- Which schools are using computer Mathematics programs; and
- What plans and policies for CAI in Mathematics are provided by the Department of Education in the North West Province.

3.2 Research problem

The main research questions that are answered in this research are as follows:

Which computer-assisted instruction software for Mathematics developed in South Africa is implemented in schools around Brits District and what plans and policies for CAI are provided by the Department of Education in the North West Province?

3.3 Research questions

As noted in the introduction to this study, the main research questions are divided into three sub-sections. For each sub-section questions are directed to different participants, *viz.*

- Mathematics teachers currently using the program;
- A North West Education representative; and
- Vendors who provide the programs.

The questions directed to the above participants are given in Table 3.1.

Table 3.1 Research questions, instruments and participants

Research question		Data collection instrument	
		Questionnaire	Structured Interview Schedule
Appendix B			
1.1	How many computers do you have in your school?	• Headmasters • Mathematics teachers	• Headmasters • Mathematics teachers
1.2	How much did the computers cost?		
2	Where are the computers placed?		
3	Who is responsible for the computers?		
4.1	Which mathematics program/s is/are available in your school?		
4.2	How much does it cost?		
4.3	Does it satisfy the objectives of the syllabus?		
4.4	Which sections of the syllabus does it cover?		
5.1	For which classes is/are the program/s compiled?		
5.2	In which classes do you use the program?		
5.3	How many times per week do you use the program?		
5.4	For how long have you used the program?		
5.5	Has the performance of learners improved since you have used the program?		
6	Is the program suitable for "Curriculum 2005?"		
7.1	How can the learners benefit from the program?		
7.2	How can the teachers benefit from the program?		
8.	What advice about computers do you have for teachers who have never used computers before?		

Table 3.1 (continued)

Research Question		Data collection instruments	
		Questionnaire	**Structured Interview Schedule**
9	What other suggestions do you have about the potential usefulness of CAI Mathematics programs?		
Appendix C			
1.1	What plans does the education department have for improving Mathematics instruction in terms of resources and underqualified teachers?	• Education Representative: North West	• Education Representative: North West
1.2	Are there any plans for computer-assisted instruction for Mathematics?		
2.	Are there policy guidelines on the use of computers in education?		
3.	What provisions does the policy make for each of the following?		
3.1	Training of teachers (both in- and pre-service).		
3.2	Provision of computer hardware.		
3.3	Acquisition of computer software.		
3.4	Sustainability, support and maintenance of computer software and hardware.		
3.5	Research into the effectiveness and optimal use of computers in schools.		

Table 3.1 (continued)

Research Question	Data collection instruments	
	Questionnaire	Structured Interview Schedule
Appendix D 1. What is the name of your company? 2. Who is the contact person? 3. What are the contact numbers: Tel: Fax: Cell: E-mail: 4. What is the name of your Mathematics program? 5. In which language is the program? 6. For which grades is the program suitable? 7. How much does it cost? 8. Where can the product be purchased? 9. What are the hardware specifications? 10. Which Software Operating System is required? Dos: Windows 3.11 Windows 95 11. Which schools have acquired the program? 12. Are evaluation reports available?	• Vendors	

3.4 Research population and sample

The population in this study consists of all schools in the Brits District within the North West Education Department. All schools which have computers and Mathematics programs within the Brits District form the sample.

A convenience sampling method (Cohen and Manion, 1994) was adopted to select the schools where interviews could be conducted. This method of sampling has been chosen to collect data because it allows the freedom to choose respondents who are geographically near the researcher. Consequently, schools that were selected for interviews are those conveniently situated for the researcher. Financial constraints and the limited time of the researcher made this sampling method the most suitable.

The suppliers of SA Mathematics programs also form part of this study. An attempt was made by the researcher, with the assistance of the supervisor, to explore all possible avenues about vendors who supply software. The efforts included contacting experts at the University of Pretoria, the National film library, the HSRC, software distributors, consultants, publishers, and by visiting exhibitions.

3.5 Research methodology

The aim of this study is to obtain information about the use of Mathematics programs in schools and to determine which Mathematics programs developed in SA are available as already stated. For these reasons, a descriptive survey approach is adopted.

Whereas Cohen and Manion (1994: 83) describe surveys as:

> Typically, surveys gather data at a particular point in time with the intention of describing the nature of existing conditions, or identifying standards against which existing conditions can be compared, or determining relationships that exist between specific events.

Bell (1987: 8) says:

> A survey will aim to obtain information from a representative selection of the population and from the sample will then be able to present the findings as being representative of the population as a whole.

The main emphasis of this study is on fact finding. Bell (1987) maintains that if a survey is well structured, it can be relatively cheap and quick to obtain information. The researcher did not obtain any grant for this study and therefore a survey appears to be the most appropriate. Furthermore, the study was done on a part-time basis and required a quick approach for collecting data.

3.6 Research instruments

Questionnaires and structured interview schedules were used in this study to collect data. These are discussed separately under their respective sub-headings.

3.6.1 Questionnaires

Questionnaires are commonly used for collecting data in a survey (Babbie, 1991; Fodd, 1993; Cohen & Manion, 1994). A major disadvantage about questionnaires is that of poor response (Babbie, 1991; Fodd, 1993; Cohen & Manion, 1994). A covering letter and follow-ups are essential to enhance the response rate. In addition, certain considerations have to be made when a questionnaire is compiled with regard to:

- length;
- type of questions; and
- order of questions.

The following questionnaires were designed for this research:

- for the schools to establish whether or not the school has computers and Mathematics programs (Appendix A);
- for the North West Education Representative (Appendices C, including two covering letters: Appendices C1 and C2); and
- for vendors (Appendix D, including a covering letter: Appendix D1).

The length of Appendices A and C are respectively one A4 page. The aim of restricting the length is to avoid a repetition of questions and to enable respondents to spend reasonable time in answering the questions (Babbie, 1991; Fodd, 1993; Cohen & Manion, 1994).

Wiersma (1991) suggests that items in a questionnaire should be straightforward to ease the task of completion by respondents. To this end questions are arranged in such a manner as to encourage respondents to take part. Short and closed form questions are form part of the questionnaires. Open-ended questions are also included. Such questions allow respondents to give their own opinions. Furthermore, respondents are able to provide useful information that may not be forthcoming with a closed form of questions (Babbie, 1991; Fodd, 1993; Cohen & Manion, 1994).

Wiersma (1991) suggests that items of a questionnaire should be tried out before being finalised. Such a pilot run should identify misunderstandings and inappropriate items

(Wiersma, 1991). Bell (1987) recommends careful piloting to ensure that questions mean the same to all respondents.

Fodd (1993) maintains that editing questions does not guarantee that all potential problems can be avoided. However, the exercise is necessary to uncover aspects of questions that may be ambiguous to or pose difficulties for respondents. Such ambiguities and difficulties may deter respondents from understanding the questions as intended.

The colleagues of the researcher were requested to edit the questions. Subsequent to their input, questions were modified or rephrased before distribution.

3.6.2 Interview schedule

The interview is an effective method of conducting a survey. According to Wiersma (1991), the interview is a social encounter. The interviewer should establish a good rapport with the interviewee and assure the respondent confidentiality.

The interview has advantages over questionnaires. In an interview there is no problem of non-response (Babbie, 1990; Wiersma, 1991). Interviews provide opportunities for interchange between two people, resulting in more in-depth and clarified information. The researcher has a chance to explain any misinterpretation or ambiguous items to the respondent. Through probing and elaboration, more valuable information may be obtained when the structured list is exhausted (Babbie, 1990; Wiersma, 1991). Interviews, however, tend to be more costly than questionnaires.

In order to obtain the necessary information efficiently, an interview is to be well structured as already observed (Wiersma, 1991). For this reason, an interview schedule for a face-to-face interview with Mathematics teachers or principals was compiled (Appendix B). Another interview schedule was compiled for the North West Education Representative (Appendix C, also used as a questionnaire). In the same way as a questionnaire, an interview schedule was piloted and modified before being implemented.

The researcher observed that most of the schools where the interviews were to be conducted are Afrikaans medium schools. The interview schedule was therefore translated into Afrikaans. However, the interview was conducted in English. The purpose of translating the schedule into Afrikaans was to encourage respondents to take part and to establish rapport. Wiersma (1991) suggests that terminology used should be well understood by respondents.

3.6.3 Structured telephonic interviews

The main aim of the structured interviews was to request the respondents to prepare for the interviews or questionnaires. The purpose of this interview with the education representative was to secure an appointment for a visit and to enable him/her to prepare for the questions. The vendors' telephonic interviews were intended to request the vendors to complete the questionnaires and to explain to them why the information is necessary for this research.

3.7 Data collection procedures

3.7.1 Questionnaires

Table 3.2 summarizes the manner in which questionnaires were distributed and to whom they were distributed.

Table 3.2 Distribution of questionnaire

Questionnaire	Method of distribution	Respondent
Appendix A: Information about computers and Mathematics programs	Through the Brits district office for Education	Schools
Appendices C1, C2 and C: Information about policy guidelines	Fax	North West Education Representative
Appendices D1 and D: Information about Mathematics programs	Faxes	Vendors

3.7.2 Interview Schedules

Table 3.3 summarizes procedures followed for interview schedules

Table 3.3

Interview Schedule	Procedure	Respondent
Appendix B	1. Letter for securing appointment to conduct interview 2. Face-to-face interview	Mathematics teacher and/or headmaster
Appendix C	1. Structured telephonic interview 2. Face-to-face interview	North West Education Representative

3.8 Data analysis

The research is primarily quantative and is reported in a descriptive manner.

Wiersma (1991: 198) describes survey results as follows:

> Survey results typically are reported in a descriptive manner, but any appropriate analyses and subsequent reporting can be done to meet the purposes of the survey.

The purpose of this study is to collect information about the use and availability of Mathematics programs and therefore describing the results is suitable.

3.9 Summary

This chapter has outlined the research methodology as well as research instruments that were used to collect information about:

- schools in the Brits District which use Mathematics programs;
- policies and plans for CAI in the North West Province; and
- Mathematics programs developed in SA and the suppliers.

The next chapter describes the findings.

CHAPTER FOUR

FINDINGS

"For computers to make a difference in how students experience schooling will require teachers and administrators to modify their concepts of appropriate and inappropriate teaching behaviours, to reprioritize the value of different types of instructional content, and to change habits and assumptions that guide their classroom and school management"

(Olive, 1996, 547).

CHAPTER FOUR

FINDINGS

4.1 Introduction

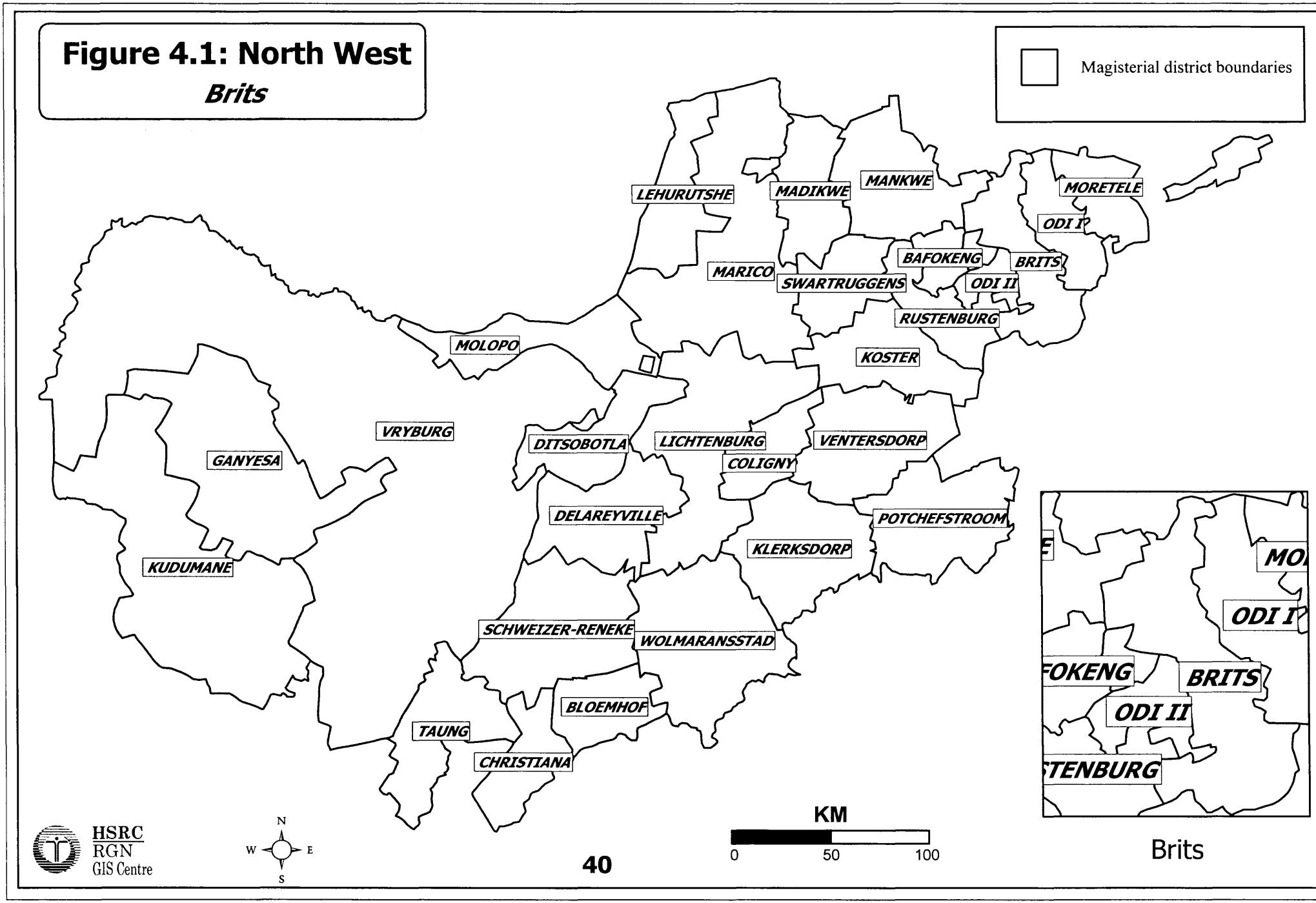
This chapter reports about the responses to questions posed at the beginning of the study. The first section presents the findings of the survey, which was intended to establish which schools in the Brits District, have computers and Mathematics programs. The second part describes responses for the interviews held at the different schools (Appendices A and B). The third section reports on the interviews with representatives from the North West Education Department (Appendix C). The last section presents responses to questionnaires that were sent to vendors (Appendix D).

Each discussion of a response is preceded by the research question posed in Chapter one of this study. However, responses are not provided in the chronological order of the questions but discussed according to similarities.

4.2 Geographical location of Brits District

4.2.1 Location

The North West Province is divided into 12 education districts of which Brits is one. The areas that fall under this district include Brits town, Bethanie, Bapong, Segwaelane, Mothotlung, Mmakau, Ga-Rankuwa, Hebron and Klipgat. Figure 4.1 indicates the location of Brits in the North West. However, the map is not specific for this study but does give an idea of where Brits is situated.



4.2.2 Sub-division of Brits District

The total number of schools in this district is 169: 112 primary schools, 29 middle schools and 28 high schools. For administrative purposes, the district is divided into six circuits *viz.* Brits, Bakwena–Bapo, Ga-Rankuwa, Hebron-Klipgat, Letlhabile and Mmakau-Mothotlung. This study is a survey of all these circuits although the District is not illustrated in the HSRC map (Figure 4.1).

4.3 Schools with computers

4.3.1 HSRC, RIEP and The Education Foundation Report

In 1996 the Department of Education, the Human Sciences Research Council (HSRC), the Education Foundation and RIEP (OUVS) gathered information on the primary schools and high schools that have computers as part of School/College audit.

This Schools/College Needs audit requested information about the number of computers available, but did not specifically request which programs were being used. The current study extends the scope of this aspect by determining which Mathematics software programs are being used by the schools with computers in the Brits District.

Table 4.1 is indicates the schools that have computers in Brits (Department of Education, HSRC, the Education Foundation, RIEP (OUVS)(1997).

Table 4.1

Primary Schools	No. of Computers	High Schools	No. of Computers
Laerskool Brits	10	Hoërskool Brits	28
Laerskool Dekroon	6	Generaal H Schoeman	40
Laerskool Elandsrand	6	Hoërskool Hartebeespoort	29
Laerskool Pansdrif	5	Hoërskool Wagpos	9
Laerskool Olienpark	5	Rabone Private school	30

4.3.2 Survey on use of Mathematics programs

This study specifically looks at the schools that have computer Mathematics programs in the Brits District.

Tables 4.2 and 4.3 summarize the findings of the questionnaire that was sent to the 169 schools in the Brits District of the North West Province to establish which schools have computers and which Mathematics programs are available (Appendix A).

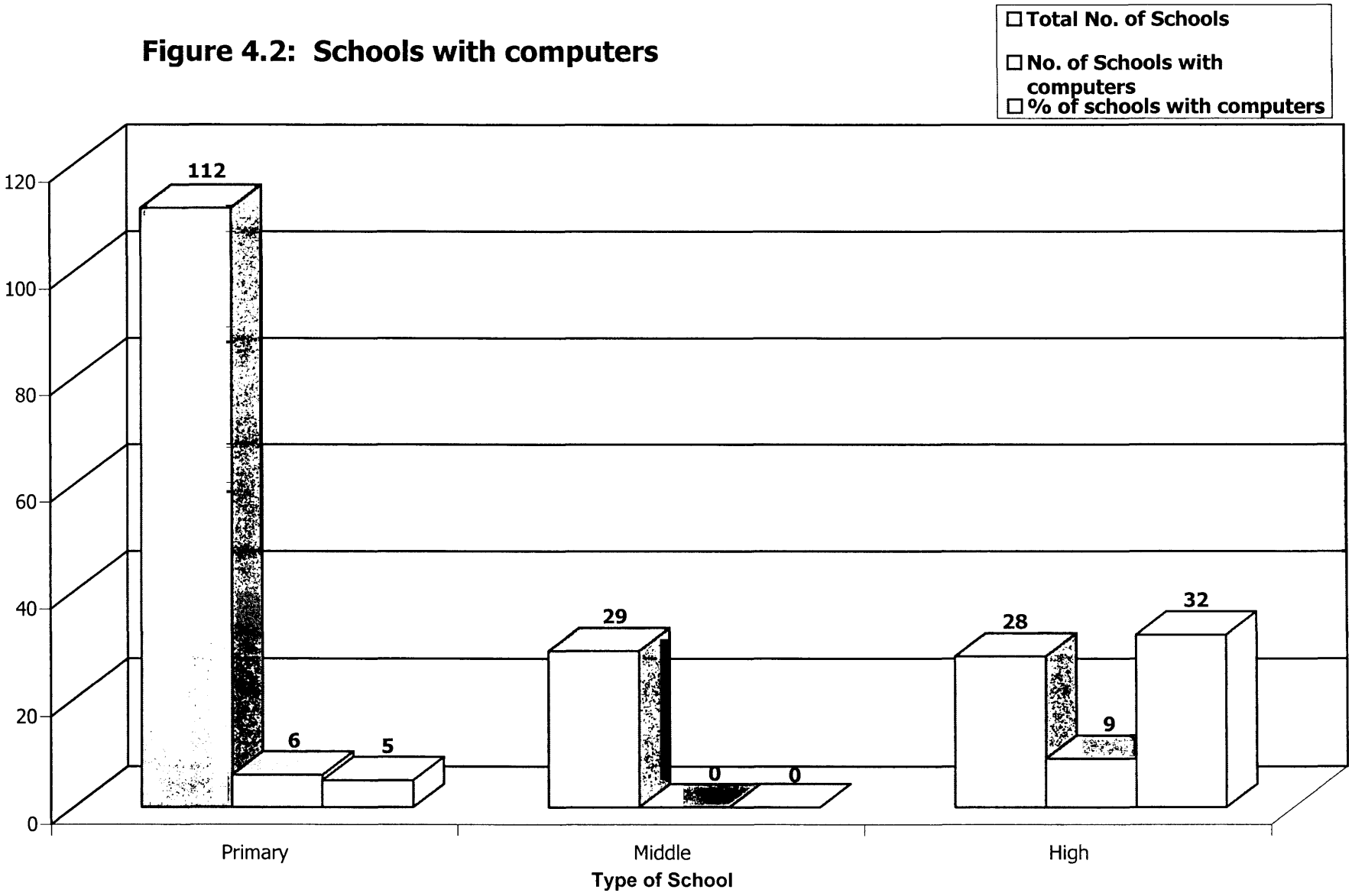
Table 4.2 Schools with computers

Type of schools	Total No. of schools	Responses		Schools with computers	
		No. of schools	%	No. of schools	%
Primary	112	56	50	6	5
Middle	29	16	55	0	0
High	28	22	79	9	32

Table 4.2 above indicates that of the 112 primary schools, 56 responded (50%) and of these 6 (5%) have computers, while out of 29 middle schools, 16 responded (55%) responded and none has computers. Of the28 high schools, 22 responded (79%) and 9 (32%) have computers.

Table 4.2 is represented graphically in Figure 4.2.

Figure 4.2: Schools with computers



Prepared by: HSRC GIS Centre

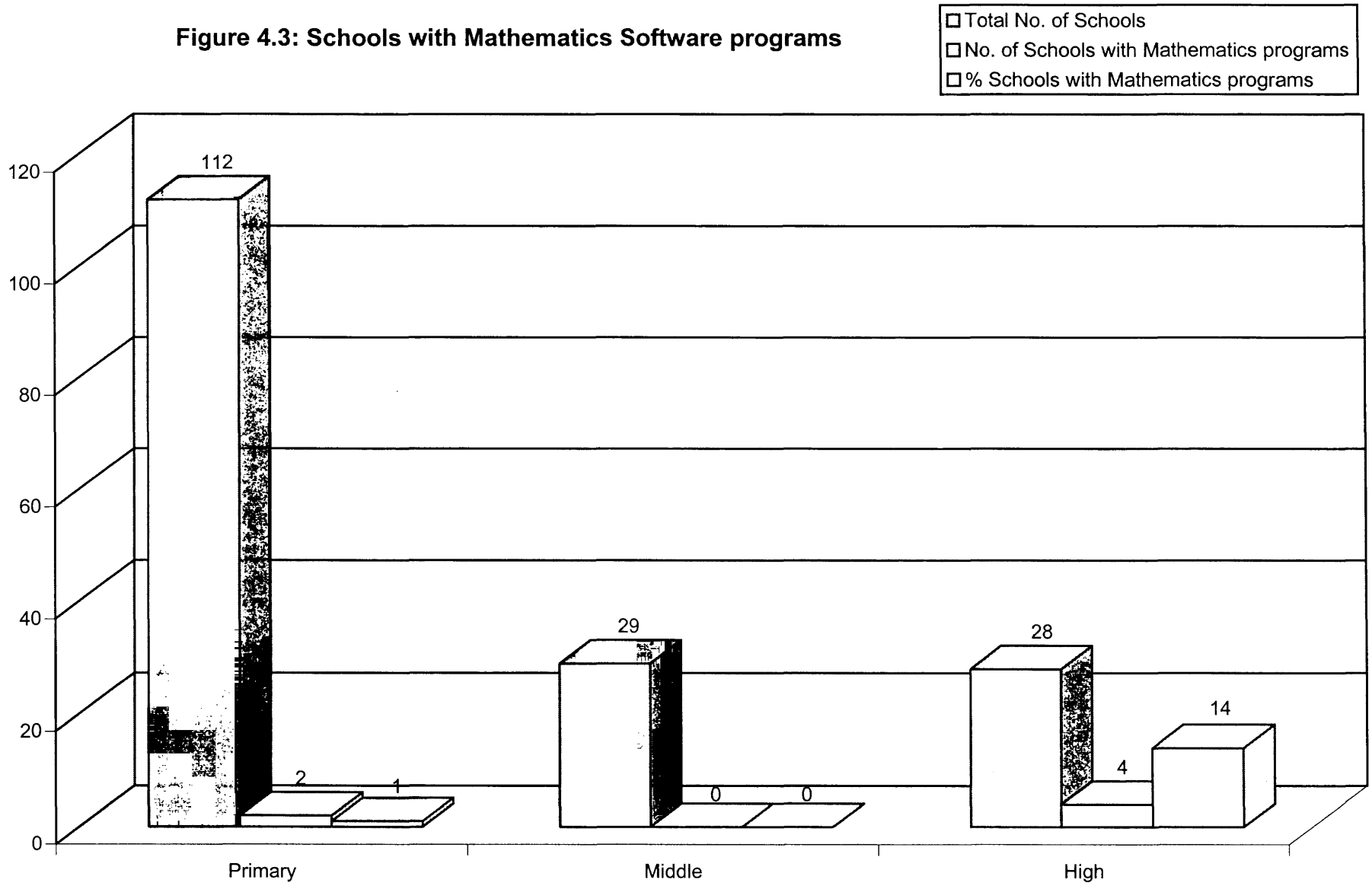
Table 4.3 Schools with Mathematics software programs

Type of school	Total no. of schools	Schools with Mathematics programs	
		No.	%
Primary	112	2	1
Middle	0	0	0
High	28	4	44

From Table 4.2 and Table 4.3 one may deduce that of the **six** primary schools that have computers, **two** (1%) have Mathematics programs while of the **nine** high schools that have computers, **four** (14%) have Mathematics programs.

Table 4.3 is represented graphically in Figure 4.3.

Figure 4.3: Schools with Mathematics Software programs



Prepared by: HSRC GIS Centre

Tables 4.4 summarizes of the actual primary schools where Mathematics software programs are used and the schools from which the sample for conducting the interview was selected..

Table 4.4 Primary schools with computers and Mathematics programs

Name of school	Number computers	Name of Mathematics programs available at the school
Morekolodi	36	*Maths Story*
Laerskool Pansdrif	4	Not available
Laerskool Skeerpoort	1	Not available
Laerskool Brits	4	Not available
Laerskool Voorwaarts	7	*Sergo, Cairoo*
Leokeng	2	Not available

Table 4.4 indicates those **two** schools, *viz.*, Morekolodi and Laerskool Voorwaarts have Mathematics programs.

Table 4.5 provides information about the high schools that have computers and Mathematics software programs.

Table 4.5 High schools computers and Mathematics programs

Name of school	Number of computers	Name of Mathematics programs available at the school
Central	20	Not available
Hoërskool Brits	28	Not available
Hoërskool Hartebeespoort	30	*Sergo*
Hoërskool Wagpos	22	*Sergo, TOD Wisk St 6, Edumaths*
L.G. Holele	1	Not available
H.L. Setlalentoa	1	Not available
Micha Kgasi	32	*Maths Tutor*
Tsogo	32	*Power Code Maths*
Rabone Private	30	Not available

4.4 A Comparison of the study by the Department of Education, the HSRC, the Education Foundation, RIEP (OUVS) (1996) and The Current Study

Table 4.6 gives a comparison between data about schools which have computers gathered by the Department of Education, the HSRC, the Education Foundation, RIEP (OUVS) (1996) and the findings of The Current Study.

Table 4.6 Schools with computers: Comparison

Type of school	Department of Education, HSRC, the Education Foundation, RIEP (OUVS) (1996)		The Current Study (1998)	
	Name	**No.**	**Name**	**No.**
Primary	Laerskool Brits	10	Laerskool Brits	10
	Laerskool Dekroon	6	Morekolodi	36
	Laerskool Elandsrand	6	Laerskool Skeerpoort	1
	Laerskool Pansdrif	5	Laerskool Pansdrif	4
	Laerskool Olienpark	5	Laerskool Voorwaarts	7
			Leokeng	2
High	Hoërskool Brits	28	Hoërskool Brits	28
	General H Schoeman	40	Central	20
	Hoërskool Hartebeespoort	29	Hoërskool Hartebeespoort	30
	Hoërskool Wagpos	9	Hoërskool Wagpos	22
	Rabone Private school	30	Rabone Private school	30
			L.G. Holele	1
			H.L. Setlalentoa	1
			Micha Kgasi	32
			Tsogo	32

From Table 4.6 one may deduce that data gathered the Department of Education, the HSRC, the Education Foundation, RIEP (OUVS) (1996) has included the following:

Primary Schools:

- Laerskool Dekroon;
- Laerskool Elandsrand; and
- Laerskool Olienpark

High Schools:

- General H Schoeman

These schools are not included in the Current Study. For the Current Study, the following should be noted:

- Only 50% of the primary schools responded; and
- 79% of high schools responded.

This study has established additional schools that have computers. These schools include:

Primary Schools:

- Laerskool Skeerpoort;
- Laerskool Voorwaarts;
- Leokeng; and
- Morekolodi.

High Schools:

- Central;
- H.L. Setlalentoa;
- L.G. Holele;
- Micha Kgasi; and
- Tsogo.

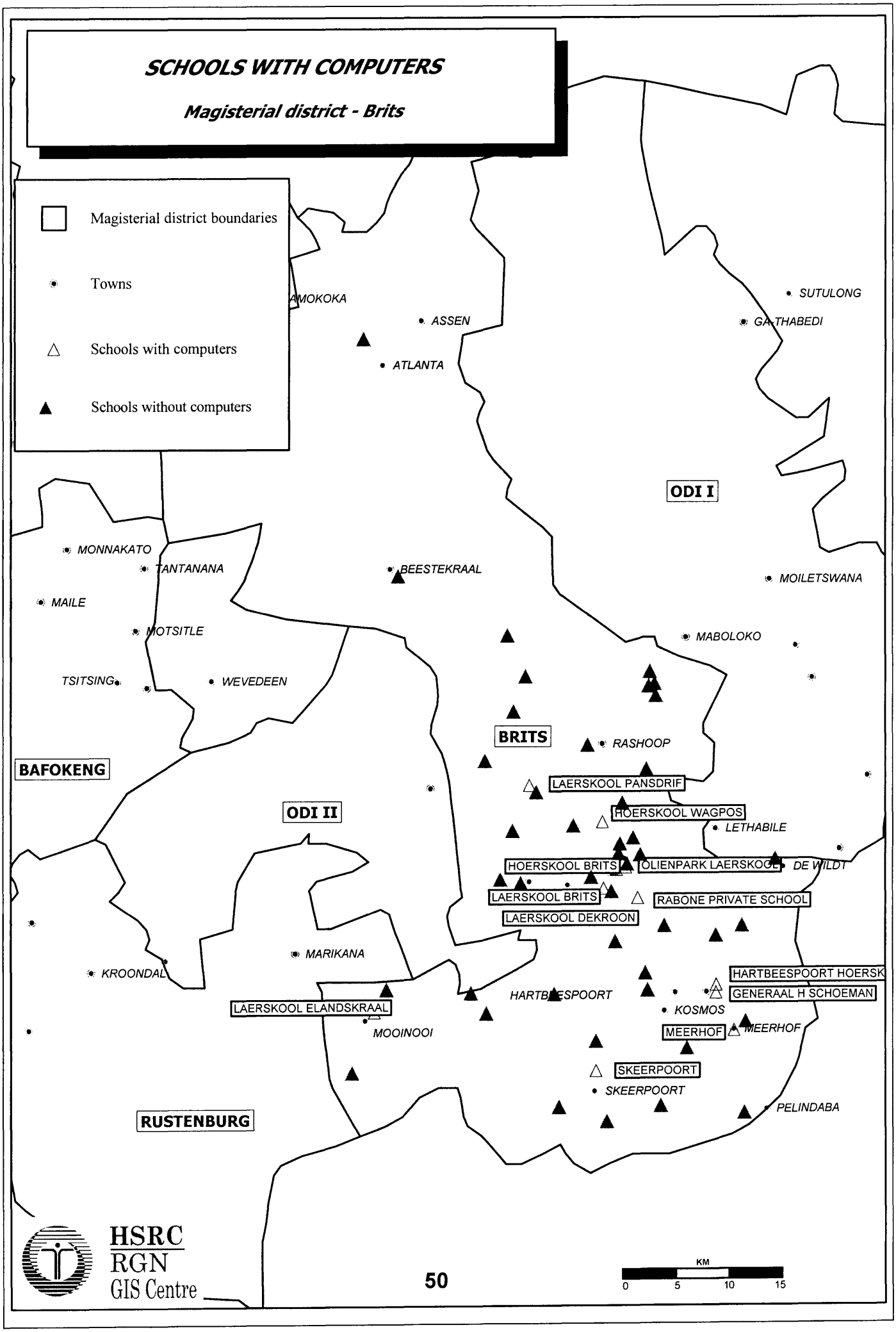
For Hoërskool Brits data is the same for both studies. Hoërskool Wagpos initially had 9 computers. According to the teacher interviewed, more computers were bought and the number increased to 22. At Hoërskool Hartebeespoort, there are 30 computers currently according to the teacher. While the Current Study has established that Laerskool Pansdrif has 4 computers, the other study recorded 5 computers. The Current Study has not

established reasons for the number of computers which are either less or more than what the study by the Department of Education, the HSRC, the Education Foundation, RIEP (OUVS) (1996) recorded for Laerskool Pansdrif and Hoërskool Hartebeespoort.

The Current Study has also established that some schools that have computers also acquired Mathematics software programs and are using the programs. These schools are provided in Tables 4.4 and 4.5.

Figure 4.4, compiled by the HSRC, shows the location of schools that have computers, according to their findings of needs analysis by the Department of Education, the HSRC, the Education Foundation and RIEP (UOVS, 1996).

The section that follows discusses the findings about the use of these Mathematics software programs available at the schools.



4.5 Use of Mathematics programs in schools

This section is devoted to reporting the findings of the current use of Mathematics programs in schools. The report is compiled from five interviews of which one was in a primary school and five were conducted in high schools. As no middle schools reported that they have computers and Mathematics programs, no interview was conducted in any middle school. For each response the question number/s on the interview schedule is/are repeated.

4.5.1 Responses to questions 1.1-4.2 of Appendix B

Table 4.7 gives a summary of responses to the questions above (Appendix B).

Table 4.7 Summary of responses to questions 1.1-4.2

Research Question		Findings					
		Name of School					
		Morekolodi Primary	**Hoërskool Brits**	**Hoërskool Hartebeespoort**	**Hoërskool Wagpos**	**Micha-Kgasi High**	**Tsogo High**
1.1	How many computers do you have in your school?	36	28	30	22	32	32
1.2	How much did the computers cost?	not sure	±R10 000	not sure	±R100 000	not sure	±R150 000
2.	Where are the computers placed?	Computer lab	Computer lab	Computer lab	Computer lab	Computer lab	Computer lab
3.	Who is responsible for the computers?	teacher	teacher for computer science	teacher for computer science	HOD for Mathematics	Headmaster HOD for Mathematics	Teacher for computer literacy
4.1	Which Mathematics program/s is/are available in your school?	*Maths Story*	*Wispro* (personal copy)	*SERGO*	*SERGO, TOD Wisk St 6, Edumaths*	*Maths Tutor*	*Power Code Maths*
4.2	How much does it cost?	not sure	±R490	not sure	± R5000	was donated with computers	not sure

From the data illustrated in Table 4.7 the following observations are made:

- All the schools where interviews were held have **at least** 22 computers. What is **common** within the schools is how they **have acquired** computers. The schools involved parents to raise money through fund raising. Furthermore the schools requested donations from different companies. The manner in which the schools have acquired computers should serve as an example to others so that **financial constraints** should not be an excuse for not looking at other resources for improving environments for learning and teaching.
- Except for Tsogo and Wagpos, the teachers at other schools were not sure about how much their computers **cost**. The two schools spent within a region of R100 000 for purchasing computers. It would seem that the teacher at Hoerskool Brits underestimated the cost of their computers which she claimed was about R10 000.
- All the schools have computer laboratories and a teacher responsible for the smooth running of the 'lab'. At Hoërskool Brits and Hoërskool Hartebeespoort, Computer Science teachers are responsible while at Wagpos the HOD for Mathematics is responsible. At Morekolodi a teacher who volunteered has been assigned the responsibility, while the teacher at Tsogo also teaches computer literacy. At Micha Kgasi the headmaster and three teachers, who volunteered, are responsible.
- Except for Micha Kgasi all the schools have South African Mathematics programs. However, *Wispro* at Hoërskool Brits is the Computer Science teacher's personal copy.
- The teachers interviewed at Morekolodi, Hartebeespoort and Micha Kgasi were not sure as to how much the programs **cost**. *Wispro* **cost** ±R490 according to the teacher. At Tsogo, the headmaster indicated that the ±R150 000 included also **costs** of the programs.

4.5.2 Responses to question 4.3

This section outlines the findings of question 4.3, which is about objectives of the syllabi.

4.5.2.1 Primary School Morekolodi

The primary school uses the *Maths Story*. The teacher is satisfied that the objectives of the syllabus are met in this program. An example that the teacher gives is that of developing **independence** in the learners. The program provides **feedback** to enable learners to work through the problems **on their own**, something that a teacher is not able

to achieve during the lessons. Feedback is one of the unique characteristics of computers, which may be harnessed to make learning interesting (Underwood & Underwood, 1990; Alessi & Trollip, 1991; Jarvis, 1993; Francis, 1994).

4.5.2.2 High Schools

The teachers who were interviewed at Hartebeespoort and Wagpos agree that SERGO **satisfies** the **objectives** of the syllabus. Tsogo, which has acquired Power Code Maths, finds the program **satisfactory**.

In all cases the teachers assert that because learners can work on the programs individually they may develop **independence** and **responsibility** towards learning. The learners can also work as a group thereby promoting **cooperation** among them, **sharing** ideas, agreeing about solutions to answers which lead to reaching **consensus** among them.

4.5.3 Responses to questions 4.4-5.4

Tables 4.8 and 4.9 provide answers to questions about sections of syllabi covered by the programs, the grades for which the programs were compiled, classes in which the schools use the programs as well as timetable and the periods in which the programs have been used.

4.5.3.1 Responses for questions 4.4-5.4

Table 4.8 summarizes responses to questions 4.4-5.4 for the primary school. The questions are repeated in the table.

Table 4.8 Morekolodi Primary School

Research Question		Mathematics Program *Maths Story*
4.4.	Which sections of the syllabus does it cover?	all the sections
5.1.	For which classes is/are the program/s compiled?	Grades 0-6
5.2.	In which classes do you use the program?	Grades 1-6 Two periods a week: 1 hour per period
5.3.	How many times per week do you use the program?	Two periods a week: 1 hour per period
5.4.	For how long have you used the program?	3 years

Table 4.8 indicates that the following deductions can be made:

- Maths Story covers **all** sections of the **syllabus** and therefore can be useful to primary schools.
- The program is **developed** for all the classes in the primary school, i.e. Grades 1-6.
- Morekolodi **implements** the program in all Grades 1-6.
- The **timetable** at Morekolodi **accommodates** all classes for **two-one hour periods** per week.
- Morekolodi has been **using** this program for **three** years.

It is possible that other primary schools may learn from Morekolodi about how to **utilize** resources to their **fullest capacity**.

4.5.3.2 High Schools

Table 4.9 summarizes responses to questions 4.4-5.4 for the high schools that are using Mathematics programs.

Table 4.9 Responses to questions 4.4 – 5.4

Research Question		Mathematics Program			
		Power Code Maths	***SERGO***	***Edumaths***	***Wispro***
4.4.	Which sections of the syllabus does it cover?	all sections	all sections	all sections	all sections
5.1.	For which classes is/are the program/s compiled?	Grades 8-12	Grades 8-12	Grades 8-12	individual basis
5.2.	In which classes do you use the program?	Grade 12	Grades 8-12	Grades 8-12	per request by interested learners
5.3.	How many times per week do you use the program?	afternoons	afternoons	afternoons	As required by learners
5.4.	For how long have you used the program?	3 years	5 years	less than a year	less than a year

Responses from the **teachers** for questions 4.4-5.4 illustrate the following:

- *Power Code Maths, SERGO and Edumaths* cover **all sections** of the syllabi from Grade 10 to Grade 12.
- The three programs have been **compiled** for Grades 8-12.
- At Tsogo, *Power Code Maths* is **used** in Grade 12 while *SERGO* is **used** for Grades 8-12 at Hartebeespoort and Wagpos.
- The **timetable** at all the high school is **overloaded** and therefore cannot **accommodate** formal periods for learners to work on the programs. From the above table one can observe that all the high schools attempt to cater for learners to work on the programs in the afternoons. However, according to the teachers this arrangement is optional for the learners. As a result, the teachers who were interviewed have observed that the majority of the learners who take the trouble to utilize Mathematics programs are those who generally do well in the subject. The learners who, in fact, need this type of remedial work seem to lack motivation or interest to explore with the programs.

The problem of **time** in the schools is not surprising. Metrowich (1991), Lamont (1993) and Gray (1997) have identified **time management** as one of the problems that many schools are experiencing because of too many school activities. Other problems include school disruptions through stay-aways, go-slows, chalk-downs, *et cetera.* (Gray, 1997). Gray (1997) has further identified that **Mathematics** in South Africa, compared to other countries, is not allocated **sufficient** time.

- *Power Code Maths* has been used for **three** years, *SERGO* for **five** years while *Edumaths* and *Wispro* have been used for **less** than a year.

4.5.4 Responses to questions 5.5 and 7.1

In this section responses to questions 5.5 and 7.1 are discussed. While question 5.5 is intended to establish whether the learners performances have improved since they have started using the programs, question 7.1 establishes whether the learners can benefit from the programs.

The first section outlines the findings from the primary school and the second, high schools.

4.5.4.1 Primary School

At Morekolodi the **timetable** accommodates **two periods** of **one hour** each **per week** for learners to do Mathematics on *Maths Story*.
The teacher at Morekolodi has observed that:

- learners go to class with **enthusiasm** and **excitement**;
- at the end of the periods learners **moan** to show **dissatisfaction** when the period ends.

The teacher said: "Kids [sic] come rushing to the centre. They complain when they are told it's time up."

These observations suggest that learners **enjoy** doing Mathematics on the computer. According to Costello (1991), learners have a greater chance of doing well if they have **interest** and **enjoy** what they are learning. Pelgrum (1991) suggests that computers make school **interesting**. This is evident from what the teacher at Morekolodi has observed.

The teacher at Morekolodi also describes various important **benefits** for learners. These are summarized as follows:

The learners:

- receive **individual** attention;
- can work together in **pairs** or **groups** of 5;
- proceed at their **own pace**;
- get **immediate** feedback;
- are exposed to **different methods** of solving problems;
- can have **remedial lessons** on Mathematics topics that they did not understand during the normal class;
- enjoy **extra support** that the programs provide for learners;
- have lessons presented through different **colours** and **shapes**; and
- are exposed to **challenging** problems.

According to the teacher, all these benefits are unlikely in the traditional style class situation. In the classes, a teacher is faced with more learners and therefore not able to give **individual** attention. Each learner may **proceed** on his/her **own** getting **immediate** feedback in the event of a mistake occurring and obtain **extra support**. The teacher maintains that some of the **methods**, that the learners get exposed to, are also new to her.

Some teachers do not have resources to prepare lessons in a **colourful** way. They tend to teach geometry theoretically or use only what is in the text-book. Generally, teachers do not have sufficient time in the classroom to do **challenging** problems. Sometimes it may not only be a problem of lack of resources or insufficient time but the poor training background of Mathematics teachers (Metrowich, 1991; Lamont; 1993; ANC, 1995; Gray, 1997). The program appears to accommodate these short-comings.

4.5.4.2 High Schools

The **timetable** situation in the high schools is different from that of the primary school, except for **one** school, **Micha Kgasi**. While Micha Kgasi accommodates **one period** per cycle of six days for working through *Maths Tutor*, the other schools allocate **afternoons** for computer-enhanced instruction. However, the teachers suggest that learners do still benefit from the programs.

The teachers at Brits, Hartebeespoort, Micha Kgasi, Tsogo and Wagpos assert that using Mathematics programs for **extra lessons** and **remedial teaching** may have potential benefits for learners.

Although the **benefits** are similar to those discussed for the primary school, they are repeated in this section to make the report complete.

The learners:

- receive **individual** attention;
- can work together in **pairs** or **groups** of 5;
- proceed at their **own pace**;
- get **immediate** feedback;
- can have **remedial lessons** on Mathematics topics that they did not understand during the normal class;
- are exposed to **different methods** of solving problems;
- enjoy **extra support** that the programs provide for learners; and
- are exposed to **challenging** problems.

Micha Kgasi is currently using *Maths Tutor*. Although this is not a South African program, the teacher has found it useful for the teaching of basic concepts in Mathematics.

The teacher has not formally assessed the impact of *Maths Tutor* on performance of the learners. However, his observation is that the learners are **motivated** and **excited** to go to the laboratory during the periods that have been allocated. The learners are always **punctual** in arriving at the laboratory, whereas they are not always punctual when there

is a changeover from one class to the other for ordinary lessons. Motivation is said to contribute positively towards learners' performance.

Brits has not acquired a Mathematics program for the school. However, the teacher has a personal copy of *Wispro*. The teacher has reported a few observations:

- that the program allows for **individual** attention and **self pacing**. The learners are able to receive **immediate feedback** each time they have committed mistakes; and
- that the program accommodates different options of lessons depending on the **level** of **understanding** of the learner.

Hartebeespoort and **Wagpos** have both acquired *SERGO*. **Wagpos** has also acquired *Edumaths* and *TOD Wisk St 6*. **Tsogo** uses *Power Code Maths*. The following findings relate to *Power Code Maths* and *SERGO*.

Both programs are not fully utilized because of lack of **time**. According to the teachers **Hartebeespoort** and **Wagpos** and the headmaster at **Tsogo,** learners who are willing to work on certain afternoons are the ones who benefit. The program provides for **individual** attention and **immediate** feedback.

The programs are **self pacing** and will not allow a learner to make a mental leap from one section to the other without having mastered a section. Learners have an opportunity to struggle alone until they can arrive at solutions to problems. This type of **challenge** enables them to **learn** more and even **better** than when they are taught by a teacher. As a result, the learners are able to work **independently** without the help of the teachers. The teachers maintain that **immediate** feedback is **invaluable** to the progress of learners. Feedback from teachers often takes some time and learners might forget about their mistakes.

Learners may also work in **pairs** or **groups** of 4 or 5 thereby promoting **co-operative** learning. Co-operative learning promotes sharing of ideas and team work, the skills that learners will need in their future careers. This **strategy** in class is said to be **time-consuming**, especially in Grade 12, where a teacher has to make sure that when these

learners write an **external examination**, they have covered all sections of the syllabus, including those that were not completed in the lower classes.

The teacher at **Wagpos** suggested that the learners may also benefit from **different methods** of solving Mathematics problems and solving challenging problems. Lack of **time** in the classroom does not allow a teacher to **explore** the different methods and to give learners an opportunity to work through **challenging** problems. Sometimes, a teacher might not be aware of the other methods available. Poor Mathematics training and lack of experience might scare the teacher away from giving learners challenging problems.

At **Tsogo** the learners in Grade 12 are allowed to go for **remedial work** in the **afternoons** by working through the lessons of the **relevant sections** of *Power Code Maths*. The headmaster reported that learners who take the trouble and are **willing** have **improved** their **performance**. Although no formal testing has been conducted, the headmaster maintains that the learners, who do exercises on the program **regularly**, have shown some **improvement** in their **class tests**.

4.5.5 Responses to question 7.2

This section discusses the findings of question 7.2, which attempts to determine whether the teachers may benefit from the program or not.

The findings suggest that Mathematics programs may play an important role for teachers too.

The teachers who have worked through *Maths Story* used at **Morekolodi Primary School**, and *SERGO* - available at **Hartebeespoort** and **Wagpos**, *Power Code Maths* – acquired at **Tsogo** - are satisfied that the **programs cover** all **sections** of the **syllabi**. As already noted, research has shown that some Mathematics teachers have **poor** background knowledge of Mathematical concepts that they have to teach (Metrowich, 1991). The programs may partially **alleviate** this problem if teachers have an **opportunity** to work through the programs with a purpose of learning. Metrowich

(1991) established in his research that the teachers' Mathematical knowledge improved after exposure in the TOAM project.

The teacher at Morekolodi Primary School suggests that the **different colour** and **shape** presentation of lessons in *Maths Story* encourage teachers to prepare **teaching aids** especially for the **geometry section**, which learners find more difficult to understand as was observed earlier in this study.

All the teachers who were interviewed maintain that the **programs** provide **various methods** of solving problems. The teacher at Wagpos has also benefited from **alternative** ways of **assessing** learners in tests and examinations. Despite the good **background knowledge** and suitable **qualifications** that the teachers have, they **acknowledge** that they have also learnt from the different methods of solving problems that are applied in the programs. The teachers suggest that if other teachers can have an opportunity to be **exposed** to the various **strategies** that are provided by the programs, they are likely to **improve** their **teaching skills** in Mathematics.

Another problem that Metrowich (1991) highlighted is that of unwillingness of teachers to do remedial work with learners. It is however unlikely for a teacher who has limited knowledge about the subject content to think of doing remedial teaching. At Tsogo, although the Mathematics teacher has a good background knowledge, *Power Code Maths* is used for remedial classes and the learners' performance is improving. According to Weichers (1982) CAI is useful in remedial teaching to reinforce and supplement normal teaching.

The **potential** that the programs have in **exposing** teachers to different ways of teaching could be exploited to assist the teachers. Metrowich (1991) observed that teachers' **attitudes** developed positively because they became more **confident** in what they were teaching.

4.5.6 Responses to question 6

When asked if the programs are suitable for "Curriculum 2005" the teachers were unwilling to provide a response. They maintain that they are not yet sure as to what

"Curriculum 2005" is about and therefore do not want to give a false impression about the suitability of the programs.

4.5.7 Responses to question 8

In this section the findings of responses to question 8, which requested the teachers to give advice about the use of computers in education, are reported.
The teachers suggest that a lot of homework is to be done before this challenging **decision** to use computers can be implemented. The **major** points highlighted include:

- the **training** and attending of **workshops** by teachers; and
- thorough **planning** of a computer centre.

The idea of training teachers is not a concern for teachers only. Hodgson (1995) maintains that teacher training is most crucial to successful implementation of IT in education. Teachers should be trained in the use of computers. Furthermore, teachers should be assured that the main objective of CAI is to improve their effectiveness and efficiency and not to replace them. Chan and Korostoff (1990) acknowledge, quite rightly, that computers cannot replace the human element crucial in the learning process.

The teachers suggest that thorough planning involving all stake holders should take place for successful implementation of computer-assisted learning programmes. They suggest various steps to be followed, which include:

- knowing the costs involved i.e. **budget**;
- determining how and which **hardware** to purchase;
- identifying what is available in terms of **software**;
- **visiting** schools with computers so that planners can learn from those with experience; and
- establishing a **committee**, which will draw up a business **plan** for computer **needs**.

4.5.8 Responses to question 9

Question 9 aimed at allowing teachers to give their own opinions about the potential usefulness of Mathematics software programs.

The teachers interviewed at Morekolodi Primary School, Brits, Hartebeespoort, Wagpos and Micha Kgasi maintain that they are confronted by **various** problems in the teaching of Mathematics.

The problems identified by teachers interviewed include:

- a **negative attitude** by learners towards Mathematics
- a belief by learners that Mathematics is **difficult**;
- the **lack** of sufficient **time** to enable teachers to attend to learners who have serious problems **individually**; lack of sufficient time to do **remedial** teaching; and
- **poor** performance by learners in general.

Consequently, the teachers suggest there should be some **incentives** for Mathematics teachers who are willing to:

- promote the use of CAI in Mathematics teaching;
- spend extra hours with learners exploring the use of Mathematics programs; and
- go for training in CAI in Mathematics teaching.

The existing problem of the school **timetable**, which cannot accommodate such extra lessons, suggests that Mathematics teachers should extend their time at school if they they are interested in exploring Mathematics programs so that Mathematics teaching in schools should improve.

4.5.9 Summary: interviews in schools

Section 4.5 outlines the findings of the interviews conducted in connection with the use of Mathematics programs at Morekolodi Primary School and five high schools, *viz.* Brits, Hartebeespoort, Micha Kgasi, Tsogo and Wagpos.

The results suggest that Mathematics programs have the potential to alleviate some of the problems that have been identified with the teaching of Mathematics in the schools.

The major findings about the **potential** usefulness of **Mathematics** programs include the facts that

- The **syllabus** is adequately covered.

The teachers who have had an opportunity to work through the *Maths Story*, *SERGO* and *Power Code Maths* suggest that the programs cover **all** sections of the syllabi. As a result, the teachers and learners benefit in terms of the mastery of Mathematical concepts.

- **Individualization and group work** is possible.

The learners may have their learning **individualized**. This strategy may enable teachers to know the type of problems that learners are experiencing. Individualized learning may also enable **slow** learners to be accommodated during the lessons because with the normal teaching that takes place, teachers rarely find sufficient time to attend to slow learners.

Group work is assumed to be **time** consuming. The learners may solve problems together as groups of **four** or **five** and in the process learn **sharing, co-operation, team work** and the importance of having to reach **consensus** about decisions so that these can be successfully implemented.

- **Teaching methods** may be extended.

The teachers have observed that the programs give **various** methods of **solving** problems and **assessment**. These may benefit all Mathematics teachers, both with good or poor Mathematics backgrounds. The teachers may improve their skills in teaching Mathematics.

- **Timetables** need to include specific times for CAI in Mathematics teaching.

According to the teachers, the **time** allocated for Mathematics is a **serious** problem. The current situation of between **three** and **four** hours **inhibits** any attempts to implement CAI in Mathematics teaching.

4.6 Interview: North West Education Department

4.6.1 Introduction

The offices of this education department are in Mmabatho, the capital of North West Province. Brits is about 300 kilometres away from Mmabatho.

The first interview was conducted on 9 June 1998 in Mmabatho. Not all the questions on the schedule (Appendix C) could be answered. For questions related to policy making on computers, the researcher was referred from one person in Mmabatho to another in Potchefstroom and again back to Mmabatho. Subsequent to this problem, the researcher then resorted to a postal questionnaire rather than the initial plan of an interview to save on travelling costs and time. As stated earlier, the researcher had no funds for the research and therefore the travelling costs needed to be kept to a minimum.

4.6.2 Interview: Responses to questions 1.1 and 1.2

Senior Deputy Chief Education Specialist for Mathematics: Curriculum Planner was interviewed in connection with plans for improving performance in Mathematics in the North West. What now follows is his response to questions 1.1 and 1.2 which attempted to establish which plans are in place for improving Mathematics performance in Mathematics in schools and whether a curriculum which can accommodate CAI in the subject will be developed (Appendix C).

4.6.2.1 Responses to question 1.1

The Education Specialist interviewed supplied information about initiatives taken to improve Mathematics instruction by the North West Education Department. These initiatives include projects funded by:

Telmast and **Eskom**: These project are meant for improving and upgrading teaching **skills** for primary and secondary school Mathematics teachers through **workshops**.

Another project involves the Education Department in association with the University of Potchefstroom. The Sediba Project is intended for **Mathematics** and **Science** teachers to **upgrade** their qualifications and, in the process, improve their teaching **skills**.

Kgatelopele and a **Maths Centre** for primary teachers are **special** projects in which **workshops** for primary school teachers are run.

4.6.2.2 Response to question 1.2

According to the representative Mathematics subject **policy** does not make any **provision** for software and hardware.

However, in 1996 twenty computers were donated by a company, which the Education Specialist does not know. These computers were supposed to be used by students who were given a **second** chance to write only Grade 12 **Mathematics** and **Physical Science** or **Accountancy** examinations so that they could **improve** their results of the previous year. These learners were taught the two subjects for a year.

The major **objective** of this project is to enable the learners to follow science **careers** at tertiary institutions the following year after having improved their **performance** in Mathematics and Science.

4.6.3 Postal questionnaire

The researcher faxed through the interview schedule to two people to whom she was referred by the Educational Specialist in order to obtain information about policy guidelines about computers and CAI.

Despite several attempts by the researcher to contact the relevant people, there was no response. Non-response is one of the major problems with questionnaires (Babbie, 1991; Fodd, 1993; Cohen & Manion, 1994).

4.6.4 Summary of findings about plans for Mathematics teaching by North West Education Department

The North West Education Department has taken initiatives to **improve** Mathematics and Science teaching in schools. Projects funded by **Telmast** and **Eskom** involve the running of **workshops** for Mathematics and Science teachers. **Kgatelopele** and **Maths Centre** are also running workshops for primary school Mathematics and Science teachers. **Potchefstroom University** is running the **Sediba Project** for the **upgrading** of teacher **qualifications** in **Mathematics** and Science.

The researcher was **not** successful in **establishing** whether there are **policy guidelines** for **computers** and **CAI** for the North West Education Department. All attempts to have a questionnaire in connection with policy guidelines completed were unsuccessful.

4.7 Responses from Vendors

4.7.1 Introduction

This section gives a report about South African Mathematics programs, which are available on the market. It should be emphasized that the list may not include all the programs available on the market. However, various academicians and practitioners were contacted in an effort to draw up as much information as possible about what is available.

The researcher's supervisor provided a list of computer programs as well as the names of academicians to be consulted for more information. In addition, the supervisor wrote a covering letter to some companies to explain the purpose of this research.

Table 4.10 is a list of academicians consulted in connection with what is available on the market.

Table 4.10 Names of academicians and practitioners contacted

Name	Institution
Professor C.A. Hodgkinson	University of Pretoria
Professor J. van Staden	University of Pretoria
Professor J. Cronjé	University of Pretoria
Professor M. Braun	University of Pretoria
Mr. J. Fouche	University of Pretoria
Dr D. Gray	HSRC
Ms A. Strehler	Softeach

4.7.2 Companies contacted

Table 4.11 provides a summary of companies to which questionnaires were sent. The table includes three dates, viz., date sent, follow-up date and the date on which a response was received.

Table 4.11 Dates: Mailing and Responses

Name of company	Date sent	Follow-up	Date responded
Bellamy & Hough	4/5/98		20/5/98
Breinlyn	4/5/98	10/7/98	10/7/98
Cami Mathematics	4/5/98	13/7/98 & 19/8/98	19/8/98
Educats	10/7/98	19/8/98	
Educorp Software S.A.	10/7/98	19/8/98	19/8/98
Force Computer Education	16/7/98	19/8/98	
Objective Business Consultants	10/7/98		10/7/98
Powercode	4/5/98	10/7/98	23/7/98

Follow-up phone calls to Force Computer Education, which provides *Maths Story* and Educats were not successful. The researcher was also trying to minimize costs on telephone bills. Educats contact number is in Cape Town.

Several unsuccessful attempts were made to contact companies that provide *Cairoo*, *SERGO* and *Ultimaths*. The researcher was unable to contact them altogether because of lack of information about contact numbers. Furthermore, the researcher could not establish information about contact person/s for *Computer Based Tutorial* (CBT) from Cliff's StudyWare suggested by Perlman (1994).

4.7.3 Findings: South African Mathematics Programs

This section reports about responses to questionnaires from the suppliers of Mathematics programs. While some companies responded promptly others were reluctant despite the covering letter written by the supervisor. However, after further explanation and clarification by the researcher, responses followed.

4.7.3.1 Bellamy and Hough

This company supplies ***Basic Math Competency Skills: Geometry Alive/ Algebra made Painless***.

The program is available in English only. It is suitable for Grades 1-12. Minimum hardware required is 486. The program can run on DOS, Windows 3.11 or 95, Novell or NT.

The price ranges from R600-R16 000.

The list of schools where the program is implemented was supplied after a follow-up phone call done on 11/6/98. The program is installed at Mmabana Cultural Centres in Mafikeng and Taung in the North West Province, and also at the International School in Mafikeng.

4.7.3.2 Brainline-Breinlyn

This company supplies Mathematics as well as other school subjects programs. The programs are compiled according to the South African core syllabus of Grades 4-9. The company anticipates completing the program for Grades 0-3 by the end of 1998.

Brainline Junior University is the name of the Mathematics program and it is available in Afrikaans First Language. The English translation version is almost complete for Grades 4-7.

The program currently costs R150 per month for 12 months for the first grade. This amount increases by R50 per month for additional grades.

The program operates on Windows 3.11 or 95, CD ROM drive, Soundcard, VGA and 8M RAM.

A list of schools was not provided. However, the contact person claims that many schools are using this program. Permission from the schools is required before such a list can be provided.

No evaluation report is available. However, a demonstration package is available for evaluation if the researcher is willing to do the evaluation.

4.7.3.3 Cami Mathematics

The program ***Cami Maths*** is available in both Afrikaans and English for Grades 0-12. The price depends on the number of workstations on a network.

It can be run on any computer from an XT and upwards. It requires Software Operating System of either DOS, Windows 3.11 or 95.

No names of schools are provided except that it is used by ± 500 South African schools. Furthermore, franchisees and schools in Namibia, Botswana, Zimbabwe and a school in

UK use it. According to the contact there are many enquiries from Australia, New Zealand, USA, Canada and Greece.

4.7.3.4 Educorp Software SA

This company provides ***EduMaths***, which is available in both Afrikaans and English. The program currently costs R200 at different dealers.

The program is suitable for primary schools and high schools.

Hardware specifications and Software Operating System:

Primary school version:
386SX
minimum 2Mb RAM
MS-Windows 3.1 or 95 and SVGA monitor

High school version:
486 DX
4Mb RAM
MS-Windows 3.1 or 95 and SVGA monitor

The program is implemented at Westville Primary School.

4.7.3.5 Objective Business Consultants

This company provides ***Wis-Pro/ Math-Pro*** which available in both Afrikaans and English.

The program is suitable for pre-school, primary and secondary schools and currently costs R495.

The program operates on any IBM compatible PC and on any Software Operating System, *viz.* DOS, Windows 3.11 or 95.

The company prefers not to disclose the names of the schools where the program is implemented.

No details of evaluation report are available. However, the researcher is invited to visit the company to peruse the letters from satisfied clients. Furthermore, Derek Saunderson of Centurion College may be contacted.

4.7.3.6 Powercode

The company provides ***Powermaths*** available in English. The name and other particulars of the contact person are provided in Table 5.4.

The program currently costs R259 per standard. It is suitable for Grades 4-12.

Hardware specifications:

Intel platform (from XT to Pentium II)
VGA colour monitor
Mouse

Software Operating System required:

DOS 3.3 or later
Windows 3.1 or 95

Table 4.12 provides the names of South African schools where *Powermaths* is known to be implemented:

Table 4.12 Schools where *Powermaths* is implemented

Province	Name of school
Western Cape	Settlers High School
Eastern Cape	Stirling High and Hudson Park High Hudson Park High
Gauteng	Bishop Bavin Bryanston Primary Laerskool Helderkruin Northcliff High Petra Neva High Roedean Sandringham High 5 Soweto Schools IBM project
KwaZulu-Natal	Wyckeham
North West	Tsogo High GaRankuwa 5 school IBM project

NOTE: Norwich Junior School in the United Kingdom also implements ***Powermaths***.

Evaluation reports: IBM (USA) Report on the state of computer-aided Maths & Science in SA (1996). *Powermaths* is according to this report the best teaching software installed into Northern Province and Soweto Schools Project.

4.8 Summary

This section summarizes the results of the information provided by the suppliers of Mathematics programs.

Table 4.13 provides the final names of companies that responded to the questionnaires (Appendix D). The table provides details which include the company, product, contact person and numbers.

Table 4.13 List of Mathematics program

Name of company	Name of Maths program	Contact Person	Contact Numbers
Bellamy & Hough	*Basic Math Competency Skills*	Brian Hugh	Tel. 011-6141364 Fax. 011-6182816 Cell. 0800118355 e-mail: hoffie @sprintlink.co.za
Brainline-Breinlyn	*Brainline Junior University*	Coleen Cronjé	Tel. 012-468658 Fax. 012-3462423 e-mail: brain@brainline. co.za
Cami Mathematics	*Computer Aided Maths Instruction*	Mrs Sarie Vorster	Tel. 011-4762020 Fax. 011-4766842 e-mail: sarie@cami.co.za
Educorp Software S.A.	*Edumaths*	Braam Jansen van Rensburg	Tel. 021-9307993 Fax. 021-9305782 e-mail: educorp@global.co.za
Objective Business Consultants	*Wis-Pro/Math-Pro*	Marina van der Merwe	Tel. 012-465894 Fax. 012-461288 e-mail: maths@obc.co.za
Powercode	*Powermaths*	Linsay Vieira Myrna Maartens	Tel. 011-4621319 Fax. 011-4622033 Cell. 0828596583 e-mail: powercod@icon.co.za

Brainline/Breinlyn, **Cami Mathematics** and **Objective Business Consultants** did not provide the names of the **schools** that have either acquired or are implementing their programs. As noted, **Brainline/Breinlyn** maintains that they need **permission** from these schools before they can provide their names. **Objective Business Consultants** preferred not to **disclose** the names of the schools while **Cami Mathematics** provided no explanation.

This chapter has outlined the findings of the study. The first section presented the findings of interviews conducted at schools and the interview with the North West Education representative. The last part reported on the questionnaires sent to vendors.

The next and final chapter summarizes the study and offers recommendations accruing from this study.

CHAPTER 5

RECOMMENDATIONS AND CONCLUSION

5.1 Introduction

This study attempted to answer the following main question:

> Which computer-assisted instruction software for mathematics developed in South Africa is implemented in schools around Brits District what plans and policies for CAI are provided by the Department of Education in the North West Province?

Furthermore, the study undertook to establish which programs are available and all the necessary information that may enable interested schools to acquire the programs.

In this chapter a summary of the findings is presented. Further discussions include the recommendations and suggestions for further research.

5.2 Summary of findings

A survey was conducted in connection with the main research question which is divided into three sections as follows:

- Mathematics teachers currently using the CAI programs;
- a North West Education Representative; and
- vendors of South African Mathematics CAI.

Questionnaires and interview schedules (Appendices A, B, C, D) were used as research instruments to collect data.

CHAPTER 5

SUMMARY AND RECOMMENDATIONS

"For more than ten years, speeches about the computer-education duo have followed one another. Little by little, more understanding and experiences have emerged. We need to be patient and we need to have a view about these problems that is not too global and comprehensive. In the world of education, it is perhaps better to work with a lowered head, moving small stones around rather than looking at the big, still unchanging educational mountain. If many of us move these small stones, although we may not move the mountain we may make it tremble. And the computer is such a nice shovel"

(Duchâteau, 1995, 25).

5.2.1 Findings:

5.2.1.1 Interviews Schools

The results of this survey drawn from the responses obtained through interviews show the following:

- of the **112** primary schools in the Brits District, **50%** responded and of these **six** have **acquired** computers, and **two** have **acquired** Mathematics computer programs despite financial constraints; and
- of the **28** high schools in the Brits District, **79%** responded, of these **nine** have **acquired** computers and **four** have Mathematics programs.

The names of the schools are provided in Table 5.1 and 5.2

Table 5.1 Primary schools with computers and Mathematics programs

Name of school	Number computers	Name of Mathematics programs available at the school
Morekolodi	36	*Maths Story*
Laerskool Pansdrif	4	Not available
Laerskool Skeerpoort	1	Not available
Laerskool Brits	4	Not available
Laerskool Voorwaarts	7	*Sergo, Cairoo*
Leokeng	2	Not available

Table 5.1 indicates those **two** schools, *viz.*, Morekolodi and Laerskool Voorwaarts have Mathematics programs. The **interview** was conducted at **Morekolodi**.

Table 5.2 **High schools with computers and Mathematics programs**

Name of school	**Number of computers**	**Name of Mathematics programs available at the school**
Central	20	Not available
Hoërskool Brits	28	*Wispro* (Personal copy)
Hoërskool Hartebeespoort	30	*SERGO*
Hoërskool Wagpos	22	*SERGO*, TOD Wisk St 6, *Edumaths*
L.G. Holele	1	Not available
H.L. Setlalentoa	1	Not available
Micha Kgasi	32	*Maths Tutor*
Tsogo	32	*Power Code Maths*
Rabone Private	30	Not available

Table 5.2 indicates that **five** schools have Mathematics programs. However, ***Wispro*** at **Brits** is a personal copy and ***Maths Tutor*** at **Micha Kgasi** is not a South African program. **Interviews** were conducted at **all** the schools that have Mathematics programs.

The major findings from this study are summarized as follows:

- **finances** for computers were accumulated through **fund raising functions** with all **stake-holders-parents**, **teachers** and **learners** involved. Morekolodi and Micha Kgasi also requested for **donations** from business companies.
- The **timetable** in the high schools is **overloaded** and cannot allocate one or two extra periods for Mathematics so that teachers and learners can have an opportunity to **utilize** the programs to full capacity. This is a serious problem that needs attention if Mathematics is to assume a status in the community that Reyes and Stanic (1988) described.
- the programs may **benefit** both teachers and learners in terms of various pedagogical factors such as **improved** knowledge of the **content** of the subject; different **approaches** to solving problems; different approaches to setting **evaluation** tests; individualization of teaching and learning; group teaching and learning; and
- all the teachers appear not to be unsure about the **suitability** of the programs to "Curriculum 2005".

5.2.2 Interview and questionnaire: North West Education Department

5.2.2.1 Interview

The department has taken initiative to improve Mathematics teaching in schools. These initiatives include:

- **upgrading** teacher qualifications through Sediba Project: Potchefstroom University
- **workshops** funded by **Telmast, Eskom, Kgatelopele** and **Maths Centre**.

5.2.2.2 Questionnaires

The researcher was unable to **glean** any **information** about **policy guidelines** for computers and CAI from the Education Department. All attempts to have a response for the questionnaire (Appendix C) by the researcher failed.

5.2.3 Findings: Questionnaires to vendors

This section presents a summary of the findings drawn from responses from vendors (Appendix D).

The study shows that there are South African Mathematics programs available on the market, which are affordable that the schools may acquire. However, the list provided is not exhaustive and may be augmented through further surveys. The research is also not conclusive about the evaluation of the Mathematics programs because some vendors did not provide that information.

Table 5.4 presents a summary of the findings of the companies.

Table 5.4 Companies that supply Mathematics programs

Name of company	Name of Mathematics program
Bellamy & Hough	*Basic Math Competency Skills*
Brainline-Breinlyn	*Brainline Junior University*
Cami Mathematics	*Computer Aided Maths Instr.*
Educorp Software S.A.	*Edumaths*
Objective Business Consultants	*Wis-Pro/Math-Pro*
Powercode	*Powermaths*

5.3 Recommendations

From the findings the following recommendations arise:

- Hardware and software are not easily affordable and therefore schools need to undertake a thorough investigation into why they would like to acquire these and how they would utilize the resources; i.e. they should spell out very clearly what their objectives are for undertaking this exercise.
- The schools should establish committees that will draw up business plans that state explicitly what the intentions and activities are for acquiring computers and software, which include budget and the type of computers and software.
- Teacher training is crucial to successful implementation of computers. The business plans drawn by the schools should include plans of how the teachers will be trained, when they will attend workshops, conferences and exhibitions.
- To promote interest by teachers, the plan should include incentives for teachers to invest the extra time in training. It should be noted that if use of computers is not part of the curriculum, teachers are more likely to regard this as an extra responsibility and therefore incentives are essential.
- The schools should request assistance from specialists of computers as well as Mathematics software before they can acquire anything on hardware and software.
- The **time** allocated for Mathematics, between **three to four hours**, in schools needs to be seriously considered if resources like computers are to be explored for

improving both attitudes and performance in the subject. Gray (1997) established that other countries allocate between **four to six** hours for **Mathematics**. South Africa should learn a lesson from these countries.

5.4 Suggestions for further research

The findings from this research suggest further research to be done on the following issues:

- The **extent** to which Mathematics computer programs can be on the development of teaching skills for teachers;
- The effects of using Mathematics software programs and other Mathematics software for remedial teaching for learners;
- The use of Mathematics programs and other forms of Mathematics software such as spreadsheets and Geometer Sketchpad for explorative problem-solving in Mathematics; and
- Whether the use of Mathematics software in general might encourage more learners to do Mathematics from Grades 10-12.

5.5 Conclusion

The findings of the research show that a very small percentage of schools in the Brits District have **acquired** computers and Mathematics software programs. **Six** (5%) out the **56** (50%) primary schools that responded have computers and of these, only **two** have **Mathematics** programs. The total number of primary schools in the Brits District is **112**.

The total number of Middle Schools (grades 7-9) is 29. Of the 16 (55%) that responded not one has computers. Of the 28 high schools, 22 (79%) responded. Of these only nine (32%) have computers out of which four have South African Mathematics programs.

This may suggest that we a have a very difficult task if these resources are to be implemented in the shools. However, the potential usefulness of computers and Mathematics software programs needs to be weighed against all obstacles. The fact that

these few schools include schools that are situated in rural and disadvantaged communities suggests that such resources are attainable. The schools should take up such challenges to make the teaching of Mathematics productive and to promote a positive attitude towards the subject so that more students are able to follow Scientific and Technological careers.

REFERENCES

African National Congress Education Department. (1995). A Policy Framework for Education and Training. Manzini: McMillan Boleswa Publishers.

Alessi, M.A. & Trollip, S.R. (1991). Computer-Based Instruction: Methods and Development. Englewood Cliffs, NJ: Prentice Hall.

Babbie, E. (1991). Survey Research Methods. Belmont: Wadworth.

Bell, J. (1987). Doing Your Research Project. England: Open University Press.

Benting, L.A. (1995). Computer supported education pitfalls, potholes and achieving the goal. In P.M. Alexander (Ed.), Computer-Assisted Education and Training in Developing Countries. SA: Pretoria: University of South Africa.

Bruder, I., Buchsbaum, H., Hill, M. & Orlando L.C. (1994). School Reform: Why you need Technology to get there. In D.H. Wishnietsky (Ed.), Assessing the Role of Technology in Education.

Chan, J.M.T. & Korostoff, M. (1990). Teahers' guide to designing classroom software. London: Sage.

Cohen, L. & Manion, L. (1994). Research Methods in Education. London: Routledge.

Costello, J. (1991). Teaching and Learning Mathematics 11-16. London: Routledge.

De Lange, J.P. (1981). Provision of Education in the RSA. Report of the Main Committee of HSRC Investigation into Education.

Department of Education, HSRC, The Education Foundation, RIEP (OUVS). (1996). School/College Register of Needs Survey Summary Statistics: North West Province. Pretoria: HSRC.

Dinkheller, A., Gaffney, J. & Vockell, E. (1989). The Computer in the Mathematics Curriculum. Washington D.C.: Mitchell McGraw-Hill.

Duchâteau, C. (1995). The computer: ally or alien? In Watson D. & Tinsley, D. (Eds.) Integrating Information Technology into Education. London: Chapman & Hall.

EduSource. (1997/01). Mathematics and Science Teachers: Demand, Utilization, Supply, and Training in South Africa. Report for the Department of Education and Training Arts, Culture, Science and Technology. Craighall: EduSource. ISBN 09583798-6-6.

EduSource Data News No. 20/March 1998, 2 – 4.

Engelbrecht, J.C. (1990). Rekenaargesteunde onderrig teenoor exploratiewe gebruik van rekenaar in Wiskunde-onderwys. S.A. Journal of Education, 10(4), 300-306.

Engelbrecht, J.C. (1997). Academic Support in Mathematics in a Third World Environment. Journal of Computers in Mathematics and Science, 16(2), 323-333.

Fodd, W. (1993). Constructing questions for interviews and questionnaires: theory and practice in social research. Cambridge: Cambridge University Press.

Fourie, E. & Henning, E. (1995). Computer literacy in a squatter community in South Africa. In P.M. Alexander (Ed.), Computer-Assisted Education and Training in Developing Countries. SA: Pretoria: University of South Africa.

Francis, R. (1993). 1982-1992: A decade of Outreach with CAI at UWC. In R.C. Lippert (Ed.), Computer-based Education and Training in South Africa. Pretoria: JL van Schaik Publishers.

Francis, R. (1994). Teaching and Learning with Computers(TLC) in the Resource-Based Classroom. In P.M. Alexander (Ed.), Computer-Assisted Education and Training in Developing Countries. Pretoria: University of South Africa.

Funkhouser, C. (1993). The Influence of Problem-Solving Software on Student Attitudes About Mathematics. Journal of Research on Computing in Education, 25(3), 339-346.

Government Gazette, June 1997. No. 18051

Gray, D.J. (1997). Mathematics and Science in South Africa: An International Achievement Study at Junior Secondary Level. Unpublished PhD thesis. Pretoria University.

Glencross, M.J. & Fridjhon, P. (1990). Planning tomorrow's mathematics curriculum: curriculum decision-making for high school teachers. South African Journal of Education, 10(4), 307-309.

Hartley, J.R. (1987). Computer-Based Support Systems for Learning & Teaching. In R. Lewis & E.D. Taggs (Eds.). Trends in Computer-Assisted Education. Oxford: Blackwell Scientific Publications.

Hawkridge, D., Jaworski, J. & McMahon, H. (1990). Compter in Third-World Schools: Examples, Experience and Issues. London: Mcmillan. In F. Lovis (Ed.), Education Informatics Worldwide. Unesco: Jessica Kingsley Publishers.

Hebenstreit, J. (1992). Where are we and how did we get there?

Hodgson, B.R. (1995). The roles and needs of mathematics teachers using IT. In Watson D. & Tinsley, D. (Eds.) Integrating Information Technology into Education. London: Chapman & Hall.

Jarvis, T. (1993). Teaching design and technology in the primary school. London: Routledge.

Johnson, D.C. (1995). The reality of learners' achievements with IT in the classroom. In Watson D. & Tinsley, D. (Eds.) Integrating Information Technology into Education. London: Chapman & Hall.

Lamont, A.G. (1993). Using Spreadsheet simulations to teach electricity concepts at the secondary level: A Case Study. Unpublished M.Ed. dissertation, Pretoria University.

Laridon, P.E. (1995). Computer-based support for the pre-examination revision of mathematics in rural KwaZulu-Natal. South African Journal of Science, 91, August, 1995.

Lippert, R.C. (1993). Computer-Based Education and Training in South Africa. SA: Pretoria: Van Schaik.

Marsh, T.A. (1990). The computer in secondary school mathematics: An analysis and classification of possible modes of applications, with suggested implications for mathematics curriculum in South Africa. Unpublished PhD dissertation, Rhodes University.

Mehl, M.C. (1991). Do we really need computer-based education in South Africa? South African Journal of Higher Education, 5(1), 5-11.

Metrowich, T.P. (1991). Computer-assisted instruction and teacher inservice education in Mathematics in Primary schools for Black children. Unpublished PhD dissertation. University of Witwatersrand.

Moulder, J. (1991). Remedial education programmes: miracle or failure? South African Journal of Higher Education, 5(1), 5-11.

National Education Coordinating Committee. (1992). National Education Policy Investigation – Curriculum. Cape Town: Oxford University Press.

O'Connor, J. (1994). Mathematics and Science Partnerships. The Computing Teacher, 22(1), 27-30.

Oldert, N. & Barras-Baker, S. (1992). Computers in education. In R. McGregor & A McGregor (Eds.), McGregor's Education Alternatives. Cape Town: Oxford University Press.

Olive, J. (1996). New Information Technology in Mathematics Education. In T. Plomp & D.P. Ely (Eds.). International Encyclopedia of Educational Technology, 546-551. Cambridge: Cambridge University Press.

Pelgrum, W.J. & Plomp, T. (1991). The Use of computers in Education Worldwide. Oxford: Pergamon Press.

Perlman, L. (1994). Solutions to our education crisis? S.A. Computer Buyer, 2(1), 68-69.

Pouris, A. (1991). Where are our university going? South African Journal of Science, 87: 218

Pouris, A. (1996). The writing on the of South African science: a scientometric assessment. South African Journal of Science, 92: 267-278.

Pretoria News, 26 November 1996.

Reyes, L.H. & Stanic, G.M.A. (1988). Race, Sex, Socioeconomic Status, and Mathematics. Journal for Research in Mathematics Education, 19(1), 26-43.

South Africa's Green Paper on Science & Technology. (1996).

SA Science and Technology Indicators. (1990). Foundation for Research & Development.

Schofield, J.W. (1995). Computers and Classroom Culture. Cambridge: Cambridge University Press.

Underwood, J.D.M. & Underwood, G. (1990). Concept and Learning. Oxford: Basil Blackwell.

Weichers, G. (1982). CAI in the South African context. In D.M. van der Vyver (Ed.), Computers in Education. Stellenbosch: University of Stellenbosch.

Wiersma, W. (1991). Research Methods in Education: An Introduction. Boston: Allyn & Bacon.

Appendix A

DEPARTMENT OF EDUCATION
SUB-DIRECTORATE: SUBJECT ADVISORY SERVICES
BRITS DISTRICT

To: District Managers
Circuit Managers
Principals
HODS
Mathematics teachers

Kindly supply the information below:

Name of school	Number of computers	Name/s of computer mathematics program

Your cooperation will be highly appreciated

_____

Mathematics Subject Advisor

_____

Co-Ordinator

Appendix B

Interview Schedule

School:

Teacher:

1.1. How many computers do you have in your school?

1.2. How much did the computers cost?

2. Where are the computers placed?

3. Who is responsible for the computers?

4.1. Which mathematics program/s is/are available in your school?

4.2. How much does it cost?

4.3. Does it satisfy the objectives of the syllabus?

4.4. Which sections of the syllabus does it cover?

5.1. For which classes is/are the program/s compiled?

5.2. In which classes do you use the program?

5.3. How many times per week do you use the program?

5.4. For how long have you used the program?

5.5. Has the performance of learners improved since you have used the program?

6. Is the program suitable for "Curriculum 2005?"

7.1. How can the learners benefit from the program?

7.2. How can the teachers benefit from the program?

8. What advice about computers do you have for teachers who have never used computers before?

9. What other suggestions do you have about the potential usefulness of Mathematics CAI programs?

Appendix C1

University of Pretoria

Pretoria

Director: Support Services
Department of Education
North West Province

Sir

The use of South African computer-assisted Mathematics software in the Brits Districtof the North West Province

Mrs Christinah Mokoka is an M.Ed (Computer-assisted Education) student who is currently researching which south African Mathematics software is presently being implemented and planned for implementation in the Brits District of the North West Province. The results of this survey form part of her mini-dissertation to be submitted in September 1998.

Please would you be so kind as to supply her with information about any current plans, policies and procedures of implementing computer-assisted Mathematics programs in the North West Province. She hopes to glean responses to the following main questions:

- What plans does the Department of Education have for improving Mathematics instruction in the North West Province?
- What policy guidelines are available for the selection and use of computers in education, especially for Mathematics?
- What procedures are in place for:
    - Provision of computer hardware
    - Provision of computer software
    - Support and maintenance of computer hardware and software

If you have any queries about the survey please contact me at (012) 420-2771.

Thank you for your co-operation in this regard
Yours faithfully
Ms Cheryl Hodgkinson (Senior lecturer).

Appendix C2

Subject Advisory Services
Brits District Offices
Private Bag X5084
Brits
0250

North West Education Department
Attention .....
.....
Research questionnaire from Mrs M.C. Mokoka

Sir

You are kindly requested to complete the **questionnaire** as requested over the telephone.

I am currently registered for M.Ed (CAE) with Pretoria University part-time. The questionnaire forms part of my research.

Kindly fax through your response to: **Hebron College of Education**
012-7027723
Attention: Mrs M.C. Mokoka

Your response will highly be appreciated

_____

M.C. Mokoka (Subject Advisor: Mathematics)

Appendix C

Interview Schedule/Questionnaire

1.1 What plans does the education department have for improving mathematics instruction in terms of resources and underqualified teachers?

1.2 Are there any plans for computer-assisted instruction for mathematics?

2. Are there policy guidelines on the use of computers in education?

3. What provisions does the policy make for each of the following?

3.1 Training of teachers (both in- and pre-service).

3.2 Provision of computer hardware.

3.3 Acquisition of computer software.

3.4 Sustainability, support and maintenance of computer software and hardware.

3.4 Strategies for the implementation of computer-assisted instruction in schools.

3.6 Research into the effectiveness and optimal use of computers in schools.

Appendix D1

Questionnaire

P.O. Box 2667
Rosslyn
0200
Tel. : 012 7022332
Fax: 012 7027723

To: .....

.....

Sir/Madam

My name is Christinah Mokoka. I am an M.Ed (Computer-assisted Education) student at Pretoria University. I am currently undertaking an investigation into the current availability and implementation of South African Mathematics programs for Grades 1-12. The results of this investigation will form part of my M.Ed dissertation.

To this end would you kindly supply me with the information about Mathematcs programs that you supply/produce by completing the questionnaire attached to this letter.

Thank you for your co-operation

Yours faithfully

.....

Mrs M.C. Mokoka

Student number: 9519367

Appendix D

Questionnaire

1. What is the name of your company?_____
2. Who is the contact person? _____
3. What are the contact numbers: Tel: _____

   Cell: _____

   Fax: _____

   E-mail: _____
4. What is the name of your mathematics program? _____

   _____
5. In which language is the program? _____

   _____
6. For which grades is the program suitable? _____

   _____
7. How much does it cost? _____
8. Where can the product be purchased? _____
9. What are the hardware specifications? _____

   _____
10. Which Software Operating System is required?

    Dos: _____

    Windows 3.11 _____

    Windows 95 _____
11. Which schools have acquired the program?

    Kindly supply a list of schools.
12. Are evaluation reports available? Kindly supply details of any evaluation report.