A SURVEY OF THE COMPUTER ENHANCED SERVICES OF THE OUTREACH PROJECT OF UWC DEVELOPED FOR GRADE 12 MATHEMATICS LEARNERS AND A CRITICAL APPRAISAL OF THE MICSEC2000 PROGRAM.

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ABSTRACT

About half of the high schools of the Western Cape Education Department (WCED) presently serve indigent township suburban and rural learners. Learners living in these adverse socio-economic conditions have a history of performing poorly in the matric examinations, particularly in mathematics.

The problem of the need to assist such learners is couched in present envisaged NPHE outcomes, which are ultimately (albeit limited) aimed at facilitating RDP endeavours of social upliftment in the Western Cape.

Since 1982, the Outreach Project of the University of the Western Cape has provided assistance to grade 12 mathematics learners and educators at previously disadvantaged Western Cape high schools and pioneered the supportive use of computers in school mathematics and science.

A survey of the literature on the use of computers in mathematics education globally (and locally) indicates that many of the problems experienced in the teaching and learning of school mathematics is not unique to South Africa.

This study initially places the Outreach Project in terms of its past (as a Gold Fields program) its transition (as a School of Science and Mathematics Education endeavour) and its present services in the context of a particular theoretical framework i.e. its *intended, implemented, perceived and achieved programs*.

The MICSEC2000 program of the Outreach Project, the latest innovative computer enhancing service to schools serving indigent Western Cape, is then described and finally appraised with respect to its *implemented*, *perceived* and *achieved* programs by participating educators.

DECLARATION

I declare that A SURVEY OF THE COMPUTER ENHANCED SERVICES OF THE OUTREACH PROJECT OF UWC DEVELOPED FOR GRADE 12 MATHEMATICS LEARNERS AND A CRITICAL APPRAISAL OF THE MICSEC2000 PROGRAM is my own work and that it has not been submitted before for any degree or examination at any university, and that all the sources I have used or quoted have been indicated and acknowledged by complete reference s.

BRIAN ERNEST LEONARD ISAACS SEPTEMBER 2005

SIGNED: ………………………………

DEDICATED TO

Ernest Joseph Isaacs and Janet Susan Isaacs (nee Keet)

my late parents

and

The Hermann Ohlthaver Trust

The Hermann Ohlthaver Trust has been a donor to the Outreach Project since its inception under the auspices of the Gold Field Resource Centre in 1982. The Trust funded the first Mini Computer Support Educational Centre (MICSEC) established at Langa in 1999. This gesture initiated the MICSEC2000 program which is the focus of this study. The trustees of The Hermann Ohlthaver Trust, particularly Mr A. R. Appel, are sincerely thanked for their support and confidence in the computer enhanced services rendered by the Outreach Project presently of the School of Science and Mathematics Education of UWC.

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Soli Deo Gloria

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CHAPTER 1

THE STATEMENT OF THE PROBLEM

1.1 INTRODUCTION

The prominence placed on mathematics, science and technology in the transformation of the South African social order through the Reconstruction and Development endeavour has brought into fresh focus the acute difficulties and problems involved in the process of teaching and learning of particularly mathematics. These difficulties and problems can primarily impede the necessary desired outcomes in mathematics that would assist in changing the South African social landscape. The problem(s) in the process of successfully teaching, learning and achieving good results in mathematics however, is apparently not unique to the South Africa educational system. The American Research Council (1989) reported that:

"From grade 8 on , America loses roughly half of the student pool taking mathematics courses. Of the 3 .6 million ninth graders taking mathematics in 1972, for example, fewer than 300 000 survived to take a college freshman class in 1976; 11000 earned bachelors degrees in 1980, 2700 earned masters' degrees in 1982, and only 400 earned doctorates in mathematics by 1986."

Expressed as a proportion this would imply; 9^{th} Grade: College freshman: B degree: M degree: D Degree = 10000: 800: 30: 8: 1

More recently, a British newspaper, the Guardian of August 29 2002, under the caption "Mathematics crises in university admission" reported that:

" A 5,9% fall in maths admission compared with the same time last year, from 3632 to 3418, will put maths departments at risk. Up to a third of maths departments face serious cuts, academics say. Charles Goldie, professor of mathematical sciences at Sussex University, and chairman of the umbrella group for university heads of maths departments, said the subject was in crisis"

A bleak picture of the situation in South African schools emerges from three reports, which are briefly discussed below.

1.1.1 The National Report on Systematic Evaluation (2001-2000)

This, the first all-inclusive South African national educational survey, involved 51308 **grade 3** learners. The results, an average mark of 30% in numeracy tests and 39% in reading and writing, are perturbing. This survey was the first of its kind and there are thus no local benchmarks to measure or compare these results. The disappointing performance of learners in this evaluation according to the report is attributed primarily to a defective school infrastructure (27% of the schools had no library, the average education level of maths teachers were grade 10). The second debilitating factor is attributed to an inefficient home support structure (53% of the households possessed no books; 31% had no TVs, radios, phones, computers and the average educational level of parents was grade 9).

1.1.2 The Joint International Unesco-Unicef Monitoring Learning Achievement Project (1999)

The Department of National Education commissioned the S.A. study of this survey in which over 10000 **grade 4** learners participated. In the numeracy test learners were expected, among other things, to calculate the sum of two four-digit numbers. In this test the South African learners recorded an average of only 30%, very much lower than their counterparts in Botswana (51%), Madagascar, Malawi, Mali, Morocco, Mauritius, Niger, Senegal, Tunisia, Uganda (49%) and Zambia (36%). “A large proportion of S.A. Grade 4 learners scored below 25% for the numeracy, while 2% obtained scores in the 75%-100% range’.

1.1.3 The Third International Mathematics and Science Study Repeat (TIMSS-R) report.

Researchers of the HSRC launched TIMSS-R in South Africa in **1998**. This was a follow up to the Third International Mathematics and Science Study (TIMSS) initiated in 1994 that included 61 countries with South Africa being one of the 41 countries completing the project. In the South African study 8147 grade 8 pupils of the 9 provinces completed the tests.

The mathematics achievement results are reported to be the following: The mean score of the South African learners (275, standard error 6.8) were more than 200 below the international mean and on average about 120 below the means of its African partners Tunisia and Morocco. Less than 0, 5% of South African learners attained the International Top 10% benchmark (i.e. a score of 616 out of 800). About 1% reached the International Upper Quarter benchmark (i.e. 555 out of 800).

The Western Cape attained the highest provincial average (i.e. 381, 100 below the international average) followed by Gauteng with 318 and the Northern Province with 266 at the bottom of the table.

An in depth analysis indicates that learners generally experienced the following problems in the test situation: interpreting tables, figures and illustrations, answering complex questions requiring more than one answer, the inability to express themselves in writing, working with fractions and area calculations in geometry. When required to answer multiple choice questions learners generally guessed and were distracted by questions testing misconceptions.

Generally learners could not verbalise their answers in the 'language of the test' and appeared to "lack the basic mathematical knowledge expected at Grade 8 level"

The report revealed the following adverse background information on school, class and pupil level of the participating learners. The average grade 8 maths class was 46 learners; the number of instructional school days varied from 120-280 days with some days being less than 4 hours; various degrees of shortage of instructional material and space, absenteeism, drug problems and vandalism were listed by the principals of participating schools. Disturbing was that 27% of the teachers of the testees had no formal maths qualification and 50% did not feel confident to teach mathematics. About 40% of the participants had no father figure in the home. Learners whose parents were educated and who had well resourced homes attained good scores. Compared to their international counterparts, South African learners had very poor self-concepts in mathematics and science but they showed a more positive attitude toward mathematics than science.

The TIMSS-R executive summary concludes that:

"Resources have to be put into a variety of well-designed, planned and effective programmes promoting and implementing mathematics and science. Greater collaboration within and between the government and the private sector will be required to optimise energies and resources. This is urgently needed to increase the number of pupils with the adequate and well-founded knowledge and skills in

these subjects to create a critical mass of matriculants able to move into higher education, business and in the industry in the short, medium and long term. (Howie S., 2001:43-44).

The foregoing stipulated surveys/evaluations are not listed chronologically in the time frames in which they occurred. They are rather indicated in ascending order of grades (i.e. 3, 4, and 8) for the specific reason that in each investigation a readily noticeable aetiology of the factors impeding progress or resulting in weak and unacceptable test results are traced to similar sets of factors.

These recurring external impediments can be classified into two broad categories i.e. defective school and malfunctioning or abnormal home infrastructures.

The three surveys manifest that the desired mathematics learning outcomes in each of the selected grade sections are not being attained. Failure to attain the desired outcomes in each of the indicated grades can be attributed to the ongoing tasks of teaching, learning, revision and evaluation being hampered or impeded by inappropriately developed home and school infrastructures, a lack of equipment and staff shortages.

1.2 THE IMPLICATIONS FOR MATHEMATICS EDUCATION IN HIGH SCHOOLS OF THE NATIONAL PLAN FOR HIGHER EDUCATION

This section intends to highlight some of the relevant provisions of the plan. In the opening preamble of this chapter it was indicated that success in school mathematics, science and technology education feature strongly as a means to the end of some of the outcomes of the present South African Reconstruction and Development.

The NPHE "provides the strategic framework for re-engineering the higher education system for the 21st century (Asmal K., 2001: 2). Pertinent to this study are the following excerpts from the NPHE:

- *"The National Plan proposes that the participation rate in higher education should be increased from 15%-20% in the long term, i.e. ten to fifteen years, to address the imperative for equity, as well as the changing human resources and labour needs. In the short to medium term, however, it would not be possible to increase the participation rate because of* ***inadequate throughputs from the schools system****." (NPHE, 2001: 5). "There has been a sharp* ***decline in the number of school-leavers*** *with* ***matriculation endorsements****, which is a precondition for entry into universities and, to a lesser extent, into technikons. Between 1994 to* ***2000*** *the number dropped by 23% (decreased from 89000-* ***68626****)."(NPHE, 2001: 21) "A participation rate of 20% would require a total head count enrolment of about 750 000 students in the higher education system. On the basis of current patterns,* ***188 000 school leavers would be required to enter the higher education system each year****. The ministry has modelled scenarios of throughputs from the school system to 2010 (with base year 1995) based on varying assumptions of flow, candidacy and pass rates, including the impact of HIV/AIDS. However,* ***a 20% participation rate should be possible within a ten to fifteen year*** *period if there is a significant improvement in the throughputs from the school system" (NPHE, 2001: 24).*

- *"The National Plan proposes to shift the balance in enrolments over the next five to ten years between the humanities, business and commerce and science, engineering and technology from the current ratio of 49%: 26%: 25% to 40%: 30%: 30% respectively. Further adjustment to the ratio is not possible in the short to medium term because of the low number of students leaving the school system with the required proficiency in mathematics" (NPHE, 2001: 6). "It should be noted that a* ***major constraint*** *on increasing enrolment in business and commerce and science, engineering and technology* ***is the paucity of matriculants who have the required proficiency in mathematics****. In 2000 only* ***19327 school leavers*** *obtained higher grade passes in mathematics". (NPHE, 2001: 22)*

The foregoing suggests the following preliminary delineation of the problem that this study wishes to address.

1.2.1 General Statement of the Problem

To attain some of the envisaged NPHE outcomes, how can the required proficiency in matric mathematics (particularly higher-grade mathematics) be substantially increased in South African high schools?

This study will focus specifically on addressing the above problem in certain schools in the Western Cape and therefore the remaining sections of this chapter will be devoted to discussing the problem in this context.

1.3 FACTORS THAT EXACERBATE THE COMPLEXITY OF THE DELINEATED PROBLEM

The Reconstruction and Development process in South Africa is being hampered by numerous *problems* existing in the various systems comprising the South African society. The emphasises placed on mathematics, science and technology as possible contributory solutions to these problems, as outlined in the NPHE, have however increasingly manifested and strongly brought into focus the *particular difficulties* encountered by learners in the mathematics teaching and learning process.

The first ***problem*** identified by the present South African architects of change, in their endeavour to change the social landscape of South Africa, is that the present economy does not provide financial equity for all. The solution is hypothesised to be found in working towards the establishment of the country as an *economically middle-class developing country* (NPHE, 2001:23).

The ongoing fundamental changes in the labour patterns and expectations caused by the ripple effect of global expectations on the economic systems of developing countries, is the next ***problem*** to factor into this equation (NPHE, 2001: 19-20).

To accommodate these requirements the ***problem*** that first year input and subsequent graduate output of the higher education system need to be realigned, in the ratio 40%: 30%: 30% with respect to the humanities; business and commerce; science, engineering and technology respectively, has crystallised. Moreover a participation rate of 20% (of the eligible population) in the higher education system is perceived to be essential.

This expectation has finally placed pressure on the South African school system and led to the ***problem*** of dramatically increasing the output with regards to the number of matriculants obtaining endorsements and mathematics passes (ideally in higher-grade mathematics).

The problem of substantially increasing the grade12 (matric) mathematics (particularly higher grade) pass rate thus obviously does not exist as a isolated singular entity but should be perceived as *containing and being contained* in a complex problem that straddles all the systems that comprise the South African society.

In the context of the R.D.P. expectations, a positive solution would bring about a 'kick-start' (i.e. initiate a domino tumbling- effect) to the (partial) solutions of a series of connected problems (easing the bottlenecks) that have accumulated (clogged) in the various systems of the South African society.

Certain precautions need to be considered when proposing and implementing solutions to these problems. Because of their complex nature and their inextricable relatedness these **problems should not to be perceived as simple cause-effect or even multiple cause-effect phenomena to which simple solutions could be found.** For example if the problem of the extreme inequity in the distribution of wealth in the South African society were to be alleviated it would require extensive and intricate negotiated solutions.

It is furthermore obvious from the foregoing quoted research that learning mathematics for many South African learners has become to be an inherently problematic and difficult experience.

The problems in the process of learning and teaching that impede progress and consistently yield bad examination results in mathematics (in the South African school system) should not be perceived as occurrences that suddenly appear during the secondary phase of the learner's school-life (particularly during the matric, i.e. grade 12, phase). The research indicates that their aetiology can be traced to a continuous ever-present series of factors, which form a persistent negating process. This process becomes ingrained in the learning experience of mathematics learners, precipitating at the beginning of their school-life.

This counter productive process (of deterioration) is compounded as learners become caught up in a vortex of 'unpleasant' encounters with unsympathetic mathematics educators and unpleasant interaction with the subject content that incessantly impinge on them at all the stages of their mathematics learning experience. To many learners, school mathematics finally becomes a 'dead weight' to which they display scant interest and are merely content to tolerate as they are promoted from grade to grade and from primary to secondary school.

A simple cause-effect (or even a multiple cause-effect) solution such as yearly constantly increasing the success rate of matriculants with a predetermined increment in mathematics (particularly higher grade) pass rates, could prove a fallacious objective, to say the least. It is evident that at some stage the outcome would inevitably peak and maintain a constant level i.e. reach a plateau. The view that a yearly incremental increase in matric higher- grade mathematics is the panacea to attaining the goals or the expectation of the H.E. system could end in a probable pipe dream.

This study proposes that alternative solutions to this complex problem could be contained in well planned intervention strategies in the form of corrective ICT enhancing programs. Such programs should be underpinned by clearly defined goals of **intention** and be **implemented** by a well trained corps of efficiently motivated educators. The **perceptions** of the target group (both learners and educators) must be measurable. The ultimate success of the program should be determined from its outcomes or **achievements**.

1.4 THE PROBLEM ADDRESSED IN THIS STUDY AND ITS RELEVANCE WITH REGARD TO WESTERN CAPE SCHOOLS

With reference to Western Cape high schools, the problem delineated in this study can further be refined to the following preliminary formulation:

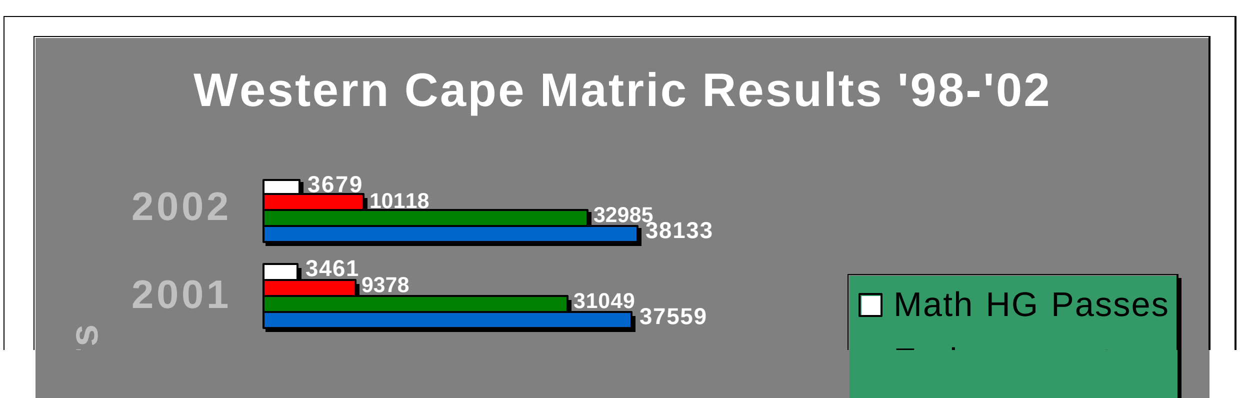
1.4.1 Statement of the Problem for Western Cape Schools

How can an ideal of 60% of 13650 school leavers, proficient in matric mathematics (preferably higher-grade mathematics), be produced and maintained annually by Western Cape high schools?

1.4.2 An assessment of the performance (particularly in mathematics) of WCED schools from 1998-2002 in the light of NPHE expectations

The following Table and the resultant Graph indicate the matriculation examination results from 1998 to 2002 of Western Cape Schools. From each of these the number of candidates who wrote the examination, the number that was successful, the number that obtained endorsements and the number that passed mathematics standard and higher-grade respectively, can be determined.

Year	Number of Candidate	Number of Passes	Endorse Ments	Math (SG) Passes	Math (HG) Passes
1998	38546	30438	9028		
1999	37199	29303	9090		
2000	37818	30489	9235	9205	3162
2001	37559	31049	9378	9555	3461
2002	38133	32985	10118		3679



The accompanying table and graph indicate the trend of the Western Cape

A matriculation endorsement is the minimum requirement to register for a degree program at any S.A. university. From the accompanying table the number of endorsements of the1999 WCED Matric Results was 9090. The 2000 intake rate at the three Western Cape universities of local students in head counts was however about 6975 (Scott and Hendry, 2002:1). The following could be speculated about the 2115 that obtained endorsements but did not register at any of the three Western Cape universities. Some could have registered at the two local technikons, some at other universities and some possibly did not have all the other entrance qualifications for the university courses they desired to do.

The first excerpt quoted from the NPHE (2001: 24) suggests that the South African school system should produce 188000 school learners annually to maintain a participation rate of 20% in the HE system. Ideally this implies that each of the 9 South African provinces of the high school system should produce 21000 school leavers annually. About 65%, (Scott and Hendry, 2002:1) of the expected 21000 (13650) school leavers should have exemptions (endorsements) if they wish to register at any one of the three Western Cape universities.

From the data in the above table, the average rate of increase in endorsement is determined to be about 343 annually. At this rate it would probably take about 10 (using 2002 as the base year) years for the Western Cape Education Department to attain the NPHE suggested number of 13650 endorsements annually.

To satisfy the proposed shift in the balance in enrolment at South African HE institutions (as surmised in the second excerpt taken from the NPHE) about 60% (8190) of the learners obtaining these endorsements should pass mathematics (ideally mathematics higher grade). Using the data in the last column of the table the average annual increase in mathematics higher grade passes is 259. This means that at the present rate it would take the WCED about [(8190-3679)/259] = 17.5 (approximately) years to obtain (using 2002 as the base year) this outcome. *This study will focus particularly on township and rural schools in the Western Cape and therefore some information concerning current performances in the matriculation examination is pertinent. This is provided in the next two sections.*

1.5 THE POOR PERFORMANCE OF CERTAIN WESTERN CAPE SCHOOLS IN THE MATRICULATION EXAMINATION

The WCED has more than 360 high/secondary schools under its jurisdiction. About 180 of these schools are situated in 'previously disadvantaged' townships or rural areas. According to the "The National Report on the Performance of Individual Schools in the 2000 Senior Certificate Examinations" released by the National Department of Education the performance of these schools were ranked as follows:

100%-80%: **64**, 79.9%-60%: **58**, 59.9%-40%: **37**, 39.9%-20%:**17**, 19.9%-0: **2**

By comparison the other schools (almost all ex-model C schools) fell into the interval 100%-80% with about a half obtaining a100% pass rate.

Endorsements (exemptions) usually indicate the 'quality' of a matric pass. An imbalance in the matric examinations is further emphasised by the fact that ex-model C schools obtained 74% (6677) of the exemptions for the province during that year.

1.6 THE POOR PERFORMANCE OF BLACK CANDIDATES IN MATHEMATICS (PARTICULARLY HIGHER GRADE MATHEMATICS) IN THE MATRICULATION EXAMINATION

The term ‘black’ is used in its historical sense to include Africans, Coloureds and Indians and is in no way intended to imply a derogatory racial label.

In “The National Strategy for Science, Mathematics and Technology Education (NSSMTE)” spearheaded by the then deputy Minister of Education, Mr M. Mangena, an analysis of the participation and performance, nationally, of all learners in matric higher-grade mathematics from 1997-2000 indicates not only a low pass rate but also a constant shrinkage in number (NSSMTE, 2002: 8-9). Disconcerting is the low number of Africans who wrote and passed the subject. From the table below it can be seen that of the about 500000 candidates who sat for the 2000 matriculation examinations, 180202 African candidates wrote mathematics standard grade of which 41540 (23.05%) were successful. Of the 20243 who wrote mathematics higher grade only 3128 (15.5%) were successful. In the Western Cape 662 out 3889 (17.02%) and 21 out of 78 (26.9%) passed mathematics standard and higher grade respectively

Area	Mathematics Hg		Phys Science. Hg		Mathematics SG		Phys. Science SG	
	Candidates	Pass	Candidates	Pass	Candidates	Pass	Candidates	Pass
National	20243	3128	33657	5136	180202	41540	77680	32874
W Cape	78	21	93	45	3889	662	2204	1100

From the discussion, it should be apparent that the majority of learners, *particularly those attending township and rural schools, do not attain the necessary requirements needed for admission to the HE institutions*. In terms of RDP objectives it is imperative to include such learners and their schools in the broader goals as expounded in the NPHE. The problem addressed by this study can finally be refined and narrowed down as follows:

1.6.1 Statement of the Problem for poorly performing Western Cape High Schools

How can learners/schools particularly in township and rural Western Cape areas be assisted/supported to improve their performance in grade 12 (matric) mathematics (particularly higher grade mathematics)?

1.7 THE FOCUS GROUP OF THIS STUDY

Central to this thesis is the manner in which learners attending high school in poor township and rural areas can be encouraged to do and be successful in matric mathematics (particularly higher-grade matric mathematics).

The terms **‘historically disadvantaged’** and **‘previously historically disadvantaged’** have of late fallen into disrepute and its continued use has become questionable. Both phrases were originally coined to describe or designate all those who were on the negative receiving end of apartheid. Ironically it will however become clear that after many years of democracy the lot of the majority of those who were categorised as 'historically disadvantaged'; particularly those who are unfortunate to still live at the lower end of the socio-economic spectrum presently fall into the category of *poor or extremely indigent.* 'The Sub-Directorate Social Research and Population Development in the Branch Social Services of the Department of Health and Social Services' using the Census 96's Community Profile Database of the Western Cape as data source, has compiled baseline data on poverty. In the paper, "**An analysis of poverty in the Western Cape as enumerated in the 1996 Census** " or briefly **"Poverty in the Western Cape"**, information on who is poor and vulnerable and how poverty is distributed in Western Cape, is detailed.

"Poverty is a multi-dimensional condition and an adequate definition of poverty will include as many facets of poverty as possible" (Poverty in the Western Cape, 1999: 7). A general definition for Poverty is still lacking but it could be delineated in two approaches i.e., *subsistence insufficiencies* and *relative deprivation.* The former defines poverty as the lack of resources to secure biological and physiological needs (cf. Maslow's hierarchy of needs) and the latter as social marginalisation due the dire lack of 'things that are socially expected'.

Subsistence insufficiency is caused primarily by the lack of financial resources to adequately feed each member of a vulnerable family. If the income baseline for poverty is taken as R1500 per month then according to the 1996 Census 41,5% of all households (i.e. 357 480 households) in the Western Cape can be classified as poor (Poverty in the Western Cape, 1999: 11). The same census revealed that

15, 6% (134 145) of those affected households usually referred to as the 'poorest of the poor' earn less than R500 per month.

The 1996 Census reports that of the Western Cape poor; 177949 (50, 5%) of the households are coloured, 132487 (37, 6%) are Black, 39056 (11, 3%) are white and 2012 (0.6%) are Indian (P.W.C: 22). The poverty rate amongst African households is the greatest.

The " Analyses of poverty in the Western Cape as enumerated in the 1996 census" document lists in ascending order: Murraysburg (1060), Uniondale (1508), Prince Albert (1417), Lainsburg (980), Calitzdorp (1084), Ladismith (1969) and Robertson (5007) as the poorest Western Cape magisterial districts. All fall below the provincial and national poverty baselines (Poverty in the Western Cape: 13). All these districts (with the exception of Robertson that lies adjacent to them) form part of the Great and Little Karoo indicating that poverty is strongly rurally biased.

Expressing the *affected ratio* of magisterial districts (using *household earnings* as criteria) for a particular province as percentages and comparing these with the national poverty baseline skews the actual 'state of affairs'.

In actual head-counts (i.e. raw scores), the Western Cape magisterial districts of Mitchell's Plain (83400), Wynberg, (34511) Goodwood (23950), Kuilsriver (16827), Worcester (15734), Paarl (13917), Bellville (13750), Cape Metropole (13247), Malmesbury (10385) have the highest incidence of poor households. Subject only to the single indicator, insufficient income or the total lack of it, the total number of poor households in the 7 most vulnerable, rural magisterial districts are identified as 13025. This amount is almost on par with that of the Cape metropole and a fraction of the 7 other leading urban magisterial districts.

This poses the problem of whether it is totally justifiable in determining strategies to alleviate the poverty in the province to give precedence to rural over urban magisterial districts.

To avoid such skews and ambiguities The Sub-Directorate Social Research and Population Development uses the PHDI (Provincial Human Development Index) to monitor poverty in the Western Cape and to ‘identify priority communities for intervention to relieve poverty’. The PHDI is similar to the HDI used internationally to designate poverty rankings of communities. The PHDI is a composite index and the average of the sum of ‘4 indicators of equal weight’ i.e. income, employment status, literacy and water supply. The index is used to categorise the poverty and vulnerability of communities. It varies between 1 and 0, with a rank of 1 designating the best worse case scenario and 0 being the best (1999: 35-36). In the Western Cape 647 communities over the province have been ranked. In terms of the PHDI ranking, 20 communities (61905 indigent households) in the Mitchell’s Plain magisterial district and 8 communities (29043 indigent households) in Knysna fall in the index interval 0.710-0.503. The identified communities of these magisterial districts should hence head the list of priority communities for poverty intervention programmes. Simonstown have 2 such communities and Caledon, Robertson, Cape Metropole, Somerset West, Paarl, Hermanus, Kuils River, Vredendal, Tulbagh, and Bellville have one each.

The relevance of this problem is emphasised by the importance planners of the new social dispensation in South Africa. have placed on increasing the number of matriculants who have the required proficiency in mathematics, particularly higher-grade mathematics.

1.8 THE RELEVANCE OF THE OUTREACH PROJECT IN THE CONTEXT OF THE NATIONAL PLAN FOR HIGHER EDUCATION

The National Plan for Higher Education became available on–line on 06/03/01. In essence the Plan aims to establish a single, national coordinated system, which would meet the learning needs of all South African citizens. It is structured around five key policy goals and strategic objectives. A priority of the strategic objective that aims to "produce graduates with the skills competencies to meet the human resource needs of the century" is "to increase participation rates in higher education to meet the demand for high-level skills through a balanced production of graduates in different fields of study taking into account labour market trends" (National Plan for Higher Education, 2001:19). The inferred implications of the National Plan for Higher Education (NPHE) for the teaching and learning (and particularly examination performance) in grade 12 school mathematics are briefly outlined in section 1.2. These implications include the requirement that South African HE institutions need 188000 school leavers for the next 10-15 years to attain the necessary outcomes in the economic sector. Furthermore the ideal ratio in terms of the humanities; business and commerce; and science, engineering and technology at universities should ideally be 40%: 30%: 30%.

It should be obvious that the particular problem formulated (in the context of NPHE inferences for schools) in this chapter i.e. "How can learners/schools particularly in township and rural Western Cape areas be assisted/supported to improve their performance in grade 12 (matric) mathematics (particularly higher grade mathematics)" is not a new problem.

Since 1982, the Outreach Project of the University of the Western Cape has provided assistance to grade 12 mathematics learners and educators at 'previously disadvantaged’ Western Cape high schools and pioneered the supportive use of computers in school mathematics and science.

The next chapter places the Outreach Project in the context of its past, initially as a Gold Fields and then as a School of Science and Mathematics Education (SSME) service.

CHAPTER 2

THE OUTREACH PROJECT AT THE UNIVERSITY OF THE WESTERN CAPE

2.1 THE SOCIO-POLITICAL CONTEXT OF THE ORIGINAL OUTREACH PROJECT

Fataar (2001) vividly traces the socio-historical context i.e. the economic and socio-political contours in which apartheid education was planned and implemented. He states that towards the end of the 1960's the South African economy experienced an economic downward spiral and the apartheid regime was coerced to reverse its 'influx control' method of restricting black education to the Homelands. To alleviate the acute shortage of cheap unskilled black labour in the urban areas, the apartheid government planned to develop 'a fully proletarian black working class in the cities'. Consequently, attendance at Black township schools was allowed to increase tenfold between 1975 and 1985. However the schools developed by the state were not designed for such a huge inflow and were generally overcrowded and under-resourced laying 'the foundation for the enduring inferior quality of black schooling.' Fataar (2001:12-13) further asserts that the educational reform by the state during this period was a response to what he terms 'the organic crises' in urban social reproduction of the mid-1970 and 1980s.

"This crisis was brought on by almost two decades of resistance to apartheid education. 'Organic crises' refers to the intractability of reforming racial capitalisation without removing race as one of the principal determinants of the capitalist states social structure." (Fataar, 2001: 13).

Education reform for Blacks during the apartheid era was primarily vocational and hence aimed at providing a large semiskilled labour force to rescue an ailing economy.

In the "Provision of Education in the RSA" (1981), a report on the then state of Education, the Human Science Research Council verifies this crisis, emphasising the then critical shortage of professionally qualified teachers, particularly African and Coloured science and mathematics teachers. In similar vein the then Minister of Manpower at a seminar at UWC lamented the lack of knowledge and skills of Blacks and Coloureds in the labour market (Mehl & Sinclair, 1982: 8-9)

2.2 COMPUTER BASED INSTRUCTION (CBI) INTRODUCED AT THE UNIVERSITY OF THE WESTERN CAPE IN 1980

When it gained its autonomy, the University of the Western Cape (or as it was colloquially dubbed the 'University of the Working Class') initiated a process of accessing and realigning its role as a Higher Education Institution. Woven into its then philosophy was a firm commitment to the development of the Third World communities in Southern Africa. This became evident in inter alia Bridging Programs for university students and Outreach Programs to high schools.

"The overriding idea behind what can be termed a strategic adaptive philosophy was a determination to place the University in greater contact with the needs and changes of the environment which supports it in order for it to function as a viable subsystem within the changing educational system of society at large. A sensitivity to the kaleidoscopic drift of political, economic and social problems - society as it stands and not the utopia we will dream about - was at the root of the change which took place over the past few years at the University of the Western Cape" (Mehl & Sinclair, 1982:11).

UWC (together with other ethnic universities) was initially a product of the educational design of the apartheid educational planners (The University Act of 1959) It was established in 1960 solely to create a small Black (African, Coloured and Indian) elite to serve a particular purpose in the 'Grand Apartheid Design'. Despite attaining its autonomy in the late seventies, its student population remained predominantly Black. The majority of the UWC student population was drawn from a specific apartheid engineered social and educational milieu, which served primarily as a source of unskilled or semi skilled labour.

Given the foregoing circumstances, the high attrition rates and extremely poor, particularly those in the Science Faculty, pass rates were to be expected. Jones (1986: 2-3) states that of the 914 Science students that enrolled between 1965 and 1976, a mere 5% obtained their degrees in the prescribed period. To address this problem, the University Management took the decision in 1980 to install a computer based education system – the Plato system, which employed the unique method of what was then called *instructional computing*. A 64-terminal PLATO (Programmed Logic for Automated Teaching Operations, an instructional computing system developed by the University of Illinois) system was installed, making the University the then third largest computer based educational centre in the world. A mainframe computer, which could handle more than double its operating terminal load, ran the instructional program. The PLATO software was specifically modified to provide a ***curriculum content Outreach Plan*** for high school learners, teacher educational programs (particularly in mathematics, the sciences, and English and Afrikaans), continuing education programs for adults (including a basic skills package), and a computer based educational research relevant to South Africa.

The success of instructional computing at UWC resulted in a Proposal for an Instructional Computing Dissemination Project that was aimed at the development of ***off–campus centres*** to serve the broader community. In anticipation, the university telephone switchboard was restructured and 200 terminals became available for outreach development.

2.3 THE GOLD FIELDS SCIENCE AND MATHEMATICS RESOURCE CENTRE (GFRC)

The development of instructional computing at UWC had a single goal, i.e. to use instructional technology to improve education at all levels. This goal was formulated in three mutually supportive project proposals. They were: a Mathematics / Sciences Matriculation Outreach Project, an Instructional Computing Services Dissemination Project and a Computer Courseware evaluation / Improvement Project

2.3.1 The Mathematics / Sciences Matriculation Outreach Project

The establishment of an on campus Science and Mathematics Resource Centre (later called, because of the source of funding for the building), the Gold Fields Science and Mathematics Resource Centre (GFRS) was an overt manifestation of the then prevalent objective of UWC to create a democratic social order by addressing the prevailing imbalances in the then South African education system. The singular purpose of the Centre constituted one aspect of the University of the Western Cape's Outreach community intervention programs, i.e. the empowerment of Black educators and learners in Mathematics and the Sciences.

The primary objective of the proposed four and a half year mathematics / sciences Outreach Project (July 82 through December 86) was the attainment of this ideal at

High School level by creating a means to improve learning and teaching in high school mathematics, physical science and biology.

The Plato–based computer educational software made available by Control Data Ltd (the supplier) was hence extended and redesigned to provide instruction in both English and Afrikaans to learners and educators of grade 11 and 12 biology, chemistry, physics and mathematics (Sinclair, 1980: 9-10).

2.3.2 The other activities of Gold Fields Resource Centre

Besides the mathematics / sciences matriculation Outreach Project, other services of the centre included: In-Service Training of Educators which included a wide variety of projects, workshops and courses; Research which entailed researching the theoretical underpinning and rationale of the services and programs of the Centre particularly in learning problems experienced by the 'historically disadvantaged' learner; Curriculum Materials Development - as the logical extension of the research this endeavour involved the development of learning material relevant to the particular needs of the 'disadvantaged' learner and Funding which involved the continual securing of finances for the perpetuation of all the services of the GFRC.

2.4 HISTORICAL PERSPECTIVES OF THE OUTREACH PROJECT AND ITS OUTREACH PROGRAM(S)

The problem addressed in this study is obviously not new. About two decades ago Jones (1986, 11-34) listed the factors that resulted in the dismal performance of 'African' and 'Coloured' learners of Western Cape schools in Gr. 12 Mathematics and Physical Science in the 1982 and 1983 end of year examinations. His report was based on the Human Sciences Research Council Investigation into Education (HSRC, 1981a), which emphasised the alarming disparities in, amongst others, educational facilities; learner/educator ratios; educator qualifications; per capita expenditure and matriculation results between 'Africans', 'Coloureds', 'Indians' and 'Whites'. He attributes the poor performance of 'Black' matriculants primarily to 'grossly under-qualified educators, poor school facilities and an abnormal growth in learner population'.

In his theoretical approach Jones concludes, based on Feuerstein's taxonomy of what he believed to be the cognitive deficiencies of the disadvantaged learner, that 'an essential and valuable component of any compensatory program at Matriculation level for Science and Mathematics must be the inculcation of specific problem-solving abilities' (Jones,1986: 47-48). He suggests that this is best realised "by the algorithmisation of problem-solving procedures" (133).

Concurring with Mehl, Jones asserted that computer-based instruction (CBI) was a viable option in the effective teaching and successful learning of 'disadvantaged' students at both tertiary and school levels. To them the term 'disadvantaged' not only had political and socio-economic connotations but could also, in terms of Feuerstein (Jones, 1986: 43-45), be applied to the 'present cognitive activity' of a student/learner (Mehl, 1983: 13-14). The 'potential cognitive capacity' of a 'learning disabled person' could be partially realised by supervised supportive and remedial computer intervention and instruction, according to Mehl.

In the initial Pilot-run of the first program of the Outreach Project (August 1982-October 1982), 120 matric pupils from neighbouring schools were bussed to the UWC campus every Saturday to work through computer–based courseware in physical science and mathematics. During the same period (the September vacation included) 130 matric pupils from the four so called African high schools in the Peninsula – Fezeka, Langa, I.D Mkize and Sizamile – took turns to be bussed to the campus every afternoon to work through computer- based courseware on the PLATO system to assist them in preparation for the matriculation examinations. The learners were accompanied by their educators so that the computer–based work could be integrated into the everyday classroom activities, and also to ensure that no knowledge gap developed between learners and educators. It was found that this was an ideal way to raise the educators' own level of subject knowledge – an excellent method of in-service training.

The first full-scale operation of this program was initiated in 1983. This phase was preceded by the establishment of a 20 terminal computer based learning centre on campus- the PLATO Outreach learning centre housed in the Goldfields Science and Mathematics Resource Centre (GFRC). 1983 was thus of special importance. It marked the beginning of a full scale Outreach service to the schools in matric mathematics and physical science over an entire year. Eight schools were involved (4 African and 4 Coloured) and a participation rate of more than 500 was maintained. By September of that year the learners had covered the entire grade 12 mathematics and physical science syllabi and grade 11 learners would be included on the program during the last term. Other programs initiated by the Outreach Project at this stage were the *Winter School*, and the *Genesis* programs. (Jones, 1986: 91-93)

Jones (1986: 16-107) meticulously monitored the implementation and the results of the Outreach program during 1984, which provided 600 'disadvantaged' grade 12 learners with three hours of Plato Computer-Based Instruction (CBI) in mathematics and physical science weekly. He comments on the impact of the programme as follows: *"The fact that the pass-rate in 1983 was comparable to that of 1982 in Mathematics and significantly better in Physical Science indicates that the Outreach Program of 1983 had a positive influence on results"* (Jones., 1986: 106-107).

In terms of its initial mandate the Outreach Project was supposed to have ended in December 1986. It however continued to expand, with increasing demands for its services especially in the rural areas. Approximately 1000 learners were bussed to the Gold Fields Centre weekly for daily three hour sessions of CBI in Mathematics and Science. Since the inception of the program, participating school showed a significant improve ment in their matriculation examination performance in these subjects with some pass rates exceeding 80%.

An exciting and successful extension of the Outreach program in 1986 was a specially designed *mobile computer unit*. This unit consisted of a large air-conditioned modified trailer pulled by a mechanical horse. It housed 18 microcomputers and accommodated up to 40 learners per session. During its second year the unit was mainly used in Mitchells Plain and serviced 12 secondary schools in the area. Plans were further under way for its use in rural areas

The building housing the GFRC was extended in 1986 and 1992 by its funders. In 1993 the then acting director of the centre, Prof. C.T. Johnson, reported that a Mathematics Education Project and a Junior Primary Language Project had been added to the traditional activities of the centre. He commented that:

"*The Gold Fields Science and Mathematics Centre at the University of the Western Cape had developed into one of the foremost facilities in the world for computer–aided education. A similar facility was established at the University of Pretoria in 1990. During 1992 substantial funds were allocated for the extension of both facilities which has enabled the centre at UP to extend its activities to developing communities in the same way as UWC has been doing for some time.*"

(GFRC Report, 1992:7)

1991 saw the mainframe delivery system at UWC replaced by a local area network (LAN) of personal computers and the upgrading of the functioning software. The former PLATO terminals were replaced by 45 workstations networked PCs (netstations). A mini science laboratory for demonstrations and hands on experiments was also in use. The then Outreach Project coordinator, Lionel Benting (GFRC Annual Report, 1992, 10-11) stressed the mutual interdependence of Courseware Development and running Outreach programs. Courseware in both mathematics and physical science were then being extensively developed to supplement the Outreach CBI endeavours.

Educator participation and involvement on the programme was encouraged and the program utilised student assistants (UWC students enrolled mainly in the Science and Education Faculties) to obtain feedback from the participating learners. The use of the mobile unit in rural areas was also realised. It was located in Tulbagh and used by three high schools in the area. Learners from 23 high schools attended the on–campus Outreach Program with 3 schools using the mobile unit.

During 1991 the CBI component of the Outreach Project made a computer hardware transition. The Mathematics and Physical Science Courseware development teams developed a structure incorporating management and record keeping features and commissioned a local company to develop a management shell, the Advanced Menu System (AMS). The PLATO 2000 curriculum of lessons for delivery on the network was purchased at the beginning of 1992. This supplemented the lessons and tests that were developed by the courseware project. Great care was taken to ensure that the materials developed were learner centred and based on learner needs. Study guides on 60 different topics were produced and used as a home resource by the participating learners. During this year the matriculation results in mathematics and physical science of most learners participating in the Outreach programs again exceeded the national average.

Furthermore during this period in the history of computers the enhanced properties of personal computers (faster speed, better colours and graphics) the presentation of materials became user friendly. It became obvious that a personal computer in a school was a much more viable option than a large, air conditioned, expensive to maintain, immovable mainframe installation. The idea to develop a workable model of 10 schools equipped with local area networks (LANs) clustered around UWC, where managed systems could be researched, started taking root.

The highlight of 1993 for the GFRC was the 10^{th} Anniversary Celebration and the inauguration of the new wing of the Gold Fields building on the 14^{th} May of that year. The GFRC then boasted a staff of 22 persons with a top structure consisting of an acting Director, a deputy Director and an assistant Director. The Outreach Project was manned by a co-coordinator, a facilitator and a science course developer. The goal of all programs of the Project was still to provide Western Cape High School learners and educators with technological alternatives to the problems associated with studying science and mathematics and to improve the matriculation results of historically disadvantaged learners in these subjects. Problems such as overcrowding, under provision of resources, lack of functional laboratories, as well as under-preparation at foundation level were addressed by giving learners access to a stimulating, challenging technological environment that focuses on promoting understanding and occurred in adequate facilities. Twenty six schools utilised the services provided by the Project after school hours and during the vacations and attracted learners from as far afield as Malmesbury and Macassar. After 1993 however, many of the services provided at GFRC started to decline.

2.5 THE ESTABLISHMENT OF THE SCHOOL OF SCIENCE AND MATHEMATICS EDUCATION (SSME)

The April 1994 democratic election heralded a new political dispensation for South Africa. The Education Philosophy of UWC was realigned accordingly as it became increasingly exposed to the rapid changes of the global higher education environment.

Prof Meschack B. Ogunniyi visited UWC in August 1994 as the incumbent Director of the Gold Fields Resources Centre (GFRC) and the UNESCO Chair for Mathematics and Science Education. He took up the positions of Chair and Director of the Gold Fields Resources Centre on the 15th January 1995. In his inaugural address (22nd September 1995) he emphasised that: *"The complexity of the learner's background and the dynamics of social interaction in science* **(***mathematics***)** *classes must not be ignored when introducing students to new learning experiences."(Ogunniyi, 1995: 26).*

At that stage the following compendium of projects/departments functioned at the GFRC: Outreach Project, Academic Development Centre, Primary Mathematics Project, Chemistry Project, Unitwin Institutions, Biology Project, Didactics, Senior Mathematics Project and Physics Education. The focus of most of these activities was school rendering services. They were not centrally coordinated and had no, or peripheral academic objectives. This state of affairs brought into question the continued viability of the GFRC and its research contribution to UWC as an academic institution. By October 1995, the projects housed in the centre had dwindled to just the Outreach Project, Primary Mathematics Project and Unitwin Institutions and the staff had decreased from 32 persons to 8. In order to re-establish a sense of unified academic purpose to the GFRC, the faculties involved agreed in October 1995 to change the name of the GFRC to The School of Science and Mathematics Education (SSME).

Prof. Ogunniyi was instrumental in ensuring that the objectives of the Outreach Project and Primary Mathematics Project included research components that could contribute to the academic objectives of UWC. The name change also ensured closer association between the UNESCO Chair of Science and Mathematics Education and the newly named school. Other projects that then formed a lose association with SSME were the Physics Educational Research and Development Group (PEG), Environmental Education and Research Unit, Academic Development Centre, Science Through Applications Project (STAP), KwaNgwanase Schools' Science Teacher Development Project (KSSTDP), Teacher Advancement in Mathematics (TAIM) Project, Chemistry Education Project and the Internet Biology Project (SSME Annual Report, 1998-1999:1-15). Ogunniyi's leadership style is reflected in the mission statement formulated for the School:

"All activities of the School of Science and Mathematics Education (SSME), University of the Western Cape (UWC), are governed by a philosophy of quality and excellence in the fields of science, technology, mathematics and environmental education. The SSME is committed to the development of a critical mass of professionals in these fields. In pursuit of excellence the School is aware of its social role to the community in terms of mounting up programmes that empower disadvantaged individuals to acquire technical, practical and survival skills necessary for productivity and self–actualization."

(SSME Annual Report, 1998-1999: ii).

He endeavoured to galvanize the SSME into a centre of excellence for the development of Science, Technology and Mathematics Education. The Gold Fields Building became a meeting place of a federation of constituencies scattered across departments and units at UWC. The primary concern of the Outreach Project at this stage was still providing supervised computer-assisted support programs in mathematics and physical science at the matric level to students from disadvantaged communities. The focus group expanded to include the upper primary school learners.

2.6 THE SERVICES OF THE OUTREACH PROJECT DURING 1998

During mid 1998, six Project services were operational. These included four on-campus programs: (1) the grade 12 learner support program, (2) the grade 12 academy, (3) the grade 12 vacation program and (4) the grade 12 teacher support program. Two programs operated off-campus namely (5) the off campus resource program and the (6) Mobile Unit program. To assist historically disadvantaged learners through CBI i.e. a computer assisted learning (CAL) program to perform optimally in the grade 12 mathematics and physical science matriculation examinations remained the underlying goal of all these services. The goals/objectives and the operational modes of these services are reflected in the following table:

SERVICE	GOALS/OBJECTIVES	OPERATIONAL MODE
1)On-Campus Learner Support	The goal of the original GFRC Outreach Program	CBI/CAL on a 20 PC network in GFRC. Pupils bussed in daily
2)On-Campus Academy	The goal of the original GFRC Genesis Program	CBI/ CAL on a 20 PC network in GFRC. Selected learners
3)On-Campus Vacation School	The goal of the original GFRS vacation Program	CBI/CAL on a 20 PC network in GFRC. Open to all pupils
4)On-Campus Teacher Support	Educators tutored in difficult topics of the grade 12 math syllabus	CBI/CAL on a 20 PC network in GFRC. Workshops and short courses on relevant topics
5)Off-Campus support to schools	Resource library of textbooks, aids & science apparatus; Motivational events	Booklets, videos on various math & science topics; physics & chemistry apparatus in loan scheme Motivational events at schools
6)Off-Campus Mobile Unit & Computer Lab	The goal of the original GFRC Mobile Unit program	CBI/CAL on a 15 PC mobile and 10PC permanent networks at schools in outlying areas

2.7 A CURSORY ASSESSMENT OF THE 1998 PROJECT SERVICES

1998 was a critical year for the Outreach Project. From the 1997 Outreach Project Annual Report it was determined that 12 schools (300 learners) had participated in the traditional activities of the Project. By May 1998, however, these had been reduced to three schools with mathematics and physical science being offered on alternate weeks. Two (one-year contract) full-time staff members, two part-time educators and two part-time student assistants manned the Project at this stage.

Innovative developments during 1998 were: the establishment of a rudimentary Mini Computer Lab at a high school in Umfuleni (Kuils River); the culmination of a series of motivational events at the V&A Waterfront to celebrate the 1998 National Year of Science and Technology; the development by Dr Jan de Dobbelaar (a Dutch chemist on sabbatical) of a number of 'Research and Design of Industry Relevant Practicals' and networking with the WCED and the American Chemical Society and 'Science across the World'. The Mobile unit was stationed at a township school in Paarl and served 2 other high schools in the area. A winter school was planned for the June school vacation. Progress at the Mini Computer Lab was erratic.

During the period May/June of that year the operating services of the Project were subjected to critical observation to gauge their *efficiency and determine to whether the immediate and long term outcomes were being attained.* The objective of this exercise was to access the viability of these services and to determine whether the Project in its present state should continue or not. The following insights were gleaned from incidental talks with, and informal questions posed to educators and learners during the recruitment, registration and participation and during the day to day running of each service.

2.7.1 The efficiency of the 1998 operative services

The On–Campus learner support program: The recruitment and registration of learners for this program was subject to certain conditions. One of these requirements was that each group of a particular school be accompanied by their responsible educator for each session they attended. It was expected that as the educator with his/her learners became acquainted with the structure and process of a session he/she would ultimately assume responsibility for all other sessions. Despite written commitments by each educator many failed to fulfill this obligation. Informal talks and questioning revealed that in many instances both teachers and learners regarded involvement in the program and CBI/CAL as an *easy and effortless way* to pass the impending matriculation examinations.

Sessions generally started with group-structured problem-solving activities followed by application activities using CBI. However a lack of homogeneity in ability, intelligence and confidence (of the total number of participants 60% had failed grade 10 and grade 11 mathematics and/or physical science) led to dominant persons controlling the activities during sessions with the rest merely content to 'tag along'. As they became more disillusioned, many left the program.

On-Campus Academy: This program was an attempt to revive the defunct GFRC Genesis program. It failed to get off the ground due to lack of funding and interest.

On-Campus Vacation School Program: About 50 learners from schools serving disadvantaged areas registered for and participated in this 4 day Winter Vacation School. Different facilitators conducted the mathematics and physical science sessions. At the end of some sessions participating learners were encouraged to verbalise their feelings about particular session. On the whole comments were positive indicating that they benefited from attending them.

On-Campus Teacher Support Program: In May a 2 hour seminar/ workshop was organised for grade 11 and 12 higher grade teachers on the topic "linear programming". A curriculum advisor of the WCED facilitated the seminar. *Many of the participating educators commented that they had benefited from the exercise. They said they now understood the topic better and could teach it with confidence.*

Off-Campus Resource Centre and Motivational Program: The first component of this service was primarily a library from which videos, textbooks, booklets and physics and science apparatus were available 'on loan' to schools. The second was a series of visitations to schools aimed at encouraging learners to do science and mathematics up to grade 12. The service proved to be very popular but the resource items were soon depleted because many borrowers failed to return the items. *Both teachers and learners interviewed indicated that the service was very helpful.*

Off-Campus Mobile Unit and Computer Lab Program: Initially participation in both components of the program was enthusiastic. After a few weeks as teachers had to take control of the service, interest at the host schools waned. The mobile unit was later vandalised and returned to the UWC campus in August 1998. Activities at the Off Campus Lab vacillated.

2.7.2 Short term achievements of the 1998 Outreach Service

The cursory assessment indicated that the expected short term outcomes of the learner support program, the envisaged academy and the mobile-unit were not being attained. The major impediment to the attainment of the immediate outcomes in the *learner support program* was the misconception by both teachers and learners that CBI/CAL was a 'quick fix' solution whereby with the minimum effort mathematics became 'easy'. Both the 'academy' and mobile-unit services failed to 'deliver' because the former was 'still born' and interest and enthusiasm at the latter decreased as participating educator responsibility increased.

The Vacation School, Teacher Support and Library & Motivational services appeared to produce many of the desired short term outcomes. The positive perceptions of participating learners toward the Winter Vacation School Program (Appendix B) resulted in the planning of a Spring Vacation School for that year. Similar positive reaction of participating teachers to the Teacher Support session resulted in the immediate planning of more of such empowerment sessions.

The foregoing findings suggested that many of the then operating programs of the Outreach Project were not aggressively fulfilling their mandate i.e. most of the1998 Project services which supplied technological alternatives to the problems associated with the learning and teaching of mathematics and physical science to Western Cape High School learners were not functioning optimally. Furthermore it was obvious that the overt goal of each service i.e. to improve the matriculation results of historically disadvantaged learners in these subjects would not be attained.

2.8 THE RESTRUCTURING AND REALIGNMENT OF THE PROJECT

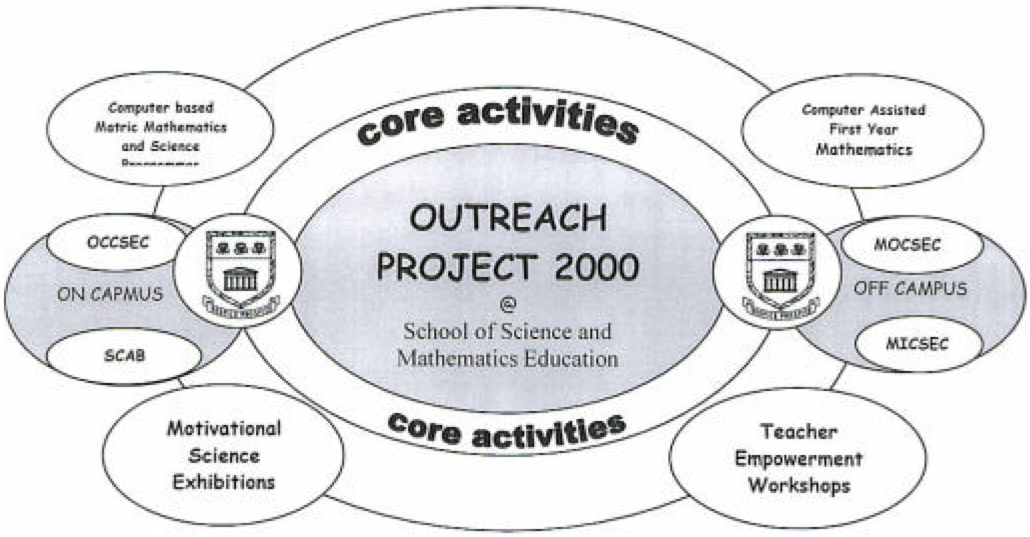
For the last six months of 1998, the Learner Support, Vacation School (September), Library & Motivational and the Off Campus Computer Lab services were allowed to function with minor adjustments till the end of that year. The Learner Support service was extended to include a group of first year UWC mathematics students doing the 114 and 124 courses.

Besides the listed anomalies regarding the perceived and achieved programs of the Project services for 1998, the following inconsistencies revealed that in order to survive the Project needed to be restructured and realigned: Finances were at an all time low; it was estimated that the amount available would only be enough to pay a part time coordinator (at half salary) and a full time administration clerk for 6 months. Consequently three different coordinators managed the Project in the space of six months. The computer technology (networks comprising netstations/dumb-terminals and a dedicated servers) used still served its purpose but was antiquated. Furthermore the other 4 higher education institutions in the Western Cape had initiated similar Outreach programs with the objective of recruiting first-year students.

Factors that, however, underscored the relevance of many of the services of the Project and necessitated the acceleration of its restructuring were the following. Although apartheid was legislatively dead the spectra of its iniquitous aftermath still haunted many spheres of the daily existence of those who were on its negative receiving end. In the field of education most schools in traditionally disadvantaged communities continued to be inferior. Overcrowding, lack of adequately qualified teachers, shortages of textbooks and laboratories still were part of the past educational arena in black areas. These retarding elements and problems, symptomatic of the malaise of the past unjust political system still characterised black 'education' and continued to make it the feeder system for the menial labour market.

It was decided that subject to financial restrains that all Project services in the future be planned in two-yearly cycles. The implementation of each two-yearly cycle was to be preceded by a six month period of intensive evaluation, planning and fundraising. Any necessary innovative service planned for a particular cycle would be formulated in the form of a proposal and presented to specifically targeted funders.

2.8.1 Restructured Project Services of the 1999-2000 cycle



As indicated in the above organisational diagram the cycle 1999-2000 of Project activities were restructured and developed around two discrete, spatial foci i.e. essentially an on-campus and an off-campus educational support service to township/rural high school in grade 12 mathematics and physical science. The off-campus activities were planned to engender the philosophy of self-sustaining community involvement with the intrinsic goal of community upliftment in the poor township and rural areas. The services were planned and implemented as follows.

2.8.1.1 On-campus Outreach Services

(1) The High School Mathematics Educator Empowerment Program: This service crystallised from a series of visitations to schools and was aimed at propagating a positive image of UWC to the high schools in the immediate township areas. During these visitations the various Project Support Services to mathematics and science educators and learners were advertised. In some instances this was accompanied by mathematics/science motivational shows aimed at encouraging grade

8 and 9 mathematics and science learners to do these subjects at grade 10-12 levels. Grade 12 learners were also engaged in motivational talks. The aim was to encourage them to do well in the matric examinations in mathematics and physical science so that they could be adequately prepared to pursue such orientated courses at tertiary level.

During these interactions at about 30 of these Western Cape township and rural schools (i.e. schools servicing learners from very adverse socio-economical circumstances) it became obvious that the acute shortage of Mathematics and Science educators had reached alarming proportions. More than half of the educators teaching mathematics and science at these schools were not or ill equipped to teach these subjects at grade10 to 12 level. The situation had been further exacerbated by the education department's policy of staff rationalisation. Many well qualified educators had opted to leave the teaching profession and in many instances educators with majors in the Arts or Biological Sciences were coerced to teach these subjects at matric level. Some of these educators had only passed matric mathematics and physical science, which in many instances were completed more than ten years earlier.

It was this state of affairs that ultimately resulted in the planning and implementation of *Mathematics/Science Educator Empowerment Programs* by the Project. This service was introduced to counter the readily recognisable circle of mediocrity that perpetuates ill-qualified educators to produce poorly qualified students who were themselves ill-prepared for either the job market or tertiary education. This cycle appears to form the malaise of the continuing crisis in education in mathematics at poorly resourced schools where inappropriately qualified teachers tend to conglomerate. Two related causes, i.e. inappropriate or lack of qualifications together with the fact that the attrition rate was outstripping the rate of newly qualified teachers, generally characterise the teaching and learning of mathematics and physical science in these situations. The need for teacher empowerment in these areas of education had thus become undisputed and imperative.

A series of **empowerment workshop in mathematics** conducted in 1999 was a short-term solution to this problem. These workshops were conducted once a month with difficult sections of the syllabus in grade 10-12 being 'workshopped' as topics. A core of about 30 educators showed a keen interest in this activity and in most instances the participating educators identified the topics they felt needed clarification. At the commencement of 2000, about 20 of these in-service educators enrolled for the FDE (High School Mathematics) diploma or other post graduate degrees in mathematics education offered by the faculty of education.

The Further Diploma Education (FDE), now called the Advanced Certificate in Education (ACE) is a fourth year diploma presently offered by the Education Faculty of UWC that empowers educators to teach high school mathematics up to grade 12. The rules of admission, duration of the course, composition of the curriculum and examination for the Advanced Certificate in Education (Mathematics) [ACE (Maths)] are found in the education yearbook issued by the Faculty of Education of the University of the Western Cape. Three course modules, Mathematics for Teaching1 & 2 (Appendix C) and Computer Studies were initially presented and examined by the Project staff. The Project played a pivotal role in funding, planning and implementing the day-to-day running of the initial ACE (High School Mathematics) diploma offered by the Faculty during 2000/2001. At the end of this period a number of the educators, who had initially been ill- equipped, were empowered with the necessary subject knowledge, communication and teaching skills to perform optimally at their schools that functioned in very adverse educational circumstances (15 completed the ACE diploma in High School Mathematics and 3 the B. Ed. degrees offered by the Education Faculty of UWC). The Project ceased its involvement in this service when one of the strategic objectives of Project 2 (Status and Quality of teaching) of the Tirisano plan of the National Department of Education i.e. to 'empower mathematics and science educators with both content and pedagogic skill and to equip these teachers to motivate learners to participate and achieve' (Implementation Plan for Tirisano, 2001-2002: 14) was initiated. By March 2002 the National Education Department had 30% of its target group trained.

The Project, however, still provides an advisory/consultative service to educators who require assistance in teaching particularly higher-grade mathematics.

(2) The UWC Outreach Matric Class: The daily learner support and vacation school program were combined and offered as a year long continuous program. It was renamed: "THE UWC OUTREACH MATRIC CLASS' and conducted on campus and at off-campus satellite schools. Centralising all Project services to learners into a single service removed numerous organisational problems which needed to be addressed and solved when this activity was fragmented. Growth and development in this service occurred in a variety of directions. The length of the program was increased to approximately 450 hours each year.

During the **1999/2000 cycle** the program commenced during the March vacation (6 days), continued on Saturday mornings during the months of April, May and June, had a daily stretch during the June/July vacation, resumed Saturday morning sessions during July, August and September. These classes continued through the September / October vacation and again every Saturday during October up to the weekend of the final examination. Each year the program ended with a *Bio-mathethon* (from *Biology*, *Mathematics and Marathon)* i.e. 20 hours of intense revision the weekend before the final examination in biology and mathematics were written. During the period 1999-2000 cycle the learner numbers more than trebled to what they were in 1998.

In the cycle **2001/2002** the structure of this program remained unchanged. However clashes occurred with the newly initiated Equitable Access Project (EAP) funded by SANTED, which targeted the same learner 'pool'. It was agreed with the manager of EAP that the Outreach Project would maintain a lesser on campus presence and concentrate its efforts in extending the satellites of the Cape Flats and rural schools using the MICSECs it had established there as its growth points.

The need for urgent supportive intervention at the Southern Cape Schools (Mosselbay, George and Knysna) became evident after an assessment funded by the Science Faculty was conducted early in 2001 by the Project staff. This resulted in about 100 matric learners from the schools in this area joining the Outreach Matric Class 2001 during the March vacation. A Winter School was held for them in Knysna in conjunction with the Science Faculty during the June/July vacation. A spin-off of this effort was a series of motivational/recruitment shows held at specific host schools in the Cape Flats. These efforts culminated in a '*Certificate Award Ceremony for Promising Matric Learners in Mathematics and Science*' (Appendix D) that involved 450 learners from about 70 high schools held on campus.

2.8.1.2 Off-campus Outreach services

The MICSEC 2000 Program: The computer support component of the off-campus services of the Outreach Project centred mainly around two contingencies: the traditional Mobile Computer Supported Education Centre (acronym: MOCSEC) and the new innovative Mini Computer Supported Education Centres (acronym:

MICSEC). MOCSEC was the acronym given to the semi-stationary (mobile) unit and served as a test bed for the establishment of the more permanent MICSEC structures.

The MISEC2000 program developed into an ambitious program, which aimed by the end of the year 2000 to have established 10 fully functional self-sustaining Mini Computer Centres to be accessible to 50 high schools in the Western Cape.

Fundamentally this operation was motivated by the idea of placing the experience, expertise and specialised knowledge developed in computer based/supported/assisted learning over many years by the Project at the disposal of the general community. In this way the Project, in contrast to the past when its objective was community intervention was steered to total community involved.

The exercise was aimed at creating the capacity/opportunity for 2000 indigent grade 10-12 learners to profit from at least 2 hours exposure of computer-assisted mathematics and physical science education on a daily basis.

This innovative service to schools was aimed at indigent learners in the Western Cape schools and will be fully described and evaluated in chapters 4 and 5

2.9 THE PERFORMANCE OF PROJECT PARTICIPANTS WHO REGISTERED AS UWC STUDENTS IN 1999 & 2000

The ultimate goal of all Outreach Project services is to encourage as many of its participants as possible to register and successfully complete a mathematics/science orientation degree or diploma at a tertiary institution preferably UWC. The following table traces the progress of some of the 1998 and 1999 Outreach Project participants (learners and educators) who registered for diplomas or degrees in the various faculties at UWC in the years1999 and 2000 respectively:

Faculty	Degree/Dip	Registration year	Completed full degree	3rd Year	2nd Year
Science	BSc(Pharm)	1999	5	2	
		2000	1	5	5
	BSc(Physio)	1999	7	2	
		2000			
	BSc (Gen)	1999	5	7	
		2000	2	13	4
	BSC(OT)	1999	1		
		2000			
	BCur	1999		4	
		2000			
	BSc(Diet)	1999	1		
		2000			
	Hon BSc	1999 /2000	2 11		
Arts	BA(Psych)	1999	2		
		2000	5	1	2
	BA(Sos)	1999	3	2	
		2000	2	2	1
	BA	1999	8	8	
		2000	9	13	11
	Hon BA	1999	3		
		2000	11		
	L Dip Lib	1999	1	2	
		2000			
	MA	1999	1		
		2000			
EMS	BAdmin	1999	2		
		2000	2	2	
	BComm	1999	10 18	43	3
		2000	16	7	
	HonBComm	1999	7		
		2000			
Law	LLB	1999	8 14	13	8
		2000			
	Hon LLB	1999	1		
		2000			
Educ	ACE(Math)	1999	3 15		
		2000			
	HDE	1999		9	
		2000			
	BEd(Math)	1999	4 4		
		2000	2		
	Dentistry	1999/2000		3	1
	Dip O H	1999/2000	5		
	TOTAL	**1999**	**62**	**42**	
		2000	**97**	**97**	**34**

In summary then , at the end of 2001 , 104 (53%) of about 195 of the learners and educators, who in one way or another utilised the 1998 Outreach Project services and registered as UWC students in1999 obtained or were in the process of obtaining a degree or diploma (tertiary qualification) at UWC. At the end of 2002, 189 (42%) out of about 450 who registered at UWC obtained or were in the process of obtaining a degree or diploma (tertiary qualification).

2.10 PROJECT SERVICES OF THE CYCLE 2002-2003

Some of the activities planned for and implemented during the cycle 1999-2000, particularly MICSEC2000, flowed over into the first half of 2001. This program became so popular that 5 extra Mini-Computer Centres were established. Another 5 other schools that possessed their own computer-centres requested that the mathematics and physical science soft-ware used and distributed by the Project be installed on their systems. At each of these schools educators and learners completed the training program to successfully and effectively use this technology.

The second half of 2001 was used for planning and raising funds for the cycle 2002-2003. The National Plan for Higher Education (06/03/01) together with The National Strategy for Mathematics, Science and Technical Education in FET (June, 2001) formed the basis in the planning of this cycle.

2.10.1 The UWC Matric Mathematics Class for indigent grade 12 learners (M^2C)

The UWC OUTREACH MATRIC CLASS that functioned from 1999-2001 was restructured and given the acronym M^2C. Admission to this program is now based on the following criteria: a learner must be extremely indigent (the total household income must not exceed R2000 per month) and have a flair for mathematics (this is determined by his/her achievement history and the recommendations of his/her educators) and its related subjects. The program has been given further depth by the addition of a motivational component by which promising learners are taken on excursions where they are introduced to professionals in various fields of work (actual role identification). The focus group of this program has completely shifted to learners emanating mainly from poor rural communities. The element of community (particularly rural) upliftment has now become ingrained in the program.

As was the case with its predecessors, the **M²C** program offers a sustained and intensive revision computer assisted service in grade12 mathematics (physical science and biology depending on funding). The program is presently conducted on campus and at four rural satellites: Worcester, the West Coast, Ceres and the Hexriver Valley.

In 2002 about 450 learners from 25 schools at 3 centres (Campus/Blue Downs, Malmesbury, and Worcester) participated in this programme. All these learners were successful in the 2002 Matric Exams. About 20% obtained endorsements (exemptions) with 4 obtaining A-symbols in Mathematics Higher Grade and 35 obtaining A-symbols in Mathematics Standard Grade. To date 200 of these learners are registered 1st year students at UWC.

2.10.2 The Computer Installation and Maintenance Skills Transference Program (CIMSTEP 2005) for mathematics and physical science learners and educators

This programme will be implemented in 2004 due to various delays in securing the necessary funding. A computer technician has undergone the necessary training needed for the practical representation of the programme. He is presently refurbishing a number of used computers, some of which will be used by the participating schools.

Five high school from Ceres and 5 from the Hexriver Valley will be invited to participate in the Programme. Lectures, practical and other activities will take place at MICSEC7 in Worester, which will serve as an off-campus centre.

CIMSTEP2005, in essence, is the continuation of the MICSEC2000 programme with many of the problems and mistakes encountered during the execution of this programme in the past being addressed and removed. This initiative is aimed at assisting high schools in poor rural areas in developing, maintaining and sustaining their **own intra-net e-learning centre** (these centres will be fully inter-net compatible).

The programme will be preceded by an intensive 3 month, "hands on" course that will include all aspects of computer networking, installation and maintenance simplified for grade 10-12 learners and educators. Schools participating in the programme will be expected to raise 50% of all the costs incurred. Ten schools (i.e. 20 educators and about 60 learners) will be selected for the programme. Selected educators and learners from established Micsecs will be invited to participate in this programme but will be expected to pay all tuition fees or other costs.

2.11 PROPOSED PROJECT SERVICES FOR THE 2005/2006 CYCLE

The present activities/programmes, particularly the computer skills transference programme (CIMSTEP 2005) will be continued in 2005. It should also be mentioned that the Outreach Project would be celebrating its 21st year of its existence and many activities of a celebratory nature are being planned for next year (2004).

Conceptualised in July 1982, with a life expectancy of only 4 years, and with the original objective of improving teaching/learning in High School Mathematics and Science (and lately Technology) through the, then integrated PLATO computer based educational software, the Outreach Project will then celebrate more than two decades of constructively addressing and rectifying the disparities and deficiencies of particularly grade 12 Mathematics, Science and Technology. This objective, which in its present modus operandi utilizes the most modern technological aids to create supportive structures and environments to aid learners and educators in the most adverse educational circumstances, still underpins and will probably remain. If funding becomes available planning for 2005/2006 would probably include the development of software in high school mathematics, science and technology that would be made available to learners and educators on-line via the UWC website. The **M²C** program will probably continue to form an integral activity during this cycle.

CHAPTER 3

LITERATURE REVIEW AND THEORETICAL FRAMEORK OF THIS STUDY

3.1 INTRODUCTION

Chapter 1 progressively delineates the problem of unsatisfactory achievement in matric mathematics of grade 12 learners attending schools serving indigent township and rural areas of the Western Cape. It is proposed that the program of Computer Assisted Learning (CAL) outlined in chapter 2 and used by the Outreach Project since 1982 is still relevant and can be employed in a modified form as one of many strategic interventions to address this problem.

Four areas of literature germane to these assertions are examined in this chapter. In section 3.2 the research literature on the use of Information and Communication Technology (ICT) in mathematics education globally and locally is surveyed and the use of computer technology is emphasised. In section 3.3 the theoretical framework that will be used to critically appraise the implementation, perception, achievement and to some extent the intention of the proposed intervention program is demarcated. Section 3.4 lists similar intervention strategies implemented in the Western Cape which encourages the use of computer technology in school mathematics. Certain aspects of these strategies are expressed in some of the categories of the outlined theoretical framework.

The research questions to be addressed in this study together with the origin and adaptation of the research instrument to be employed to appraise the perceptions of participating teachers in the proposed program are finally detailed in section 3.5.

3.2 THE USE OF ICT IN MATHEMATICS EDUCATION

3.2.1 A theoretical paradigm of ICT generally used in Education and its adaptation to the survey of the literature on the use of ICT in Mathematics Education in particular

Mlitwa (2004:2) refers to the online website Bergen. org which outlines present educational technology generally to encompass "computers, software, video communications, interactive video, robotics, satellite communication, television, video, robotics, CD-ROM, and the internet. It includes the knowledge and skills necessary to use technology as a tool". Mlitwa then uses the paradigm (illustrated below with a small addition) posited by Andrew Feenberg (2003) to indicate how academics conceptualise and employ ICT in higher education. In this section a slightly modified version of Feenberg's paradigm will serve as the theoretical backdrop to illustrate how ICT, which is changing continually, was and is productively used in mathematics education.

Technology (ICT) is :	*Autonomous*	*Humanly controlled*
Neutral (Complete separation of means and end)	**Determinism** (e.g. modernisation theory)	**Instrumentalism** (liberal faith in progress)
Value-laden (means form a way of life that includes ends)	**Substantivism** (means and end linked in systems)	**Critical Theory** (choice of alternative means-ends systems)

According to Feenberg, depending on what is emphasised, technology (ICT) when used in education can be either *neutral* or *value laden*. The above schematic presentation categorises educational ICT as deterministic, instrumentalistic, substantivistic or critical depending on whether it is autonomous or humanly controlled. Educational ICT whether neutral or autonomous has presently become an indispensable supportive aid utilised by humans purely to procure particular goals. Concurring with Flick and Bell (2000), Alagic (2003: 384) suggests the following guidelines which she employs to successfully integrate ICT in mathematics teaching and learning: "ICT should (a) be introduced in the context of mathematics, (b) address worthwhile mathematics with appropriate pedagogy and (c) make scientific views more accessible." Alagic contends that when ICT is introduced in the mathematics teaching and learning process the level of *calculational* and *conceptual* development of both teachers and students should be known. In the context of this knowledge, the use of ICT in mathematics education should initially enhance calculational skills and then ideally lead to conceptual learning. When applied in this way, ICT in mathematics education functions ultimately as a 'cognitive tool' (Alagic, 392).

3.2.2 The ICT orientation used in this study

In this study the "instructivist theoretical approach" (Mlitwa, 2004: 2) i.e. educational technology does not replace the teacher is cardinal. The various components of ICT as indicated above are therefore educational aids or tools available to the teachers which can be employed to assist in the transference of knowledge and activate conceptual thinking. In terms of Feenberg's paradigm, educational technology utilised in this manner is "neutral and humanly controlled, i.e. instrumentalist" (Mlitwa, 2004: 2-3). This study is furthermore confined to a single element of the present ICT arsenal i.e. the use of a specific type of commercially available *calculational* (drill-practice) high school mathematics computer software.

This software is extensively used in the MICSEC2000 program and other Outreach Project services which are aimed at assisting disadvantaged or indigent grade 10-12 learners emanating from a particular South African socio-economic milieu to improve their performance in the final grade 12 mathematics examinations.

3.2.3 A literature survey of research conducted on the use of ICT particularly in the use of computer technology in mathematics education in the classroom

3.2.3.1 Global Research Perspectives To obtain these perspectives, the author perused numerous research articles appearing in the Journal of Computers in Mathematics and Science Teaching from 1989 to 2003. This Journal will be abbreviated: JCMST. A tabulated summary of the important features in these articles is included in Appendix E. From these articles it can be discerned that as computers became more sophisticated, so their use in mathematics education, particularly in the American mathematics classroom, became more indispensable. The initial 'drill/practice sessions' on rudimentary computers (stand-alones and networks) finally culminated in the present ICT 'virtual mathematics classroom' with the 'information highway' the super service provider.

"The 1980s were a decade of exploration in the use of computers in mathematics and science instruction" and between 1985 and 1989 the number of computers used in American mathematics and science classrooms more than doubled (JCMST, 1991: 19-25). Early mathematics software was designed for Computer Based Instruction (CBI) and Computer Assisted Instruction (CAI) and emphasised *drill* and *practice* essential to the *behaviouristic* learning approach (JCMST, 1989: 45-50). ICT was then rather rudimentary and the computer technology utilised in the American mathematics classroom at this stage was purely *deterministic* and or *instrumentalistic*.

Qualitative research of the early nineties experienced a paradigm shift from a calculational orientation (drill, practice, tutorials and simulations aimed at obtaining correct answers to problems) to the use of computers to stimulate conceptual thinking i.e. application, analysis, synthesis and evaluation in mathematics education. Computer software consequently took the form of utility programs or general purpose tools (e.g. function plotters) which were developed to solve a wide range of problems. The following discussion traces the salient aspects of relevant quantitative research projects on school, college and pre-calculus mathematics involving students, pre-service teachers and teachers reported in the Journal of Computers in Mathematics and Science Teaching (JCMST) over the past two decades.

3.2.3.2 Quantitative research articles

The applicable reports in the JCMST can be divided broadly into two areas of research in mathematical education. In the first, researchers evaluate or compare the effect of the use of computer technology on *student achievement* in clearly demarcated sections of mathematics content taught at a particular level. The second examine the perceptions, attitudes etc (cognitive/connotive aspects) of teachers or students who used computer technology in the teaching and learning of mathematics.

3.2.3.3 Student Achievement centred Quantitative Research

Tirosh et al (JMST 10(2), 90/91: 71- 78) reports that an interactive computer instructional tutoring program effectively increased the awareness of pre-service teachers of their tendency to divide by smaller number(s) and improved their performance in solving division word problems.

Vonstein (1982), Morris (1983), Austin (1984) and Schumann (1991, 1992), report positively on the use of school geometry computer software as an effective tool in the classroom at various levels of teaching (JMST 18, 1999: 24).

McCoy (JMST 11, 1992; 53-62) investigated "the effect of a geometry tool software program on high school geometry achievement" of two *honours* grade 10 classes. The experimental group used the *Geometric Supposers* periodically for one school year and a similar class (control group) did not. The achievement of the experimental group in higher order (analyses, syntheses, and evaluation) questions was significantly better on the final examination in geometry. No difference was recorded on questions testing knowledge and comprehension between the groups.

By contrast, the comparison of three groups of high school geometry groups with students of *average ability* using the *Geometry Inventor* in varying amounts, Roberts and Stephens (JMST 18 (1), 1999: 23-30) indicated that the group not using the software scored higher than the groups using the software. Furthermore the geometry software used in the investigation did not stimulate the interest and participation of students in geometry.

Tilidetzke (JCMST 11, 1992: 54-55) surveyed the use of CAI in American College Algebra prior to the spring of 1988. He lists the pioneering work of DD Bickerstaff (1976) who "investigated the effect of CAI drill and practice used for homework credit on both achievement and attitude in a college-level intermediate algebra course" (54); Diem (1982) "studied the effectiveness of CAI in a college algebra course" and Graff(1987: 55) used computers as an aid to instruction for adults in introductory and intermediate algebra and " found that the groups that used computers made greater improvement between the pre-test and post-test than students in the control classes"

Kulik and Kulik (1985, 1986, and 1988) pioneered numerous meta-analyses of the use of computers to deliver instruction during the eighties. Tilidetzke (59) adds that "in the various meta-analyses of computer-based instruction (CBI) at a variety of educational levels, it was found that the evidence favours CBI over classroom instruction". "In a majority of the studies in which CAI was compared with traditional classroom instruction, it was found that CAI was at least as effective as classroom instruction".

In his investigation, Tilidetzke (1992: 53-62) compared "CAI and Traditional Instruction in a College Algebra Course". Two experimental classes were taught three topics of pre-calculus College Algebra (multiplication and division of complex numbers, completing the square and solving linear equations) in a two hour session in a CAI lab. Two control groups received normal instruction on the same topics. No significant statistical difference in the mean scores of the experimental classes and the control classes in their post or their delayed post-test was found. He concluded that the software package used in his investigation "was as effective as classroom instruction on the three topics in the study" (53).

Contrary to the evidence that computer technology positively influences mathematics teaching, Simmt (JCMST 16, 1997 269-289) cites the work of Becker (1991) and Barrett et al (1990) which disputes this positive evidence. She suggests that the problem of immediate availability and accessibility of computers in classrooms, one of the possible causes of this discrepancy can be successfully countered by introducing teachers and students to the relatively inexpensive and manageable *graphing calculator*. This device is in essence a hand-held computer. Research, however, according to Simmt in determining the impact and effect of graphing calculators on achievement in mathematics is limited. She lists the work with computers and graphing calculators of Wilson and Krapft (1994), Dugdale et al (1992) Ruthven (1990), Heid et al (1990), Lesh (1987), Wright (1989), Stuessy et al (1989) but contends that these research studies were narrow and student centred.

3.2.3.4 Educator Cognitive/Connotive centred Qualitative Research

Alkalay (JCMST, 1993) appraised the attitudes of students toward mathematics and computers. No significant difference in mean scores before and after completing a pre-calculus manual (consisting of shifting, stretching, flattening, and reflecting functions; inverse functions and polynomial functions) was found. She concluded that the use of computers for independent exploration is a worthwhile option in pre-calculus classes. Fleener (JCMST, 1995, 481-498) measured "the possible effects of technological diffusion efforts on teachers with fundamentally different beliefs about the use of technology tools for mathematics instruction". Many differences on various items between teachers who believed (graphing) calculators should not be used until students achieved conceptual mastery" and those who did not was obvious. Rochowicz (JCMST, 1996: 423-435) investigated the perceptions of calculus instructors' of the impact of using computers and calculators on certain calculus topics, student motivation and learning and the role of the teacher. He concluded that "the calculus course that uses computers and calculators in instruction will be more conceptual, relevant intuitive, and meaningful for each individual student" (430). Other research findings of the use of graphing calculators in mathematics education, i.e. Tharp et al (1997), Simonsen and Dick (1997), Merriweather and Tharp (1999) and Gningue (2003), are summarised in the Appendix.

3.2.3.5 South African Research Perspectives

In his literature review under the section the "application of computers in the teaching and learning process", Hartley (2002: 33-44) briefly discusses how computers are used in mathematics/physical science teaching and learning. He concurs with Johnson (1995) and others who indicate that CAI produces significantly greater achievement in science and mathematics. The bulk of Hartley's review concentrates on research regarding school physics and chemistry. Bennett's (1992) review is the only research he mentions on CAI and mathematics education. Bennett indicates that students should work co-operatively rather than competitively or individually on computers. Some studies reveal that the combination of a positive teacher input and a computer use improve student problem solving skills and results in positive attitudes towards both the computer and school mathematics (Hartley, 35)

Hartley agrees with Tsvigu and Maswera (2002) that, "most mathematics teachers were yet to realise the effectiveness of computers in mathematics education on schools". He concludes that more research is needed into "appropriate software programmes, teaching strategies used with computers, and student perceptions of computer-assisted learning.

The "worksheet" and the "graphics calculator (GC)" are essential ingredients of the "workshop-lecture" advocated by Kannemeyer (1996). Kannemeyer used this method of instruction in the Mathematics 114/124 course developed particularly to provide students considered to be at risk to succeed in first year mathematics at the University of the Western Cape (JOSAARMSE 1(1), 1997: 41-49). The 1993-1996 report of this course show that "just below 70% of students who register for M114/124 pass the course, and an average of 70% of students who sit for the examinations pass the course" (1996: 1).

3.3 THE THEORETICAL FRAMEWORK OF THIS STUDY

3.3 .1 PROGRAM EVALUATION: THE INTENDED, IMPLEMENTED, PERCEIVED & ACHIEVED PROGRAM

3.3.1.1 The Structure of this Conceptual Framework

In his investigation into "The effectiveness of an Outreach Programme in science and mathematics for disadvantaged grade 12 students in South Africa", Hartley (2002) developed the following theoretical framework, which he used as template to evaluate the role of Computer-Assisted Learning (CAL) as it occurred at two Mini Computer Supported Educational Centres (MICSECs) established by the Outreach Project of the University of the Western Cape.

Goodlad's Curriculum Representation	Ideological Societal curricula	Instructional or Operational Curriculum	Perceived or Institutional Experiential Curricula	
Van den Akker's Curriculum Representation	Ideal Formal Curricula	Operational Curriculum	Perceived Curriculum	Attained Experiential Curricula
Treagust's Curriculum Rep	Intended Curriculum	Implemented Curriculum	Perceived Curriculum	Achieved Curriculum
Hartley's Program Rep	**Intended Program**	**Implemented Program**	**Perceived Program**	**Achieved Program**
	Program goals, objectives & Theory	Implementation of CAL Lessons	Student perception of CAL	Teaching and learning outcomes
	Program documents & Interviews	Observations of lessons during site visits	CALEQ and student Interviews	Matric exam Results and teacher Interviews
	What must be Measured	How Implementation Take place	Students experience the implemented program	Did the program have the desired effect

As indicated in the first three rows of the above table Goodlad's conceptual framework for educational evaluation, which was adapted by Van den Akker and then by Mills and Treagust, form the basis of this theoretical paradigm. The four representations developed by Treagust (1987) and Mills and Treagust (2002), were redesigned by Hartley to the intended (**InP**), implemented (**ImP**), perceived (**PeP**) and achieved programs (**AcP**) to evaluate generally the effectiveness of an outreach program (Hartley, 2001:16-19).

Program evaluation explores the degree of success of each four of these aspects of an educational intervention strategy. *Intention* in program evaluation scrutinises the objectives underpinning an intervention strategy. *Objectives* are the measurable and attainable verbalisations of the broad and abstract *goals* of an intervention strategy. The theory of a program is the theoretical model of how a program is supposed to work, whether it worked, and why it did not work to produce the intended outcomes. As indicated in the last three rows of the third column in the above table, addressing *implementation* in program evaluation confirms the intended contents of a program and if it is actually received by the targeted group.

Recipient perceptions evaluation, the third phase of program evaluation, is initially preceded by collecting data, in the form of interviews, questionnaires etc, directly from participants. The process determines whether the designated services were delivered, but also that it was received, used and understood as intended. Briefly it entails the evaluation of the actual learning experiences as perceived by recipients. *Outcomes Evaluation* is finally the process that evaluates whether the desired outcomes were attained as determined by a set of operationally defined objectives.

3.3.1.2 Hartley's application of this Conceptual Framework

From his on-site visitations Hartley compiled a thick narrative (73-120) of the locations, activities and his personal experiences at the schools, where the two MICSECs were located. Against the backdrop of the program representations of the conceptual framework, he simultaneously formulated the following **four research questions.** These he used to measure the effectiveness of the **CAL** program in grade 12 mathematics and physical science, which he observed in the MICSECs at various stages of his research at these schools:

1. **Intention**: What was the outreach programs intended to achieve?

2. **Implementation:** How were the computer-assisted lessons in the outreach programs actually implemented, perceived and achieved?

3. **Perception:** How did students perceive their computer-assisted learning classes?

4. **Achievement:** What were the outcomes in mathematics and physical science as a result of the students' participation in the outreach programmes?

Hartley's data collecting instruments included on-site observations of 3 computer-assisted lessons, questionnaires, semi-structured interviews for learners and educators and protocols for analysing documents.

3.3.1.3 Hartley's interpretation of the Goals / Objectives of the Outreach Project

Hartley analysed five Outreach Project annual reports and concluded that one of the two broad goals of the intention of the 2001 CAL programme in the MICSECs was: "To use technology in support of teachers and students at disadvantaged schools in mathematics and physical science" (69). This goal he then expanded into six composite objectives (Hartley, 70) which he qualitatively and quantitatively measured with the research instruments he devised.

3.3.1.4 Aspects of Hartley's Methodology, Research findings and discussions of findings relevant to this study

The information relevant to this study is listed in the following table.

It is a concise summary of Hartley's methodology, research findings and discussions of findings tabulated placed against the theoretical framework he employed.

PROGRAMME/ PROCESS/PEOPLE	Intended (InP)	Implemented (ImP)	Perceived (PeP)	Achieved (AcP)
Participants	2 Programme managers	4 Educators (E)	89 Grade 12 Learners (L)	E/L support outcome
Methodology i.e. data collection procedures (Hartley, 45-66)	Interviews, Document Analyses	Interviews, Lessons Observed	Interviews, CALEQ Questionnaire (actual/preferred)	Analyses of 1999-2001 matriculation examinations
Research Findings (Hartley, 67-120) **MICSEC A:** **MICSEC B:**	Goal: CAL to improve matric math & science results at disadvantaged schools Objectives six	On site observation of In, Im & Ac CAL **CAL used daily** **CAL used occasionally**	>3 for all (actual)scales hence a positive inclination to CAL Two tail t-test **H = 0 (for all scales)** **H>0 (for Learning Assessment scale only)**	Both schools had a history of weak results CAL led to matric maths pass **Increase of 11%** **Increase of 6.8%**
Discussions of Findings (Hartley, 121-134)	CAL assisted educators/ learners, led to better results however the number of computers insufficient	Software allowed educators to track progress of learners and from this they were able to structure revision	Demand for more computers for individual work. Majority saw group work in CAL positively Preferred educator centred CAL	Principals & educators at both schools indicated that CAL partly contributed to the improved results

In the table the *categories or representations* of the theoretical framework are portrayed horisontally in contrast to the vertical hierarchical rigid structure used by Hartley and his predecessors. The second row has been introduced to add the human element of each representation of the conceptual paradigm and indicates the most prominent role-players involved in each representation. The categories of the conceptual framework hence become linear democratic process set into motion by various key persons.

3.2.1.5 Hartley's Summaries and Conclusions

In this section of his evaluation Hartley reiterates that his investigation was a response to a National Consultative Conference (2000), which recommended inter alia that high priority be given "to interventions in language, science, mathematics and technology, and the evaluation of the success of such interventions".

The major findings of his study (135-152) was that in its *intention*, the outreach program, which over twenty years had gained overwhelming support from physical science and mathematics educators in the Western Cape, was a response to a particular educational need (138). In its *implementation*, CAL reinforced "previously learnt concepts, and thereby was a continuation of the problem-based approach in both physical science and mathematics" (140). One *perception* highlighted the limited amount of computers available. Group usage of the limited resources became the norm and this emphasised the learner dependence on teacher-centred teaching.

In the *achievement* category it was evident that computers became useful educational tools. They were also a supplement for textbook shortages and were successfully employed to supply content knowledge where it was lacking. Matriculation mathematics results improved by 7.5% at the two schools utilising the technology available in the MICSEC facility and was expected to increase as educators and learners became more acquainted with the technology.

3.3.2 CRITIQUE OF VARIOUS SECTIONS OF HARTLEY'S EVALUATION OF WHAT HE CALLS "THE OUTREACH PROGRAMME"

3.3.2.1 The history of the Outreach Project

Paragraph 1.4 (8-11) of chapter 1 of Hartley's thesis is a very brief and sketchy outline of the 20 year history of what he terms 'The University of the Western Cape's

(UWC) Outreach Program'. The researcher used only five (out of a total of twenty) annual reports of the Outreach Project to reach his conclusions. This survey contains numerous erroneous statements and certain misquotations. Furthermore it does not do justice to an endeavour that was initially a reaction by UWC to the disparities created and perpetuated in mathematics and science education by the apartheid educationists. Disputable sentences and statements are the following: "In the year 2001, it was in its twentieth year of existence". "The outreach programme was one leg of an Outreach Project which was started in 1982 by the Teaching Centre of the University of the Western Cape" (8).

"The Outreach Project started with three programmes in 1982 to support the goal 'to use instructional technology to improve education all levels' namely the mathematics sciences matriculation outreach programme, the instructional computing services dissemination programme, and the computer evaluation/improvement programme (Sinclair & Kansky, 1989)" (9). ".MOCSEC, which was in use since the inception of the Outreach project, became a semi-stationary unit that was placed in schools in the outer-lying areas of the Western Cape. It was used as a centre to serve a number of schools in its surroundings" (10). "In the year 2001, a total of 9 MICSECs were installed to serve a total of 50 schools in different parts of the Western Cape. Each centre consisted of approximately 15 computer terminals with a server" (11).

3.3.2.2 What was the Outreach program intended to achieve?

The intention of the outreach program is discussed in paragraph 4.2 (68-72) and addresses the first research question i.e. "What was the outreach program intended to achieve", which was formulated by Hartley to evaluate the intentions, goals, objectives, underlying philosophy and program theory of the program.

The author's information sources were two program 'managers' and the 5 already mentioned reports. The first 'manager' Hartley refers to was actually the first director of the Gold Fields Resource Centre (GFRC). When it became fully operative in 1982 the Outreach Project to high schools, headed by a coordinator, was one of many interdependent services of GFRC. Since then it has had six successive coordinators each organising the Project according to his/her own managerial and leadership style. The following sentences and paragr aphs in this section create an incorrect perception of the inception and goals of the Outreach Project: **"**In an interview with the Outreach manager who started the project in 1982 and carried it through for the first ten years" (68). **"**In the year 2001, the basic philosophy behind the outreach programme remained unchanged" (69). "In brief, the outreach programme was designed to assist and support students and teachers from disadvantaged communities" (69). "In response to this information, the Outreach Project embarked on an aggressive strategy of developing Mini-Computer Supported Education Centres in different parts of the Western Cape" (69).

A "recognisable cycle of mediocrity which perpetuated ill-qualified educators to produce poorly qualified students who were themselves ill-prepared for either the job market or tertiary education" (71). "This cycle appeared to be the malaise of the continuing crises in education. The need to address teacher and student empowerment in mathematics and physical science has therefore become undisputed and imperative" (71).

3.3.2.3 The relatively small sample of MICSECS and participants used

Hartley's investigation into the effectiveness of what he refers to as a computer-based outreach program is limited to CAL as it occurred in only two of the then established ten MICSECs. His study appears to be not inclusive in that the schools he selected are located in “African” townships. His sample of participating educators (4 out of a possible 50) and learners (89 out of a possible 1000) is relatively small and non-randomly selected. He observed only 3 CAL lessons (two at centre A and one test at Centre B). He makes no attempt to generalise his findings to the general population i.e. all the participating educators and learners of the MICSEC2000 programme.

3.3.3 THE NEED TO CORRECT THESE DISCREPANCIES

3.3.3.1 The History of the Outreach Project

Chapter 2 of this study traced the history of the Outreach Project in terms of its genesis in its original socio-political context to its relevance in the present democratic dispensation. At its inception in 1983 the Project was one of the many activities of the Gold Field Science and Mathematics Resource Centre (GFRC). In 1993 it was placed under the auspices of the School of Science and Mathematics Education (SSME).

It is evident that the Project pioneered the use of computer technology, particularly in the area of CAL to assist Grade 12 mathematics and science educators to produce better examination results, at all high schools in the Western Cape negatively affected by apartheid education. During 1998 all the services of the Outreach Project were assessed and restructured to address the expectations in high school mathematics teaching and learning brought about by the changes in the South African educational system as determined by the Reconstruction and Development Program. The MICSEC2000 program was an innovative off-campus strategy that crystallised during this restructuring period of the Outreach project. As this history unfolds it becomes evident that the various programs of the Project have undergone numerous subtle nuances in their *intention* and *implementation*. The following tabulated summaries of the programs of the Outreach Project over the past two decades in terms of the categories of the conceptual framework manifest these differences.

A TABULATED SUMMARY OF THE PROGRAMS OF THE OUTREACH PROJECT DURING THE PERIOD 1982-1993

PROGRAM	INTENDED	IMPLEMENTED	PERCEIVED	ACHIEVED
Trial-run **Outreach Program** RC Jones : Aug-Oct 1982	To pilot Plato Matric Math/Science Software	Part time use of 20-53 terminals of UWC mainframe by 250 disadvantaged matric pupils	4 coloured & 4 black schools	Pass rate of the 4 Black schools increased by 32%
Original **Outreach program** RC Jones: 1983-1984	Assisting 600 disadvantaged learners in Physical Science and mathematics	Learners were bussed to the GFRC to work on Plato mathematics & physical science software	A detailed questionnaire determined the opinions & perceptions of pupils of Plato	70% pass rate increase for schools who attended 50% of the sessions
Genesis Program 1984- RC Jones & M Mehl	Preparation of matric pupils for tertiary studies in Maths/Science	An intensive CBI course for 60 selected pupils for each June/Sept vacation	A more positive, confident attitude to Maths/Science	Better prepared students for tertiary studies
The Mobile Computer Unit (MCU) program 1986- RC Jones & L Benting	For pupils from outlying areas to work through Plato Maths/Science software	An off-campus mobile version of CBI was made accessible in Mitchells Plain and rural areas		CAL became immediately available in school hours to pupils.
Mathematics Courseware Development Program RH Francis 1988-1993	Diagnostic software and booklets to supplement Plato based CBI	Used in conjunction with Plato software Outreach activities	Evaluation forms in Study guides used to obtain feedback from Outreach participants	Partially implemented because objectives to be completed by Sept 1993
Science Courseware Development Program D Finnemore 1993	Development of matric Physics/Chem software in 40 topics to replace Plato	Used by Outreach pupils and HDE students of Education Faculty	Courseware Corrections & improvements as evaluated by Outreach pupils	60 tests and 2 tutorials were being used by Outreach participants

A TABULATED SUMMARY OF THE PROGRAMS OF THE OUTREACH PROJECT DURING THE PERIOD 1998-2004

PROGRAMME	INTENDED	IMPLEMENTED	PERCEIVED	ACHIEVED
Mathematics Educator Empowerment: **MEE Program** B Isaacs 1999	To assist educators in difficult topics in the grade 11-12 syllabus	30 educators were assisted to understand and present these topics	Educators found topics less intimidating	Educators taught these topics with confidence
CAL for first year Maths students: **CAFMA Program** B Isaacs 1999	To assist a group of Math114/124 students in tutorial classes	5 students were assisted with the aid of a Calculus computer software package	Skills to solve differentiation & integration improved	Concepts grasped more readily and 21 passed both courses
ACE Program High school Mathematics B Isaacs & C Julie 2000	To empower educators with Math knowledge & skills	Partial bursaries were obtained for 20 of MEE educators to register at UWC	Participants became adept in handling all aspects in grade 12	At the end of 2002, fifteen educators the ACE diploma
Matric Program B Isaacs & M Peters 1999, 2000 & 2001	Using CAL to assist indigent learners to obtain good symbols in matric math & science	A year long on & off campus program for 500 learners from the townships and rural areas	At the end of each school term learners were required to complete evaluation forms	Each year the pass rate was 100% and many obtained exemptions
Matric Maths Class: **M²C Program** B Isaacs & R Jacobs 2002, 2003	Using CAL to assist indigent matriculants to obtain good symbols in math SG/HG	A year long on & off campus program averaging 500 learners from the townships and rural areas	Reports from the schools these learners attended indicated a progressive improvement	the pass rate was almost 100% and many have registered at tertiary institutions
MICSEC2000 Programme B Isaacs & A Snell 1998-2004	To create the capacity for 2000 indigent matric pupils to immediately access math & science CAL daily	Construction of 10 strategically placed MICSECs (1998-2001) Training educators and learners to use the facilities MICSECs to become ICT nodes	2001 Study by MS Hartley established that learners at 2 MICSECs perceived CAL positively	Matric Physical Science at both centres increased by 10%, Maths results increased by 5%

3.4 A SURVEY OF OTHER INTERVENTION STRATEGIES IN THE WESTERN CAPE WHICH ADDRESSES THE SAME PROBLEM AS THE OUTREACH PROJECT OF UWC

Numerous intervention strategies have been implemented in the Western Cape by NGO's, the WCED, and local tertiary institutions to assist learners to cope with particularly grade 10-12 mathematics. Because no quantitative research literature which evaluates the impact, effectiveness or success of these programmes is a vailable, not much can be mentioned about their *perceived* and *achieved* programs.

An analysis of the information brochures and some annual reports of the following organisations reveal that they use the same modes operandi (*intended* and *implemented* programs) and in varying degrees have similar, if not the same, objectives and outcomes as the Outreach Project i.e. they essentially assist grade 12 learners to do well in mathematics. *The intended and implemented programs of these organisations are briefly summarised because a group of the educators of these organisations were used as a control group of the educators used to appraised the implemented, perceived and achieved MICSEC2000 program*

3.4.1 The Scientific and Industrial Leadership Initiative (SAILI)

SAILI was started in 1996 with the purpose "to promote improvement in mathematics and science education for learners and educators in schools serving disadvantaged communities in the Western Cape to enable learners to gain access to post secondary programs requiring mathematics and science" (*Intended Programme*). Education and vocational planning are viewed as a continuous process with SAILI facilitators providing sustained assistance in mathematics and science at selected schools from grades 1to grades 12. Selected post school participants are assisted with bursary applications and provided with coping mechanisms to survive in either the HE environment or the workplace *(Implemented Programme)*.

3.4.2 The Equitable Access Project of the University of the Western Cape

A South African-Norway Tertiary Education Development (SANTED) Programme, the *Equitable Access through Enrolment Management*, was started at UWC in 2001. It is a component of the UWC "Enrolment Management and Student Development Plan" which is a primary component of the university's strategic 2001-2005 plan. Its objectives are aligned to most of the outcomes of the NPHE. Its primary strategy is to "Increase access to higher education by providing advice and subject-specific support to Grade 10-12 learners and school teachers" *(Intended Programme)*. This objective is realised through weekly tutorials, laboratory visits, a winter school and a spring school for grade 12 learners, as well as ICT teacher training *(Implemented Programme)*

3.4.3 The Khanya Project

The goal of this project according to its business plan (2002: 3) is: "To promote learning and maximise educator capacity by integrating the use of appropriate, available and affordable technology into the curriculum delivery process".

This goal is expanded into nine primary and four secondary objectives. The seventh and eighth aims at increasing the number of learners doing higher grade mathematics (and science) and the number entering the HE system. *(Intended Programme)*.

The first aspect of the theory of this project i.e. the theoretical model of how this project is supposed to work is contained in the first fifteen pages of their business plan. In it the principles, scope and strategic framework of the Khanya Project are outlined. The Khanya Project aims by 2012 to empower all educators at all schools in the Western Cape with the "appropriate and available technology to deliver curriculum to each and every learner" (7). By the end of March 2003 this project serviced 175 out of its targeted 1474 schools. Thirty-nine (including Merit Award Schools) of these are **Mathematics HG Sub-Project 1 and 2** schools, which have been supplied with the necessary technological infrastructure to start curriculum delivery in mathematics higher grade *(Implemented Programme)*.

3.4.4 The Centre of Science and Technology (COSAT)

COSAT, a Western Cape Education Department (WCED) initiative was founded in 1999. It is a small Mathematics and Science school for Grade 10-12 learners with academic potential which are recruited from local high schools in Khayelitsha. It has well equipped Science and Computer laboratories and learners are instructed in mathematics, science and biology on the higher grade to prepare them for HE mathematics and science courses.

The intended and implemented programs of the intervention strategies of these organisations can be tabulated as follows:

INTERVENTION	INTENDED PROGRAM	IMPLEMENTED PROGRAM
SAILI	Maths and Science classes to schools in disadvantaged areas to assist learners to access to HE maths and science courses	SAILI facilitators provide sustained assistance in mathematics and science at selected schools from grades 1 to grades 12.
EQUITABLE ACCESS	Access to HE by providing advice and subject-specific support to Grade 10-12 learners and their educators.	Weekly tutorials, laboratory visits, a winter & spring schools for grade 12 learners of selected schools. ICT teacher training
KHANYA	Maximising educator capacity by technology.	Computer Labs established to assist in maths teaching at many Khanya high schools
COSAT	To prepare grade 10-12 learners in small groups for HE by CAL in mathematics	A small school in Khayelitsha for offering CAL in Grade 10-12 mathematics HG

3.5 HOW THE INTENDED, IMPLEMENTED, PERCEIVED & ACHIEVED PROGRAMS OF THE MICSEC2000 PROGRAM WILL BE APPRAISED

3.5.1 A critical resume of Hartley's evaluation of the effectiveness of MICSEC2000

Hartley essentially designed his investigation to evaluate the effectiveness of a CAL program in both grade12 mathematics and physical science at two selected MICSECs of the Outreach Project. His conclusions of the *intended program* were obtained from interviews with only two (one past and one present) 'managers' and the analyses of five Outreach Project documents. His impression of the *implemented program* was obtained by observing only three mathematics CAL sessions conducted by educators in these MICSECs over a period of four months. Two instruments - the actual and preferred versions of the *Computer-Assisted Learning Environment Questionnaire* and individual and group *interviews* of learners formed the bases of his information of the *perceived programme*. The *achieved programme* was gauged generally from the performance of learners of the participating schools in the matriculation examinations in mathematics and physical science.

3.5.2 How the MICSEC2000 program will be appraised in this study

In chapter 5 of this study all 10 MICSECs will be appraised in terms of their implementation, perception and achievement of the MICSEC2000 program. This evaluation will be initially introduced in chapter 5 by a *thick narrative* of the development of this off-campus intervention strategy of the Outreach Project. The program was initiated in 1998 and designed to make CAL immediately accessible *to grade 12 learners attending schools in the indigent township and rural areas of the Western Cape so that their performance in grade12 mathematics could improve*.

The *intended* program will be outlined in terms of its present goals. CAL, in the *implemented*, *perceived* and *achieved* MICSEC2000 program, will be appraised as it was encountered and experienced by all the participating educators. This is in contrast to Hartley's investigation of the *implemented*, *perceived* and *achieved* program of only two MICSECs and whose conclusions are based almost entirely on the perceptions of the participating learners.

The ***intended*** MISEC2000 program is both short and long termed. The immediate goal is to make CAL in the MICSECs immediately accessible to a specifically targeted group of learners and their educators. The long term goal is to facilitate the RDP endeavours, though limited, of social upliftment of the target group. The program thus creates the opportunity for indigent learners with potential to do mathematics to attain the necessary proficiency in matric mathematics to gain access to mathematics oriented courses offered by the Higher Education system.

The immediate goal gravitates around educator and learner support with the objective of enhancing achievement in matric mathematics. The capacity to develop scarce skills and the extent to which the MICSECs are utilised by the community are the concerns of the objectives of the long term goal. The long term goal and its associated objectives will <u>not</u> be appraised in this study.

3.5.3 How educators will be expected to appraise the MICSEC2000 program

The *intended* MICSEC2000 program will not be appraised by the participating educators. How mathematics educators perceived the *implemented, perceived and achieved* MICSEC2000 programme will be determined by the following research questions formulated to address these perceptions:

1. What is impact of using CAL in the MICSEC on the *role of the educator* as perceived by mathematics educators?

2. What is impact of using CAL in the MICSEC on *student motivation* as perceived by the mathematics educators?

3. What is the impact of using CAL in the MICSEC on *student learning* as perceived by the mathematics educators?

Participating educators will appraise these research questions by an instrument called the *Computer-Assisted Learning Educator Perception Questionnaire-Mathematics* (Appendix F: CALEPQ-M). All grade12 mathematics educators who participated in the MICSEC2000 program will be invited to complete the questionnaire. A control group of more or less the same number of other educators teaching grade 12 mathematics at 10 high schools in similar socio-economic as the MICSEC schools and using CAL will also be requested to complete the instrument. The control group will be comprised of educators from schools assisted by the SAILI, SANTED, KHANYA and COSAT intervention programs

3.5.4 The Computer-Assisted Learning Educator Perception Questionnaire - Mathematics (CALEPQ-M)

The CALEPQ-M instrument was chosen because it conformed to the unique circumstances of the mathematics educators participating in the MICSEC2000 program. The instrument is designed in such a way that it affords these educators the opportunity to express their perceptions of the impact of the *implementation*, *perception* and *achievement* of the MICSEC2000 program at their schools.

The instrument has 3 scales, each consisting of about 10 Likert type items. These scales are the last three of four scales of the Computing Technology Utilisation/Impact Questionnaire used by Rochowicz to determine "The impact of using Computers and Calculators on Calculus Instruction: Various Perceptions" of a selected group of participants of the National Colloquium, *Calculus for a New Century: A pump, not a Filter* (JCMST 15(4), 1996: 423-435).

According to Rochowicz the reliability of the questionnaire was determined by the Cronbach's alpha test with values of 0.92; 0.90 and 0.81 being computed for student motivation, student learning and the role of the teacher respectively.

In this study items of each scale follow the same numerical order used by Rochowicz. Minor grammatical changes were made to some items and where the word 'calculus' occurred in an item, it was replaced by the word 'mathematics'.

Similar to the composite Computer-Assisted Learning Environment Questionnaire (CALEQ) developed by Hartley (2002:58) to assess 'learner perceptions' of two MICSECs of the Outreach Programme, CALEPQ-M is relatively concise, can be completed quickly and can be hand scored. The format of the three scales of the CALEQ-M instrument is included as appendix F

3.5.5 The perceptions of learners of the MICSEC2000 program

Hartley's investigation into the effectiveness of the MICSEC2000 program in 2001 is learner-centred. He used the CALEQ instrument and student interviews to evaluate and report upon how 89 learners at two MICSECs responded to an actual and then a preferred format of the CALEQ (2001: 87-114). More comprehensive results could have been obtained if the learners of *all* the MICSECs were included. The actual format of CALEQ should have been administered at the end of the first term and the preferred format towards the end of the year. In this study learner perception as determined by the CALEQ instrument will not be measured. Learner performance as determined by their achievement in the final matric examination over a three year period and over a four year period will be thoroughly evaluated.

CHAPTER4

THE DEVELOPMENT OF THE MICSEC2000 PROGRAM

4.1 THE EXPERIMENTAL STAGE IN THE DEVELOPMENT OF THE OFF CAMPUS MINI COMPUTER LABORATORIES

From chapter 2 it is apparent that the distinguishing feature of the 20 year legacy of the Outreach Project had been its provision of supportive educational services in the form of 'computer assisting environments' to grade 12 mathematics and physical science learners and their educators. Over the years these services did not stagnate but were modified continually to conform effectively to the prevailing mix of constantly changing global, political- social-economic and technical promptings. Consequently a unique reservoir of expertise and experience presently characterise the ICT content of each service.

To function optimally in the present South African democratic educational dispensation all Outreach services were customised in such a manner that they became immediately accessible to the secondary school community (particularly those that UWC serves). From these schools the services could then be 'freely' dispensed to the broader community, mainly to those sectors at the lower echelons of the socio-economic scale.

During its first two year cycle (1999-2000) all the restructured activities of the Project took the form (in their physical implementation) of *on* and *off campus services*.

Because of the Project's lengthy association with high schools in 'township' and 'rural' areas, these schools automatically became the 'platforms' from which all restructured or innovative off-campus initiatives were launched. *The focus group of all new off-campus endeavours thus* *remained matric mathematics (and physical science) educators and learners at High schools in the marginalised township and rural areas.*

It goes without saying that the mandate required of the Statement of the Problem delineated in Chapter 1 i.e. "**How can indigent learners/schools particularly in township and rural Western Cape areas be assisted or supported to improve their performance in grade 12 mathematics particularly higher grade mathematics ?"** had already been addressed by the Project for more than two decades. Consequently ,the provision of 'immediate computer assisting environments', which could be utilised parallel to or could be integrated into the normal everyday teaching and learning mathematics and science activities – the precursor of the MICSEC2000 program - became a top priority in the planning of all future off campus Outreach services.

Assisting and supporting mathematics and physical science educators in their ordinary teaching endeavours developed into the focal point of all off campus service planning.

It was envisaged that a secondary aspect of the planning of this endeavour was that as more funds became available and community involvement and interest increased, the 'rudimentary support technological systems' established at selected high schools in indigent areas would be upgraded into practical ICT hubs from which a wide range of community ICT activities could be initiated and conducted. These ICT centres could then be developed into potential technological community upliftment nodes.

The following outlines the establishment of the first three off campus Outreach Mini-computer laboratories and details the experienced gained and the lessons learnt in this endeavour.

4.1.1 The first off-campus Outreach Mini Computer Lab

In collaboration with the UWC Community Health Project a 'Mini Computer Laboratory' consisting of 9 'resurrected' netstations, a 12 point hub and 'low memory' dedicated server (denoted by the Community Health Project) was set up at a high school in the Mfuleni Township in Kuilsriver. This network was a rudimentary star topology with 9 nodes connected through a 12 port hub to the server operating on MS-DOS and loaded with a limited amount of Quest based mathematics exercises and physical science software. This software had been originally developed by the Courseware Development Project of the GFRC. The entire network was supported on 6 normal school tables, stacked together, in such a way that the learners, when seated faced the monitors and were able to access and use the software through prompts via keyboards and mouses. The 'Mini Computer lab' was visited twice a week by the Project administration clerk who also served as the Project's computer technician. He generally serviced the network, which was prone to continual breakdowns due mainly to 'heavy handling' by learners. During the first few weeks he attempted to show both the educators and learners how to operate the netstations and in order to access and use the software. Many attempts were made to get the school leadership to take ownership of the Mini Computer Lab but all efforts proved fruitless. It was later realised that on occasions when Outreach staff manned the lab, they were regarded and exploited as extra staff members. Visitations to the school by the Outreach staff deteriorated into 'glorified baby sitting sessions' of large groups of learners for which no supervising teachers were available and were to be entertained by the computers.

4.1.2 The second off-campus Outreach Mini Computer Lab

A Second Mini Computer Centre was established at a high school in Mitchell's Plain while educator and learner programs were finalised at Mfuleni. The computer centre at UWC donated 9 used 486 computers (i.e. processors, keyboards and mousses), cat5 cables and a used hub. This second Mini Computer lab was constructed by the administration clerk/ computer technician assisted by a third year Computer Science student assistant. The 9 node network was mounted on a 3metre table/desk with cupboards along each side. Four computers (each consisting of a processor, a monitor, a keyboard and mouse) units were placed on each side of the table. Eight stations were available for use by the learners. The 'server' was installed at the one end of the table in such a way that it could be accessed only by the educator. The hub was placed inside one of the end cupboard and all cables from the 'server' and the other 8 nodes ran from the cupboards through holes drilled in the desk top.

The operating software on the 9 computers was MS-DOS and the 'server' contained similar mathematics and physical science software as the first Computer lab. This software would be accessed at the other nodes when and as required. The 9 nodes of this Mini Computer lab operated as a network and each node could function simultaneously as a 'stand alone station' at which other tasks such as 'word processing' etc could be done. The second Mini Computer lab was designed to be multi functional. Three different groups of clients involved in entirely different tasks could be simultaneously accommodated in the lab. Training of educators and learners in the necessary computer skills and the integration of the mathematics and science software into the school curriculum occurred over a month and the school took ownership of the lab 2 months after its establishment.

4.1.3 The third off campus Outreach Mini Computer Lab

The establishment of this lab was a 50-50% collaboration between the management of a high school in the Bishop Lavis Township and Outreach Project. In many respects the physical structure of the network developed at this school reflected the high degree of sophistication and professionalism the Outreach Staff had accrued in the area of the physical construction of rudimentary computer infrastructures for classroom use.

This lab was planned to house 25 computer stations (developed along the inner perimeter of the room), fully networked in a star topology with all the nodes (computers) connected individually through a hub to a dedicated (low processor) server. Power points were fitted by a qualified electrician. The Outreach staff fitted the hub, measured and laid the cat5 cables (about 70 metres of cabling neatly enclosed in about 20 metres of PVC trunking) that connected the hub ports (from the server) to the stations. Patch panels were superimposed on the section of trunking passing each station and connected to the cable joined to the hub for that particular station.

Each individual computer set up at a station was connected to the system through a fly lead. The computers (processor, monitor, keyboard and mouse) were mounted on typing tables placed along the walls of the room. This arrangement of the computer infrastructure along the sides of this room made a large space available in the middle and front section of the room which would be used for normal teaching purposes. This innovative development gave the room multi function flexibility and the capacity to be developed into a multi media centre. When required it could be used as a normal classroom in which formal lessons could be conducted, a computer lab for a particular clientele and in special instances as the combination of both. In the case of the latter a teacher could start his session with a formal lesson, which could be rounded off with applications on the computer. Another lesson could be pitched to accommodate the average learner while learners who had mastered the work could be allowed to do advanced work on the computers on the same subject matter.

The training of staff and learners proved easier than what occurred at the previous two labs. The student assistant who had been involved in the establishment of this centre (and the previous two) graduated at the end of 1998 and was appointed by the school as a computer educator. Part of his job description was maintenance of the lab and the training of the members of staff and the learners who used the lab. This he did in conjunction with the staff of the Outreach Project.

4.2 PREPARATORY EXPERIENCE AND EXPERTISE ACQUIRED BY THE OUTREACH STAFF DURING THE EXPERIMENTAL STAGE IN THE ESTABLISHMENT OF OFF CAMPUS MINI COMPUTER CENTRES

4.2.1 Knowledge and Experience in Practical and Theoretical Computer Technology

In the construction of the three computer labs the Outreach staff members working 'on site' gained invaluable first hand practical knowledge and experience in activities that were previously normally outsourced by the previous Goldfields organisation to well established and reputable ICT companies. Fortunately many of the students assisting in the 'on site' operations possessed previous theoretical knowledge (Computer Science 1 &2), which they could by trial and error, now apply practically. Unfortunately, not many students were employed by the Project for more than 6 month. Consequently this source of manpower needed to be replenished and student assistants needed to be retrained continually.

The Project administration officer became the computer technician and officially managed all the off campus technical operations and activities. He was encouraged to obtain a better theoretical and practical understanding of practical ICT particularly networking considerations and successfully completed the 'MCSE' (Microsoft Certified Systems Engineer) in 1999.

4.2.2 Knowledge and Experience in the transference of Computer and other skills to Educators and Learners

On completion of a computer lab, educators and learners were trained in how to maintain and effectively use 'their' computer system, and how to effectively integrate the 'computer support environment' it generated into their normal everyday teaching and learning activities. For the Project staff, both these activities were unique experiences because they occurred in the room (on site) where the technology was installed and immediately accessible**.**

A notable achievement of the entire exercise was that the 'computer assisting environment' no longer featured as a sporadic artificial intrusion in the learner's life but it now became an 'immediate' integral component of his/her everyday learning environment.

The computer technician facilitated the transference of the technical skills and the coordinator demonstrated how the mathematics and physical science software would be incorporated into normal classroom activities. In the later phase of this 'on site theoretical knowledge and practical skills transference endeavour', the coordinator gained invaluable insight into the deficiencies (i.e. qualifications and experience) of educators teaching grade 10-12 mathematics (and physical science) and the necessity of 'upgrading the qualifications' and the strengthening of the confidence of these educators.

4. 2.3 First hand Knowledge and Experience of the Needs and Deficiencies of schools in poor township and rural setting

Prior to the extrapolation of the Outreach Project activities into the community, the services of the Project had been conducted in the relatively 'stable' academic surroundings and atmosphere of the university. There was no actual 'on the ground' interaction with educators and learners in the 'physical, everyday environment' in which teaching and learning occurred for them. The average time spent at each school to complete the series of tasks associated with the construction of each Mini Computer Centre was about 2-3 months. This gave the coordinator of the Outreach Project, who had been principal of high schools in similar socio-economic circumstances for almost 15 years, enough time to assess and rate the schools.

Two of the schools could be classified as malfunctional, characterised by lack of consistent constructive management, high educator absenteeism rate, low external examination pass rates etc. Lack of basic equipment and inexperienced and low qualified educators compounded the problem.

4.2.4 Knowledge and Experience of how the Implementation of an Intervention Programme could lift the teaching and learning morale at a school

The planning, organising, establishing and final utilisation of the computer labs at each school initially generated a lot of excitement, enthusiasm and various pseudo expectations amongst the educators and learners at each school. The introduction of hi-tech equipment like computers in social situations usually characterised by high degrees of poverty and consequent deprivation usually awakens false feelings that the mere presence of such technology would solve all problems. It was, however, made clear to educators that the technology that they now possessed were machines, incapable of individual thinking and making independent decisions. These machines were not 'teacher replacements'. They were to be perceived and used primarily as sophisticated 'teaching aides', which could be effectively employed in conjunction with other teaching aides to attain particular short term and long term teaching and learning outcomes.

A minimum requirement by the Outreach staff was that the resident 'computer assisting environment' developed by them should be made available (under adult supervision) to 100 grade 10-12 mathematics/physical science learners for half their weekly instructional time. The Computer lab should also be available to the same learners (or shared with learners from 4 surrounding schools for the same subjects) for 2 hours during week days after school hours.

Equipped with this wealth of knowledge, experience and insight gleaned in the process of establishing the three off campus computer labs, the Project moved to the next stage of making 'computer assisting environments' available to schools to which such a degree of technological sophistication was beyond their financial reach.

It should furthermore be apparent that the Outreach Project (in its reconstructed form) had since 1998 been addressing the problem (Chapter 1, 16) inferred by the NPHE for poorly performing township and rural WCED schools in grade 12 mathematics.

4.3 THE DESIGN AND IMPLEMENTATION OF A LARGE SCALE TECHNOLOGICAL INTERVENTION STRATEGY TO IMPROVE THE GRADE 12 MATHEMATICS RESULTS OF 10 POORLY PERFORMING TOWNSHIP AND RURAL HIGH SCHOOLS IN THE WESTERN CAPE

It was emphasised in Chapter 1 that learning mathematics is for the vast majority of learners both locally and globally, inherently a problematic and difficult experience.
At the Conference on Public Understanding of Science and Technology (4-7 Dec. 1996) of the School of Science and Mathematics Education, UWC, Prof JD Volmink referred to the TIMSS (94/95) report (which places South Africa last in all categories of mathematics and science tests) and the World Competitive Report (which ranked SA last out of 42 countries) to substantiate his assertion that South Africans are generally ill - prepared to effectively participate in the activities of the 'global village'.

The 1998 TIMSSR report, which emphasises that weak and unacceptable test results in mathematics by South African grade 8 learners can be traced inter alia to defective school and malfunctioning home infrastructures, strengthens the veracity of Volmink's argument.
During the initial reconstruction phase of the Outreach Project some of the many relevant questions that inter alia needed to be pondered at that juncture were:

- For how long should it be expected, by the national educational planners in the new democratic dispensation, of tertiary institutions to be engaged in 'rectifying/mop up' operations such as intervention strategies?
- For how long should the valuable time and resources of tertiary institutions and academics be spent on 'correcting' problems that obviously had its roots in a malfunctioning secondary school system?

Until these questions can be answered in the affirmative, the services of the restructured Outreach Project of the SSME of UWC will still remain a relevant initiative that will lend 'supportive assistance' to high schools in the difficult areas of mathematics and physical science learning and teaching. In the past most of this 'supportive assistance' was executed on campus of the University of the Western Cape.

The construction of three functional Mini Computer Labs created the capacity for about 10 educators and 600 grade 10-12 learners (functioning in very adverse socio-economic environments) to daily assist themselves in teaching and learning mathematics and physical science in their own 'resident' computer assisting environment.

It was these deliberations and accomplishments - on the one hand emancipating academics from time consuming correcting educational activities on 'defective products' of a malfunctioning school system and on the other hand empowering mathematics/science educators to deal with these problem themselves - which was one of the primary motivations of the idea to design and implement a large scale technological intervention strategy to improve the grade 12 mathematics results of 10 poorly performing township and/or rural high schools in the Western Cape.

A further consideration that accelerated and considerably increased the rate of precipitation of this comparatively large scale intervention strategy was the FRD 1996 Science and Technology Indicators. It stated that in 1992 the science and engineering workforce consisted of 208 978 persons (out of 12 million economically active South Africans) of which 2720 (i.e.5 in every 100) were African. During the same year only 30% (14020) of all (45971) Science and Engineering students at SA tertiary institutions were African. This was an indication that the South African Educational system (in its then state) was not producing many 'non white' persons capable and able to successfully compete on the national level, let alone on the global level.

4.4 THE DESIGN OF THE MICSEC2000 PROGRAM

The three laboratories were referred to as Mini Computer Supported Educational Centres resulting in the acronym MICSEC. The envisaged off campus MICSEC programme was intended to create immediate resident or 'on site' computer access and usage for 2000 grade 10-12 mathematics and physical science learners and their educators by the end of the year 2000. Thus the program was baptised the MICSEC2000 Program.

4.4.1 The Design of the physical basis of each Mini Computer Supported Educational Centre (MICSEC*)*

The historical development of mathematics was probably accompanied by a parallel development of a unique system of mathematical technology. Ifrah (1987:115) asserts that the plethora of technological (mechanical) devices invented by mathematicians to facilitate mundane and cumbersome mathematical procedures and calculations over the centuries culminated in the invention of the electronic computer.

If Ifrah's assertion is correct then present day computers should be the ideal technological aid to assist educators and learners in the teaching and learning of mathematics. Such an assumption gives some degree of historical justification to the initiation, continued existence and present perpetuation of the Outreach Project particularly in one of its present manifestations i.e. the MICSEC2000 programme.

The MICSEC2000 programme was essentially conceived as an intensive off campus computer assisting educational service which would be immediately available and accessible to both teachers and learners of grade 10-12 mathematics and physical science.

The physical design of this relatively extensive technological intervention strategy was developed on the past accrued experience and expertise in the use of computers to assist mathematics and science education and the present *first hand* present knowledge and insights acquired by the Outreach staff during the precursory exercise of establishing 3 off campus mini computer laboratories. The objective of the program was to, before the end of the year 2000, establish 7 extra similar off campus computer networks at high schools serving indigent communities. In this way an immediate, extensive 'off campus computer assisting environment ' would be generated at 10 township/rural high schools creating the capacity for instant access for 2000 grade 10-12 mathematics and physical science learners and their educators.

4.4.2 The Physical Design of each MICSEC

The blueprint for the physical design of each of the 7 extra envisaged off campus computer centres was gleaned from the modus operandi employed to construct the 3 mini computer labs. The insights gained and the knowledge acquired during and after the establishment of each computer lab was collectively scutinised and developed to form the basis of this blueprint.

In the planning of each laboratory expenses were kept to a minimum. Each laboratorywas designed to be user friendly to both teachers and pupils as possible. To keep costs to a minimum all tasks in the planning and physical construction(cabling, fitting of table tops, repairs to and the installation of computers, software loading, initial running of programs etc.) of the envisaged laboratories were executed by the staff of the Outreach Project. This became guiding considerations in the construction of each new MICSEC.

Each centre was planned furthermore to function ultimately as a multi- functional- media space i.e. when necessary it could be utilised as a formal classroom, a computer room or the combination of both. Each specific room was to be fitted with a minimum of 20 nodes (computer stations) along its inner perimeter. It was to be fully networked in a star topology with all the nodes connected individually through a hub to a dedicated (low processor, non expensive) server. The connecting cables (cat5) were to run through PVC trunking. Patch panels superimposed on trunking would connect each node through a fly lead to the cable joined to the hub. The computers (processor, monitor, keyboard and mouse) were to be mounted on specially fitted table tops attached to the walls of the room. The star topology of the cabling of the network ensured that with minor modifications, one or more computers (or if necessary the entire network through the server) could be removed or connected to the network. The design of the network of each centre in this manner gave them the capacity to be, with minor adjustments, immediately connected to the largest Wide Area (inter)Network (WAN), the internet. Furthermore each MICSEC was designed to function as an e-learning centre.

4.4.3 The Operating Software of the Network of each MICSEC

The Open System Interconnection (OSI), for network communication developed by the International Standards Organisation (ISO), is presently the prescribed standardised model utilised in network communication. The model describes network communications as a 'from the bottom upward' interaction through seven layers that work together to provide network services. The last three layers (physical, data link, and network) of this cylindrical, pyramid hierarchy are grouped together because of their technological dependence (Taylor P.J. et al, 2001:357-366).

The least expensive *Network Operating System* (NOS), which was then available to be used to manage all the resources that the designed MICSEC network embraced, was the Novell Netware. This is fortunately the NOS of the UWC WAN. Unfortunately Novell Network is not a desktop operating system. An additional Operating System (OS) thus was required to run applications, control peripherals, and communications between nodes (computers or dumb terminals). The most inexpensive available software was the user friendly Microsoft Disc Operating System (MS-DOS), which manipulates software on the machines by simple keyboard and mouse clicks rather than intricate text instruction.

4.4.4 The Time Frame for the establishment of the 7 MICSECS

During the experimental stage of this program, it was determined that the minimum period required to develop a MICSEC i.e. the construction of the computer centre, training of learners/educators was about 3 months. On this basis it was planned to establish 3 MICSECS in 1999 (stage 2) and 4 in 2000 (stage 3) according to the following scheme of implementation.

THE OUTLINE OF THE IMPLEMENTATION PLAN OF THE MICSEC2000 PROGRAM

OUTCOMES	DEADLINE
Stage 1 MICSEC 1 in **Mfuleni** Fully operational serving 200 resident learners and/or learners from 4 local highs in the area have access to the facility. Manned by 5 resident educators, trained on site.	completed
Stage 1 MICSEC 2 in **Mitchell's Plain** Fully operational serving 200 resident learners and/or learners from 4 local highs in the area have access to the facility. Manned by 5 resident educators, trained on site.	completed
Stage 1 MICSEC 3 in **Bishops Lavis**	completed

It is fully operational serving 200 resident

learners and learners from 4 local highs in the area have

access to the facility.

Manned by 5 resident educators, trained on site.

Stage 2 MICSEC 4 to be established in **Langa** 30 – 06 - 99

It will serve 200 local learners and/or 4 other schools

This facility will be manned by 5 trained teachers

Stage 2 Establishment of MICSEC 5 in **Eerste Rivier** 30 - 09 – 99

It will serve 200 local learners and/or 4 other schools

This facility will be manned by 5 trained teachers

Stage 2 Establishment of MICSEC 6 in **Lentegeur** 31 - 12 - 99

It will serve 200 local learners and/or 4 other schools

This facility will be manned by 5 trained teachers

Stage 3 Establishment of MICSEC 7 in **Worcester** 31 – 03 – 00

It will serve 200 local learners and/or 4schools

This facility will be manned by 5 trained teachers

Stage 3 Establishment of MICSEC 8 in **Phillipi North** 30 – 06- 00

It will serve 200 local learners and/or 4 other schools

This facility will be manned by 5 trained teachers

Stage 3 Establishment of MICSEC 9 in **Khaye lisha** 30 - 09 - 00

It will serve 200 local learners and/or 4 other schools

This facility will be manned by 20 trained teacher

Stage 4 Establishment of MICSEC 10 in **Saldahna Bay** 31 - 12 - 00

It will serve 200 local learners and/or 4 other schools

This facility will be manned by 10 trained teachers.

4.5 THE CRITERIA EMPLOYED TO CONSTRUCT A MIC SEC AT A PARTICULAR SCHOOL

The ideal criteria to determine whether a school qualified for the establishment of a MICSEC was to have assessed the poverty and vulnerability of the community the school served. In chapter 1 the focus group of this study as detailed in "An analysis of poverty in the Western Cape as enumerated in the 1996 Census" issued by the Sub-Directorate: Social Research and Western Cape Population Unit, November 1999, is briefly described. Germane to this study is table 14 (pages 37-50), which ranks 647 Western Cape communities according to their PHDI (Provincial Human Development Index). PHDI is the yardstick devised by the Sub-directorate: Social Research and population Development to rank order and prioritise poverty and vulnerability of Western Cape communities.

The following information, obtained from table 14, locates the place name, district, population size and PHDI of the high schools where the MICSECS had already been, or were planned to be established.

Place Name	**Magisterial District**	**Population Size 1996**	**Provincial HDI *(Rank Order)***
MFULENI	Kuilsriver	10036	O,449 (*55*)

ROCKLANDS	Mitchell's Plain	24177	0,144	(*391*)
BISHOP LAVIS	Goodwood	25962	0,216	*(264)*
LANGA	Goodwood	46505	0,299	(165)
EERSTE RIVIER	Kuilsriver	16375	0,132	(*414*)
LENTEGEUR	Mitchell's Plain	34618	0,178	(*335*)
ZWELETEMBA	Worcester	12025	0,421	*(69)*
PHILLIPI NORTH	Mitchell's Plain	No data Available	No data Available	
KHAYELITSHA	Mitchell's Plain	2288	0,563	(*22*)
DIAZVILLE	Vredenburg	9197	0,212	(*270)*

From the table it is obvious (for various reasons) that the proposed or completed MICSECS were not strictly chosen in conformity with the rank order of the most poor and vulnerable of Western Cape communities as suggested by table 14.

This was partly due to the fact that prior to and during the erection of the first four MICSECS, the contents of the Report of the Social Research and Western Cape Population Unit was not available. The decision to earmark specific schools in Rocklands, Bishop Lavis and Langa was based purely on the longstanding relationship these schools had fostered with the Outreach Project and hence the prior knowledge of the living conditions the Project staff possessed of these areas. On close investigation, the relatively high PHDI of Rocklands, Bishop Lavis and Langa, compared to Mfuleni, could be attributed to the high population sizes of the former three. For example the population size of Rocklands, Bishop Lavis and Langa were then 2,4; 2,6 and 4,6 of that of Mfuleni respectively. It could be safe to assume that these high populations probably negatively skewed each of their PHDI.

Of the proposed (or already established) MICSECS four were planned to be located at high schools in the magisterial districts of Mitchell's Plain, two in Goodwood, two in Kuilsriver, one in Worcester and one in Vredenburg – the areas in the Western Cape, which in head-counts (according to the 1996 census report) had the highest incidence of poor households.

4.6 THE IMPLEMENTATION OF THE SECOND STAGE OF THE MICSEC2000 PROGRAM

The second stage was implemented by the coordinator and staff of the OUTREACH PROJECT in phases as follows:

4.6.1 The Introduction Phase

This phase was planned to cover a period of 4 weeks (10 hours) and was conducted in the On Campus Computer Supported Educational Centre (OCCSEC). Educators and learners from 5 cluster schools were invited to attend a prescribed cycle of lectures and workshops. All practical work was done on the computer stations in the OCCSEC facility.

4.6.2 The Apprenticeship (self-help) Phase

It was surmised that after 10 hours of supervised and structured guidance in the use of the computers (and more important the mathematics and science software the computers carried) on the OCCSEC network, both participating educators and learners would have gained sufficient experience and motivation to work on their own on the network in the mobile computer unit (the Mobile Computer Supported Educational Centre, MOCSEC).

MOCSEC was then stationed at one of the five cluster schools. Learners and teachers of the five schools were afforded the opportunity (5 weeks i.e. 1school day week per school) of using the computers of the MOCSEC network on a weekly roster basis. This phase was planned to last a month and was to be monitored and controlled by an off campus facilitator who was expected to manage the operation, handled unexpected contingencies and to make weekly reports to the coordinator of the Outreach Project.

4.6.3 The Independent/Consolidation Phase

This phase was planned to be implemented concurrently with phases 2 and 3 and was anticipated to last for no longer than three months. The ultimate goal of the MICSEC 2000 endeavour was the establishment of a Mini Computer Supported Educational Centre (MICSEC) at one of the five participating schools. When completed, the computer network of the MICSEC would be similar to that of OCCSEC and MOCSEC. It was surmised that the computer skills acquired by the participating educators and learners (during phases 1 and 2) could be sufficient to enable them to independently and effectively utilise the newly established 'computer assisting environment' generated by the 'on site' MICSEC. The latter part of phase 3 was planned to be the final facet of the process for the particular participating group and it was hoped that at this stage the educators and learners would be able to work on their own.

For the Outreach staff this could signal the start to the planning of the next MICSEC for the next cluster of five secondary schools.

4.6.4 The Process of Evaluating the Outcomes of each phase

The cumulative outcome (ultimate objective) of all the phases of each endeavour with the selected group of educators and learners was fully self supported MICSEC.

Each phase in the process of establishing each MICSEC however had its unique set of outcomes, which were evaluated by as stipulated in the following table

Phase of Programme	Outcome/s	Evaluators
One **Introductory** (OCCSEC activities)	The degree to which teachers and learners had acquired an understanding and mastery of the technology operative in OCCSEC	Co coordinator Specialised group of mentors (Educators) and consultants (lecturers)
Two **Apprenticeship** (MOCSEC activities)	The outcomes of this phase was determined by the implementation of the outcomes realised successfully at OCCSEC	Off Campus facilitator, Math/Science department heads of the participating schools and Western Cape Maths curriculum advisor
Three **Independent/ Consolidation** (MICSEC activities)	A particular outcome of MICSEC was the creation of a specialised area of educational research	Interested researchers in this specially created field of Educational research in mathematics

4.7 INDICATORS OF THE SUCCESS OF THE PROGRAMME

Short term success indicators: This was generally the measure of the performance of learners in the matric exams and more importantly the number qualifying for mathematics / science orientated programmes at tertiary institutions.

Long term success indicators: The total success of the program is indicated by the sum of the successes at the end of each phase of the programme and can be determined as follow:

Phase1: During this phase both teachers and learners were placed in a structured environment. The degree to which they acquired the necessary skills and the manner in which they integrated these with the subject matter as well as the enthusiasm they manifested to move to the next phase was a key indication of the success of this phase.

Phase 2: The environment of this phase was diffused and an indication of the success attained was the manner in which the leadership ability and the innovative potential of an individual (both educators and learners) had developed.

Phase 3: Community (i. e. the school and its immediate social environment) response and interest aroused to keep the MICSEC viable and sustainable was the most important indicator of success at this final stage.

4.8 FINANCIAL IMPLICATIONS OF STAGES TWO AND THREE OF THE MICSEC2000 PROGRAMME

It has been mentioned that each MICSEC was earmarked for high schools serving indigent communities. To burden communities, which battled daily merely to survive, with part of the costs in establishing a MICSEC in their area would have been very unreasonable. Consequently in the financial planning of the MICSEC program, funding was raised by forming partnerships with specifically targeted institutions in the corporate world with costs being kept at minimum. The following details the estimated financial budget of all the services of the Outreach Project, including the proposed MICSEC program, for the years 1999 and 2000. Staff salaries are not included.

4.8.1 Estimated Annual (1999-2000) Budget of the Outreach Project

Projected On Campus Expenditure		R **77150.00**
OCCSEC EXPENDITURE		
Transport of learners	R 36 000.00	
(1 bus per day for 12 weeks @ R600 per day)		
Computer Maintenance	R 25 000.00	
(25 PC's & Server @ 1000 per annum)		
Software Procurement, Licence & Installation (CAMI	R 6 400.00	
Software maintenance	R 750.00	
(25 PC's x R30 per annum)		

Vat and other indirect costs	R 9 000.00
Projected Off Campus Expenditure	**R 87 100.00**
MOCSEC EXPENDITURE	
Computer hardware replacement	R60 000.00
(8 PC's, Cabling, Installation, etc.)	
Computer Maintenance	R 15 000.00
(15 PC's + Server @ R1000 p.a. each)	
Software Procurement & Installation (CAMI)	R 650.00
Software maintenance	R 450.00
(15 PC's x R30 per annum)	
Vat and other indirect costs	R 11 000.00
Estimated cost of one MICSEC	**R 144 578.00**
	(R *53 908*.2)
Cabling of School Lab	R 5848. 00
1 Dedicated PC server	R 8450.00
	(*R3500.00*)
MS NT server licence and client licence	R 4560.00
20 x PC's for client based server	R126600.00
(R40000.00)	
TOTAL	**R308828.00**

4.8.2 Funding required to implement Stages Two and Three of the MICSEC2000 Program

All project services are financed by funders of the corporate world. Experience has shown that prudent research and planning, leading to well orchestrated strategies, based on efficient business principles, is the key to successful fund raising.

The forgoing proposed budget for 1999 and 2000 was the monetary indicator of the minimum funds required to satisfactorily sustain all the intended Outreach Project services for these specified periods. It also indicates that the MICSEC 2000 program is one of a variety of services for which funding was required.

From these estimates it can be ascertained that the funding required to erect a single MICSEC varied from a minimum of R 50 000.00 (using refurbished computers) to a maximum of R150 000.00 if new (or almost new) computers were installed.

The first step in the fundraising process was to initiate procedures to vividly bring the MICSEC2000 program, as an innovative supportive aid in the teaching and learning of mathematics and physical science, to the attention of the donor community. This was initially done by including in the usual mid-year reports to the then contributing donors, a convincing advertisement on the extension of the IT support service of the Outreach Project to high schools i.e. the then completed 3 MICSECS. Photographs of these completed MICSECS were included in specially designed brochures and invitations were extended to the contact persons of specifically targeted donors to attend specially arranged tours of the schools and areas where these MICSECS were located.

The contact persons of corporate institutions who expressed a positive reaction to the concept of the MICSEC program were short listed and a 'Proposal for Funding' was dispatched to each person. Each proposal was a 6 page document briefly structured as follows: Section One (2 pages) described the details (name, address, bank details, history, vision, mission, focus etc) of the Project. Section two (4 pages) outlined the Project details, beneficiaries, outcomes, timeframe of events, evaluators and estimated budget (examples of these proposals are included in the Appendix G).

4.8.3 The actual Finances raised for the implementation of Stages Two and Three of the MICSEC 2000 Programme

The funding secured to finance each of the proposed MICSECS is tabulated as follows:

Place Name	Magisterial District	Funding Amount	Year Completed
MFULENI	Kuilsriver	No funding was available	1998
ROCKLANDS	Mitchell's Plain	No funding was available	1998
BISHOP LAVIS	Goodwood	No funding was available	1998
LANGA	Goodwood	R70 000.00	1999
EERSTE RIVIER	Kuilsriver	R50 000.00	1999
LENTEGEUR	Mitchell's Plain	No funding was available	1999
ZWELETEMBA	Worcester	R36 000.00	2000
PHILLIPI NORTH	Mitchell's Plain	R30 000.00	2000

KHAYELITSHA	Mitchell's Plain	R100 000.00	2000
DIAZVILLE	Vredenburg	R50 000.00	2001

In that the costs in the erection of the first three MICSECS during 1998 were minimal no funding was sought for their development. Other than the everyday use in the schools where they were situated, these MICSECS were developed in the experimental stage of the program and were fairly rudimentary. As mentioned, they served as models to demonstrate to aspirant donors where and in what they would be investing their finances. T o develop the remaining 7 MICSECS in the two planned stages each stage requiring a minimum of R150 000.00/R200 000.00 and a maximum of R350 000.00/R600 000.00 respectively. During 1999 and 2000 only R156 000.00 and R216 000.00 could be raised respectively (a total amount of R372 000.00). This did not dampen enthusiasm or deter the commencement of the implementation of the next two stages of the project.

4.9 THE IMPLEMENTATION OF STAGE 2 OF THE MICSEC 2000 PROGRAM

The process in the establishment of these Mini Computer Support Educational Centres is tabulated in the phases of their implementation together with the consequent outcomes, the contingencies that arose and they were dealt with.

Phases in the implementation	**Outcome/s**	**Alternative contingencies**
Phase One MICSEC4 & 5: 3 educators and 15 learners from each selected school (36 persons) were chosen to participate in this phase and invited to attend 2.5 hour sessions each Monday in April 1999.	The first session was attended by only 1 educator and 5 learners of one the schools. The second session had a completely different audience of 7 persons. No progress was obviously being made.	The coordinator and the participating groups decided mutually that the educators join the *teacher development group* and the learners team up with the *Matric Class* where the same activities and information was available.

Phase Two		
MOCSEC became operative at the MICSEC5 site in Eerste Rivier at the beginning of May 1999. As planned the facility was shared by 3 high schools in the area and the site of MICSEC5 being the host school. MOCSEC was to be transferred to serve the high schools of Langa from the site of MICSEC4 during June.	Unfortunately the mobile computer facility was badly vandalised and a number of netstations and monitors stolen. The then Project budget did not make allowance for such eventualities and the remaining computer equipment was stored in the room earmarked for MICSEC5 at the school in Eerste Rivier.	The computer technician somehow converted the salvaged MOCSEC equipment into a rudimentary 10 node star network which could be used by the Eerste Rivier Matric learners. Phase 2 for the Langa educators /learners was not implemented. They were encouraged to stay on the phase 1 program which was modified to suit phase2 requirements.

Phase Three		
While phases 1 and 2 were attended to by the Project coordinator phase 3 i.e. the physical construction of MICSEC 4 and 5 was simultane ously in the process of being implemented by the computer technician.	**MICSEC4:** A 20 node star network with 19 computers and a dedicated server was completed in July and the facility officially opened on 01/08/99. **MICSEC5:** A 30 node star network was developed. Only 15 netstations with a dedicated was functional in this facility from 1/10/99	MICSEC4: The funding raised was insufficient. Refurbished computers were installed MICSEC5: Half of the funding received was used to develop the network. The IT equipment salvaged from MOCSEC was fitted in the facility.

4.9.1The Software installed on the networks of MICSEC 4 & 5

The final stage in the development of MICSEC4 and MICSEC 5 was loading the mathematics and physical science programs, then operating on the OCCSEC and MOCSEC networks, onto their servers. These programs were now available for use by clients accessing the nodes of these MICSECS. The physical science program was developed by the Courseware Program of the now defunct Gold Fields Organisation and covered the grade 10-12 school syllabus. The mathematics program is an interactive commercially available CAI product, which covers the grade 1-12 mathematics syllabus.

4.9.2 The official opening of a MICSECS 4 and 5

These were usually auspiciously planned celebrations intended to give maximum advertising exposure to the MICSEC2000 PROGRAM, its funding partners, the schools they served and other important role-players. Prominent guests were invited to the launch of each MICSEC. The dignitaries include representatives of each funder, the University, the Western Cape education department and the immediate community. Other guests were school principals, mathematics/physical science educators from the immediate high school community and the news media (newspapers, radio and television). Each occasion was regulated by a carefully executed program (Appendix H) conducted by a master of ceremonies and culminated in a Plaque unveiling ceremony followed by a finger lunch. (This kind of activity, a unique micro-layer of subsystems introduced in the financial subsystem of the Outreach Project, was coined *donor-reciprocation*).

4.9.3 The establishment of MICSEC 6

The development of the computer centre at Lentegeur differed slightly from MICSEC 4 and MICSEC 5. This school had a functioning computer room with about 15 stand alone computer stations, which were managed by a competent educator and used by learners who were completely computer literate. This educator attended the launch of MICSEC 4 and was very impressed with the mathematics software used on the network of this MICSEC. After a period of collaboration with the leadership of the school, a 30 node star network, partly sponsored from project funds was constructed in this room.

After the educator and some learners attended a few sessions at OCCSEC, they acquired the necessary skills to work on the CAMI mathematics program which was installed through a low processing server on their own network.

4.10 THE IMPLEMENTATION OF STAGE 3 OF THE MICSEC 2000 PROGRAMME

During the 1999-2000 cycle four services, one being the MICSEC program was operational. ICT formed the core of each endeavour. After the four services had operated concurrently for the year (1999), the degree to which overlapping of activities, which resulted in unnecessary duplication amongst the four, was *determined*. (Such a check is a good disciplinary measure to enforce when one's budget is restricted and running costs needs to be monitored continually).

4.10.1 Overlapping of the MICSEC 2000 programme and the Teacher Development Program

The support service rendered to teachers was initiated in 1999 as the High School Educator Developmental Workshop Program and developed into the FDE/ACE (High School Mathematics) program in 2000 Prior to the implementation of stage 3 of the MICSEC program, the selected participating educators were advised to register for the ACE program or other relevant post graduate programs offered by the Education faculty of UWC. Phases 1&2, which was compulsory during the development of the MICSEC process fell away. (By involving these educators in the structured programs offered by the University gave them full accreditation and the opportunity to advance further in post graduate studies). Educators at the already established and operating MICSECS were also encouraged to register for these academic programs.

The following table indicates in summary that 19, 5 and 6 educators (participating in the MICSEC 2000 program) were registered for the ACE, B Ed and M Ed (in Mathematics Education) programs at UWC at the beginning of the year 2000 respectively.

MICSEC	**Educators registered for ACE (Maths)**	**Educators registered for**	
		B Ed	**M Ed**
1 (MFULENI)	*1		
2 (ROCKLANDS)	2		
3 (BISHOP LAVIS)	5	1	*1
4 (LANGA)	2		*1
5 (EERSTERIVIER)	1	2	*2
6 (LENTEGEUR)	*1		1
7 (ZWELETEMBA)	1	*1	
8 (PHILLIPI NORTH)	3	1	*1
9 (KHAYELITSHA)	*2		*1
10 (DIAZVILLE)	*1		

* indicates that the educators had registered prior to or after the completion of a specific MICSEC at their school.

4.10.2 Overlapping of the MICSEC 2000 Program and the 'UWC Outreach Matric Class 1999'

With the introduction of the restructured learner program, learners attending the mathematics class increased dramatically. This resulted in the 'UWC Matric Class 1999' being extended to off-campus satellites. The MICSECS developed at Bishop Lavis, Eerste Rivier and in Mitchell's Plain now fulfilled an added role. They became the ideal centres for the' Matric Class Program'.

4.10.3 The establishment of MICSEC 8 and 9

Phases 1and 2 were deemed redundant. The theoretical component of the educator training of this program was incorporated in the ACE program (or the other post graduate programs for which some participating educators had registered at UWC). These educators were furthermore required to do a minimum of 5 sessions on the Matric Class program and so obtained practical experience in using computers and the mathematics/science software they carried. To prepare the learners of the Phillipi North and Khayelitsha schools to be optimally prepared it was made compulsory for them to attend the nearest Outreach Matric Class (either the on campus class or the nearest satellite class) for one school term.

The following briefly tabulates the initial potential & actual output, the operating & opening date and the various contingencies experienced in the establishment of MICSEC7, 8 and 9.

MICSEC	**Potential Output**	**Actual Output**	**Operating Date**	**Official Opening**
7	30 node star network , hub,	20 netstation	February 2000	

	server	terminals		
8	30 node star network , hub, server	15 refurbished 486 terminals	May 2000	
9	30 node star network , hub, server	20 new Celeron terminals	August 2000	1st September 2000

4.10.4 The establishment of MICSEC 7 and10

As was the case with MICSEC6 at Lentegeur, the construction of the computer centres in Worcester and Saldahna Bay deviated from the pattern in which MICSECS 8 and 9 were developed. Distance from all functional Outreach Project services was the primary obstacle encountered during the development of the MICSECS at these schools. Training of educators and learners in the necessary computer skills and the integration of the mathematics and science software into the school curriculum was similar to the process follow ed when MICSEC2 was developed. While the Project technician managed the construction of the computer centres at each school, the coordinator facilitated the training program of the educators and learners on site.

The construction of MICSEC 10 was delayed till late 2001 because funding only became available in early 2001. A 30 node star network through a hub was developed. 20 refurbished computer with a low processing dedicated server started operating from mid August 2001 and MICSEC10 was officially opened on 27 September 2001

4.11 TEACHING METHODS AND COMPUTER SOFTWARE EMPLOYED AT THE MICSECS

4.11.1 Teaching methods employed at the MICSECS

During teacher training sessions prior to and during the construction of a MICSEC, no individual teaching method or groups of methods were advocated as the panacea to the successful teaching and learning of school mathematics. Educators were advised to phenomologically reflect on their own experiences in the classroom and to integrate the 'computer assisting environment' (Appendix J) to which they now had immediate access into the teaching model with which they were most comfortable. Educators remained pivotal in the mathematics teaching and learning process. The disadvantages, however, of over assertiveness as evident in the 'authoritative teaching method' (Kannemeyer LD, 1996: 7-9), which generally characterise mathematics teaching at Western Cape High schools was emphasised. This method of teaching, a negative legacy of the educational policy (Christian National Education) of the former apartheid government, advocated and enforced a pedagogy that portrayed teaching and learning as a superior (educator) - inferior (educant) situational relationship. The prescribed high school mathematics syllabus, a 'ready made product' further encouraged and facilitated the subject to be taught according to a pre-established deductive system. In this static 'situational relationship', learners were guided to passively 'reproduce' the prescribed 'ready – made' subject matter and learner activity was limited to application which in essence consisted of invented problems which merely drilled the pre-established algorithms. (Freudenthal H, 1973: 114-119)

4.11.2 The 'Workshop-Lesson'

The participating educators were introduced to the 'workshop-lecture' teaching paradigm devised and employed by Kannemeyer (1996, 23-26) to engage first year mathematics students at the University of the Western Cape 'in meaningful mathematical activity. In this study Kannemeyer's model was modified for high school learners and educators and called the workshop-lesson. Similar to the *workshop-lecture,* the workshop lesson can be reduced to five overlapping teaching activity types i.e. whole group, small group, teacher circulation, teacher intervention and plenary intervention. Worksheets (tutorials) and the mathematics software which could be accessed from the computer network formed the essential learning aids. An example of a worksheet (Introduction to differentiation) and a 'workshop-lesson' outline is included in the Appendix K.

4.11.3 The CAMI Mathematics Software Package

CAMI is the acronym for Computer Assisted Mathematics Instruction. According to its programmer, Vorster, in contrast to CBT (Computer Based Training) the CAMI software package does not negate the human aspect of the teaching process (the educator or tutor). The CAMI software is subservient/secondary to the educator and the textbook and was compiled 'to focus on mental retention' of the many mundane arithmetical procedures which is a cumbersome yet necessary aspect of many mathematical activities. The software consists of numerous graded exercises of the 'drill and practice' type in which predominantly arithmetic procedures are repeatedly done until a stage of 'perfection' in doing the type of exercise is attained.

4.11.4 The Graphic Calculus Software package

With this software the graph of any single variable function can be drawn almost instantly. During the explanation or the introduction to difficult concepts cumbersome calculation can be kept to a minimum.

Differentiation as slopes/gradients to a point on the graph of a function can be easily 'seen'. Integration as determining the area under a curve can be 'seen' immediately.

The servers of MICSEC 4-10 carried the C AMI internal 1984-1999 mathematics software. This software has a Main Menu of modules numbered 1-9 or (A-I). Module 1-4 is applicable to the then primary school mathematics syllabus and 5-9 contained material was compiled for high school learners. Each Module is divided into a number of topics e.g. module 6 (Senior Algebra) can be accessed for exercises on exponents & surds, exponential & quadratic equations, remainder/factor theorem & the nature of roots, linear inequalities/absolute values & matrices, linear programming, logarithms, differential calculus, applications of differential calculus and complex numbers & advanced calculus. Each topic again has a number of sub sections. The topic on Differential calculus will be used as an example to illustrate the way in which the CAMI software is organized and operates. The first sub-section is a rather scant theoretical introduction. The dynamic nature of differentiation is illustrated by a diagram in which 'h' can be decreased till it equals zero and the line graph is tangent to the curve. Sub-sections 2-9 contain exercises (differentiated on 4 levels of degree from first principles, the derivative of a function, standard forms and rules for differentiation and elementary vector calculus. Examples of the some of the types of exercises that can be accessed under the topic differential calculus are given the Appendix M.

CHAPTER 5

A CRITICAL APPRAISAL OF THE MICSEC2000 PROGRAM BY PARTICIPATING EDUCATORS AND AN ANALYSIS OF THE FINAL RESULTS OF PARTICIPATING LEARNERS

On the completion of the training and orientation programs with the participating educators and learners during the development of a MICSEC, the school leadership (principal or his official designate) took ow nership of the MICSEC and became solely responsible to continue all the MICSEC activities initiated by the staff of the Outreach Project. These included the continued and sustained functioning of the activities as prescribed by the Outreach Project for the MICSEC. During the first year, the technical equipment at each MICSEC was serviced regularly (at least once per school term) by the technician of the Project. In addition the Project coordinator made regular telephone calls (at least two times per school term) to the educators using each facility to ascertain whether the MICSECS were still functional. During these telephonic discussions the educators were encouraged to make verbal reports on their progress and were required to inform the coordinator if the y required any assistance or support. Visits were made to the participating schools where this was necessary. During 2004 the MICSEC2000 program was appraised as it was perceived by the participating educators. A n analysis of the results obtained by the le arners who wrote the final grade 12 mathematics examination during 1999 to 2002 was also conducted.

5.1 METHODOLOGY

This section outlines the research questions, design and method, and the instrument employed to appraise and evaluate Computer –Assisted Learning (CAL) as used in all the Mini-Computer Supported Educational Centres (MICSECs) in the context of the theoretical framework of Program Evaluation as espoused by MS Hartley.

5.1.1 Research Questions

The Research Problem restated:

How can learners/schools particularly in township and rural Western Cape areas be assisted to improve their performance in grade 12 (matric) mathematics.

In Chapter 2 the historical perspectives of the Outreach Project are detailed and it is emphasised that since its inception in 1982 the Project has been addressing this problem at historically disadvantaged Western Cape schools mainly through on campus CAL programs. The MICSEC2000 program, briefly outlined in 2.8.1.2 and extensively described in chapter 4, is the latest intervention strategy implemented by the Outreach Project.

Research questions: The conceptual framework in terms of which the MICSEC2000 was appraised is outlined in 3.3. Although the *intended program* of MICSEC2000 was not directly evaluated, it can be inferred from the responses of the educators to the three program representations which were directly appraised.

The research questions formulated in 3.3.5 regarding the *implementation*, *perception and achievement* of CAL occurring in each MICSEC, as observed by participating educators, were further refined. The implemented, perceived and achieved CAL program impacted on specific areas of the teaching and learning of mathematics and the research questions were verbalised to address the impact of CAL in these areas. The refined three research questions together with a fourth research question, which addresses the long *term achievement* of all the MICSECs as indicated by the success of participating learners as in the 1999-2002 matric mathematics examinations, were the following:

1. How did the *implementation* of CAL impact on the *role of the educator*?

2. How did educators *perceive* CAL as indicated by its impact on *student motivation***?**

3 What were the *immediate achievements* **of learners as indicated by the impact of CAL on** *student learning***?**

4 What were the *long term achievements (outcomes,)* **as indicated in the matric mathematics examination of participating schools, due to the use of CAL?**

5.1.2 Data Sources

The sources of the data used in this study were the 10 Mini-Computer Supported Educational Centres (MICSECs) constructed by the staff of the Outreach Project. Each of these computer centres were established with the sole purpose of enhancing the mathematics teaching and learning of grade 12 learners at high schools serving indigent communities in the township and rural areas of the Western Cape. These MICSECs were erected at "previously historically disadvantaged" schools i.e. five ex DET (Department of Education and Training) schools and five at ex HOR (House of Representatives) schools. These schools had a history of low achievement in the final matriculation mathematics examinations.

5.1.3 Data Collection

This section details how the data, used to answer each of the research questions formulated in 5.1.1, was gathered. The primary areas of data collection were the responses of educators to the items in the CALEPQ-M and the final matriculation examination results of participating learners obtained from the WCED.

5.1.3.1 The scales and items of the Computer Assisted Learning Educator Perception Questionnaire - Mathematics (CALEPQ-M)

The format of this instrument is described in 3.5.4. The instrument consists of three scales which give educators the opportunity to appraise the implemented, perceived and achieved CAL program as it impacted on specific areas of the teaching and learning of grade-12 mathematics.

Scale 1 consists of 10 items which explores the experiences of participating educators of how the implementation of CAL impacts on their role as educators i. e. whether they experience CAL as supportive or intrusive. Five items (1, 5, 6, 7 & 8) assess the degree to which educators feel that CAL encroaches on their role in the teaching and learning process. The phrases "more time", "more creative teaching" and "reflection on meaningful ways" respectively, imply that CAL requires more effort. Items 2, 3, and 4 probe the reactions of educators to this possible increase in their workload. Items 9 and 10 appraise the feeling of educators toward the possible effect of CAL on educator and learner relationships and learner evaluation.

Scale 2 has 8 items and examines the perceptions of educators on the impact on student motivation on learners who perceived CAL positively. In his 'Summaries and Conclusions" Hartley refers to the perception of the MICSEC program by learners and reports "a positive perception of CAL environments" at the two ex DET MICSECs he evaluated in 2001(141). In this study it is assumed that Hartley's finding is generally valid for most learners at all the MICSECs and scale 2 affords educators the opportunity to appraise the effect of this positive perception on learner motivation. Item 1 and item 2 determines whether CAL generally *improves motivation* and whether its use *develops better attitudes toward the learning of mathematics.* Item 5 establishes *the relevance of the subject matter,* 7 *if students become more persistent in attaining solutions*, 8 *if anxiety decreases* and 6 to what extent *students enjoy mathematics*. Items 3 and 4 finally measure if *self-confidence increases* and whether *learners are challenged to do their best*.

Scale 3 consists of 10 items which identify some of the immediate outcomes attained by learners when the impact of CAL on their learning is assessed. Educators are asked whether CA lessons *improve, increase the rate of, initiate more active, individualises, facilitate application in, and if visualisation enhances* the learning of mathematics (items 1, 4, 7, 8, 9 and 10). Items 2, 5 and 6 prompt educator responses *to cognitive awareness, flexibility in thinking and interpretation of results* respectively. Item 3 probe *the importance of the reasonableness of output*.

A Table summarising the data collection procedures

Program Representation	*Implemented*: How did educators perceive the Implementation of CAL	*Perceived*: How did CAL impact on Student motivation	*Achieved*: How did CAL impact on Student learning
Methodology	CALEPQ-M E1	CALEPQ-M E2	1. CALEPQ-M E3 2 .WCED Matric exam results

Data Source	Responses of Educators	Responses of Educators	1. Responses of Educators 2. Achievement in matric mathematics

5.1.4 Educators and learners participating in this study

Twenty educators (Experimental group), two from each participating school, who participated in the MICSEC program for more than one year, were invited to complete the CALEPQ-M instrument. Twenty other educators (Control group) involved in the SAILI, SANTED, KHANYA and COSAT programs were also invited to complete the questionnaire. This was done to ensure a fairly diverse perception of educators using CAL in their mathematics lessons. The grade 12 learners who benefited from this program from 1999-2002 changed each year. Obtaining their opinions or perceptions of the program during the course of this investigation would have been an extremely difficult task.

Long term outcomes achieved by learners who participated in the program

These outcomes are the success rate of participating schools in the MICSEC program and measured by their pass rate in mathematics in the matriculation examinations. These results were obtained from the WCED for a three-year (1999-2001) and four-year period (1999-2002).

5.2 RESEARCH FINDINGS

In section 5.1 the research questions originally formulated in 3.5.3 were revisited and refined so that certain aspects of the three categories (implemented, perceived and achieved) of the MICSEC program could be appraised by the participating educators. In this section the collected data is analysed. Each research question was formulated so that the perceptions of participating program educators could be determined. The responses of all participants to each individual scale of the CALEPQ-M will now be fully listed under the heading of each research question. Only 17 of the experimental group (E) and 15 of the control group (C) returned fully completed questionnaires.

5.2.1 Educator observation of how the implemented MICSEC2000 program impacted on their role as educators

Research Question1: How did the *implementation* of CAL impact on the *role of* ***the educa tor***?

Table of responses of participating educators to items of Scale1

Item	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**S(10)**
SA	11	0	1	3	3	5	1	3	2	0	29
SA'	*9*	*2*	*4*	*6*	*2*	*3*	*3*	*5*	*3*	*3*	40
A	6	10	9	12	8	8	9	9	9	3	83
A'	*6*	*8*	*6*	*9*	*10*	*10*	*8*	*8*	*6*	*0*	71
Tot	17	10	10	15	11	13	10	12	11	3	112
Tot'	*15*	*10*	*10*	*15*	*12*	*13*	*11*	*13*	*9*	*3*	100
%	**100**	**59**	**59**	**88**	**65**	**76**	**59**	**71**	**65**	**18**	**66**
%'	***100***	***66***	***66***	***100***	***80***	***87***	***73***	*87*	***60***	***20***	***66***
U	0	0	3	2	1	0	2	2	2	3	15
U'	*0*	*0*	*3*	*0*	*0*	*0*	*1*	*0*	*3*	*2*	9
D	0	5	3	0	4	4	4	3	3	9	35
D'	*0*	*3*	*2*	*0*	*3*	*2*	*2*	*2*	*2*	*9*	25
SD	0	2	1	0	0	0	0	0	1	2	6
SD'	*0*	*2*	*0*	*0*	*0*	*0*	*1*	*0*	*1*	*1*	5
M	4.6	3.1	3.4	4.1	2.9	3.8	3.1	3.4	3.5	2.4	3.8
M'	4.3	2.8	3.8	4.4	3.7	3.9	3.4	3.5	3.5	2.7	3.9

The meaning of the symbols used in the Table

The table above indicates the responses of both the experimental (**E**) and the control (**C**) groups of participants. The numbers in the first row following the word **Item** indicates the questions **1-10** of scale 1 of CALEPQ-M. **S (10)** is the sum of the responses of the10 items of scale 1.

SA, SA', A, A' U, U', D, D', SD and SD' in the first column represent the total number of responses of the **E**-group and **C**-group to the items 1-10 of scale 1 and represent those who strongly agreed (SA), those who agreed (A), those who were uncertain (U), those who disagreed (D) or those who strongly disagree (SD) to each item. Each response was numerically loaded i.e. SA=5, A=4, U=3, D=2, SD=1 as is usually the case with Likert items. **M** and **M'** are the mean for the E-group and C-group of the total number of particular responses. The symbols **Tot**, **Tot', %,** and **%'** are self explamatory

The responses of participating educators to items 1-10 of Scale1

Both the E group (17 educators) and the C group (15 educators) were unanimous (strongly agreed or agreed) that the use of CAL in their lessons *did not replace the educator* (item 1).

Items 5, 6, 7 and 8 which prompted responses to change of role of the educator: 11 and 12 (65% and 80%), 13 (76% and 87%) of each group, 10 and 11(59% and73%), 12 and 13 (71% and 87%) educators of the respective groups strongly agreed or agreed that *their roles changed to that of tutor* (item 5) *or facilitator* (item 6) *or co-learner* (item 7) *or manager* (item 8) during CAL lessons.

To items 2, 3 and 4 which prompted answers to whether *CAL required more effort* the participating educators responded as follows: 10 (59% and 67%) of each group responded that more time (item2) and *more creative effort was required of them* (item 3) and 15 (88% and 100%) of each group strongly agreed or agreed that when using CAL they *needed to reflect on meaningful ways in which they taught mathematics* (item 4).

Finally, 11and 9 (65% and 60%) of the two groups of educators strongly agreed or agreed that during CAL lessons *the educator/learner relationship became more personal* (item 9). 12 and 11 (71% and 73%) strongly disagreed or disagreed that CAL made *assessment of student learning more difficult* (item 10).

5.2.2 Educator observation of how the perceived MICSEC2000 program impacted on student motivation

Research Question 2 How did the *perception of* CAL impact on *student motivation?*

Table of responses of participating educators to items of Scale2

Item	1	2	3	4	5	6	7	8		S (8)
SA	7	6	5	4	6	7	5	4		44
SA'	5	5	7	5	3	4	2	2		33
A	9	11	10	10	8	9	10	7		74
A'	7	7	7	7	4	11	8	7		58
Tot	16	17	15	14	14	16	15	11		118
Tot'	12	12	14	12	7	15	10	9		91
%	94	100	88	82	82	94	88	65		87
%'	80	80	93	80	47	100	67	60		76
U	1	0	1	2	3	1	2	5		15
U'	3	2	1	3	6	0	2	5		22
D	0	0	1	1	0	0	0	0		2
D'	0	1	0	0	2	0	3	1		7
SD	0	0	0	0	0	0	0	1		1
SD'	0	0	0	0	0	0	0	0		0
M	4.4	4.4	4.1	4	4.2	4.4	4.2	3.8		4.2
M'	4.1	4.1	4.4	4.1	3.5	4.3	3.6	3.7		4

The responses of participating educators to items 1-8 of Scale2

Responses to items 1 and 2: The responses to each item were as follows; 16 and 12 (94% and 80%) strongly agreed or agreed that CAL in the classroom *improved student motivation*, 17 and 12 (100% and 80%) strongly agreed or agreed that *students developed better attitudes to learning mathematics*.

Responses to items 5, 7, 6 and 8: The responses to each item were as follows; **14 and 7 (82% and 47%)** strongly agreed or agreed that CAL made mathematics *more relevant to the learners*, 15 and 10 (88% and 67%) strongly agreed or agreed that *learners became more persistent in attaining solutions to problems*, **11 and 9 (65%**

and 60%) responded that the use of CAL *reduced mathematics anxiety* and 16 and 15 (94% and 100%) strongly agreed or agreed that *their learners enjoyed mathematics*, Responses to items 3 and 4: The responses to each item were as follows; 15 and 14 (88% and 93%) strongly agreed or agreed that the use of CAL *increased self confidence* and 14 and 12 (82% and 80%) of both the E and C-groups strongly agreed or agreed that CAL in the classroom *challenged students to do their best*.

5.2.3 Educator observation of how the achieved (short term) MICSEC2000 program impacted on student learning

Research Question 3: What were the *immediate achievements* due to CAL impact on *student learning*?

Table of responses of participating educators to items of Scale3

Quest	1	2	3	4	5	6	7	8	9	10	S (10)
SA	1	2	2	2	2	4	3	4	0	3	33
SA'	4	1	1	3	2	4	3	6	3	2	29
A	13	13	15	8	10	12	14	10	12	14	121
A'	9	10	8	5	9	5	12	8	8	12	86
Tot	14	15	17	10	12	16	17	14	12	17	154
Tot'	13	11	9	8	11	9	15	14	11	14	115
%	82	88	100	59	71	94	100	82	71	100	90
%'	87	73	60	53	73	60	100	93	73	93	77
U	3	2	6	5	5	1	0	1	5	0	22
U'	2	3	0	5	4	5	0	0	3	1	23
D	0	0	0	2	0	0	0	2	0	0	4
D'	0	1	0	0	0	1	0	1	1	0	9
SD	0	0	0	0	0	0	0	0	0	0	0
SD'	0	0	0	2	0	0	0	0	0	0	2
M	3.9	4	4.1	3.6	3.8	4.2	4.2	3.9	3.7	4.2	4
M'	4.1	3.7	3.7	3.6	4	3.8	4.2	4.3	3.7	4.1	3.9

The responses of participating educators to items 1-10 of Scale 3

Responses to items 1, 4, 7, 8, 9 and 10: The responses to each item of this cluster were as follows; 14 and 13 (82% and 87%), **10 and 8 (59% and 53%)**, 17 and 15 (100%

in each group), 14 (82% and 93%) of each group, 12 and 11 (71% and 73%), 17 and 14 strongly agreed or agreed that in the CAL lessons *learning improved*, ***learning took place in less time***, *more active learning took place*, *learning was individualised learners were able to apply their learning in the absence of computers and visualisation enhanced their learning..*

Responses to items 2, 5 and 6: The responses to each item were as follows; 15 and 11(88% and 73%), 12 and 11 (71% and 73%), 16 and 9 (94% and 60%) respectively strongly agreed or agreed that *cognitive awareness increased, learning took place in less time and interpretation of results from problems was necessary.*

Responses to item 3: The response to this item was the following; 17 and 9 (100% and 67% strongly agreed or agreed that the *reasonableness of output became important.*

5.2.4 The impact of CAL on long term outcomes

Research Question 4: How did the CAL program impact on long term achievement i.e. the mathematic matriculation results of participating schools?

5.2.4.1 A Qualitative Comparison of the Matric Mathematics (s g) results obtained at the MICSECS over the period 1999-2002 (4yrs) and 2000-2002 (3yrs).

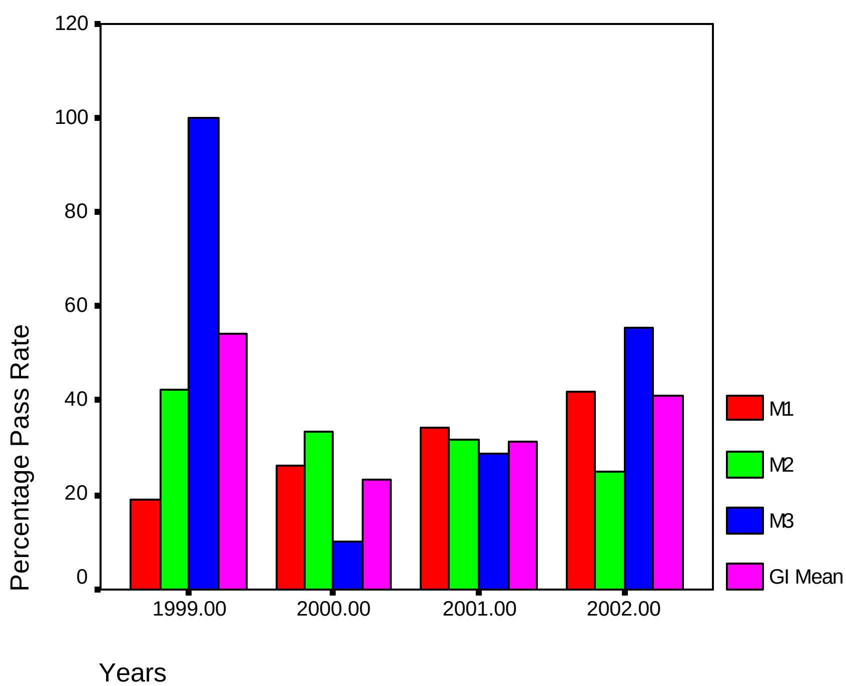
To avoid cumbersome and superfluous repetitions in this discussion the acronym MICSEC will be replaced by the symbol M. MICSEC 1 thus becomes M1; MICSEC 2, M2 etc. The 3 MICSEC groups will be referred to and represented as follows: GI (GROUPI) will indicate MICSECS 1, 2 and 3: GII (GROUPII) will indicate MICSECS 4, 5, 6 and GIII (GROUP III) indicate MICSECS 7, 8 and 9. *GI will further represent M1 andM2; *GII, M 5 and M6 and *GIII, M7 and M8 respectively.

*At the MICSECs n**ot many learners wrote the grade 12 Mathematics Higher Grade matric examinations and these results will thus not be evaluated.***

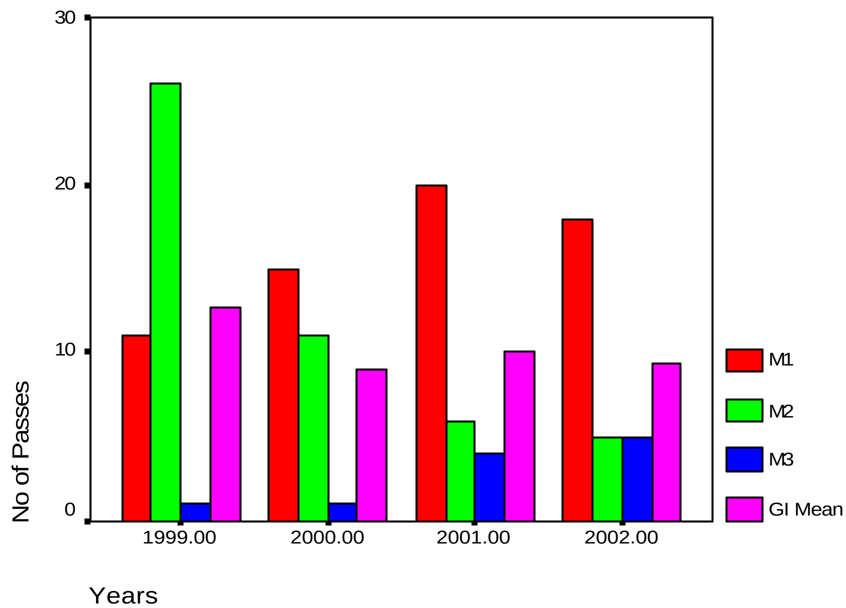
The grade 12 Mathematics Standard Grade results are summarised in the table in appendix M. Column 1 lists each MICSEC (i.e. 1-10); column 2 indicates in three successive rows the number of candidates who wrote the matric mathematics standard grade examination each year, the number who were successful and the pass rate of each group as a percentage; columns 3-6 reflect these achievements (where applicable) over each year from 1999 to 2002. In columns 7, 8, 9 and 10 the total number of candidates that wrote and the mean for each total over the 4 year (1999-2002) and 3 year (2000-2002) periods respectively are indicated.

2.4.2 The performance of GI schools

Bar Graph of the Pass Rates at M1, M2 and M3 from 1999 - 2002



Bar Graph of the Number of Passes at M1, M2 and M3 from 1999 - 2002



Bar graphs 1 and 2 indicate the percentage pass rates and the number of passes together with their means for the period 1999-2002 (4yr) at GI i.e. M1, M2 & M3. Graphs were drawn from the data recorded in rows 2-20 of the table1 in appendix M. If the 1999 results of GI are ignored (the abnormal performance at M3 obviously positively skewed these results) then the pass rates and number of passes at M1 and M3 (despite abnormally low participation rate) indicate a gradual increase in performance (positive tendency) from 2000-2002. The performance of learners at M2 during the same period, on the other hand, indicates a negative tendency. If the percentage pass rates and number of passes of M1, M2 and M3 are compared with the corresponding successive yearly means (which indicate a positive tendency) of GI then only the results of M1 show a positive tendency in performance.

In 2001 the learners of M1 performed above the national average but below the provincial average. During the 4 year period, the achievement of M1compared well with the national average but it was well below the provincial average for the same period.

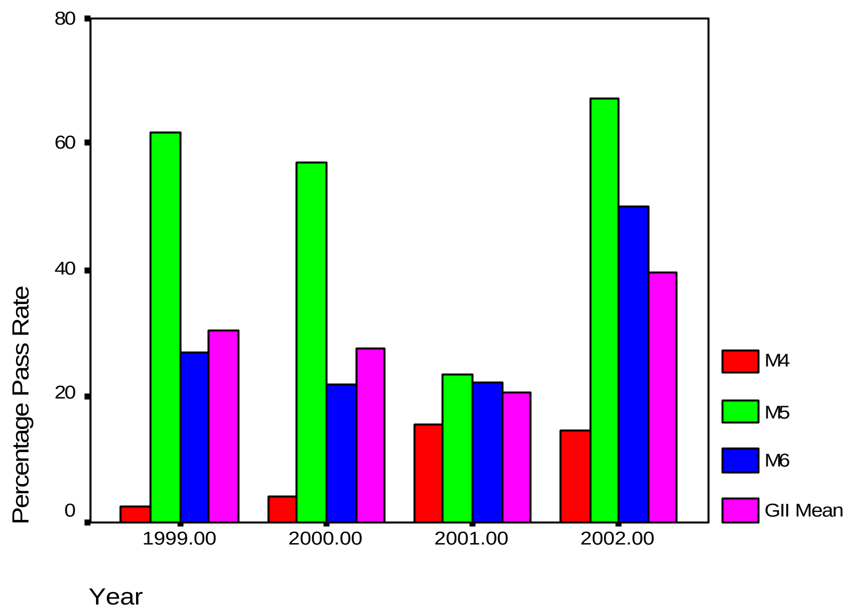
During the period 1999-2004(4yrs), a total of 133 learners out of 407 (32.7%) passed matric mathematics(s g) at GI schools. During the period 2000-2002(3yrs), 85 out of 286 (29%) passed.

*If the results of M3 are ignored then for the 4 year period, a total of 123 out of 373 (33%) were successful at *GI. Similarly in the 3 year period 74 out of 253(29.2%) was successful .The contribution of M3 to the pass rate of GI was obviously minimal.*

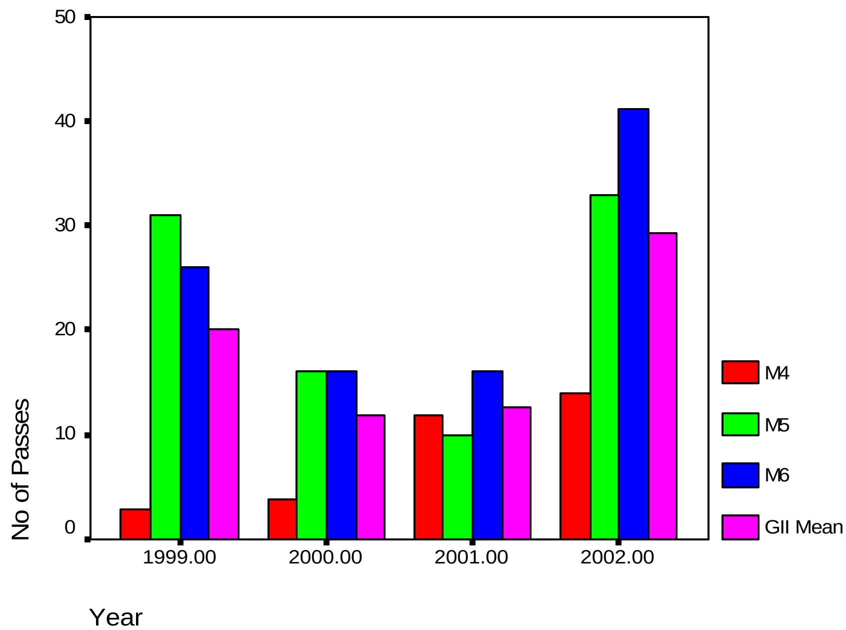
None of the MICSECs of GI carried the CAMI software.

5.2.4.3 Performance of GII schools

Bar Graph of the Pass Rates at M4, M5 and M6 from 1999 - 2002



Bar Graph of the Number of Passes at M4, M5 and M6 from 1999 - 2002



The results of GII schools are recorded on the grid, in rows 21-40 (appendix M). Bar graphs 3 and 4 indicate the number of passes for the periods 1999-2002 and 2000-2002, with the yearly averages, for GII i.e. M4, M5 and M6.

The pass rate and number of passes at M4, despite being disconcertingly low, indicate a gradual positive tendency. From 1999-2001the results at M5 and M6 show a negative tendency, which became positive in 2002. A comparison of the pass rates and passes of M5 and M6 with their corresponding successive yearly means (which indicate a positive tendency) indicate a positive tendency from 2000-2001.

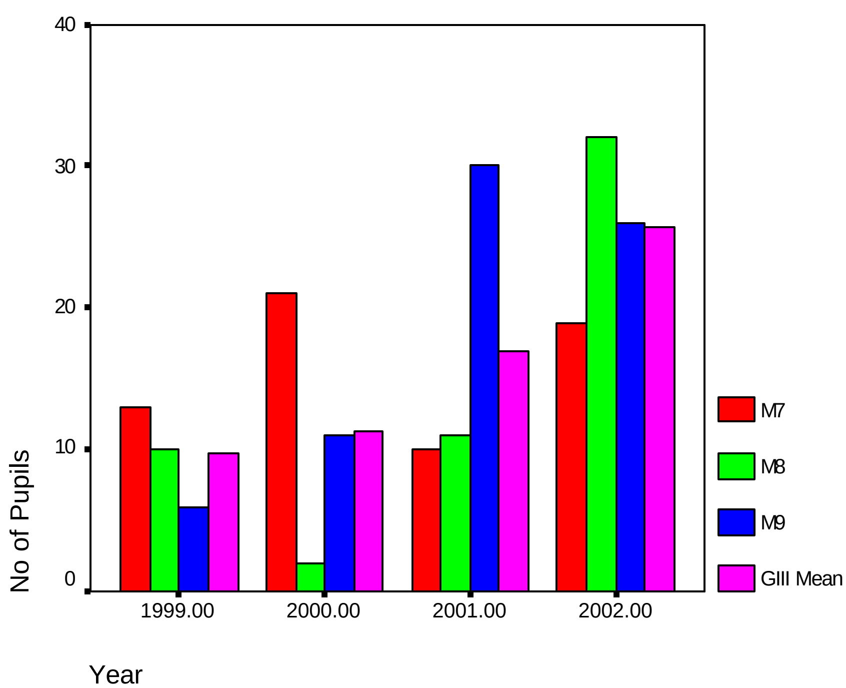
The pass rate of M5 (except for 2001) exceeded both the provincial and national results each year and those of M6 surpassed the national results and compared favourably with the provincial results in 2000.

*During the period 1999-2004(4yrs), a total of 222 learners out of 896 (24.8%) passed matric mathematics(s g) at GII schools. During the period 2000-2002(3yrs), 162out of 626 (25.9%) passed. However, the school housing M 4 was classified as an 'under performing school' by the WCED. If the results at M5 and M6, were considered apart from M4 then over the 4 year period, 189 out of 491 (38.5%) learners passed and during the 3year period 132 out of 348 (37.9%) were successful at *GII.*

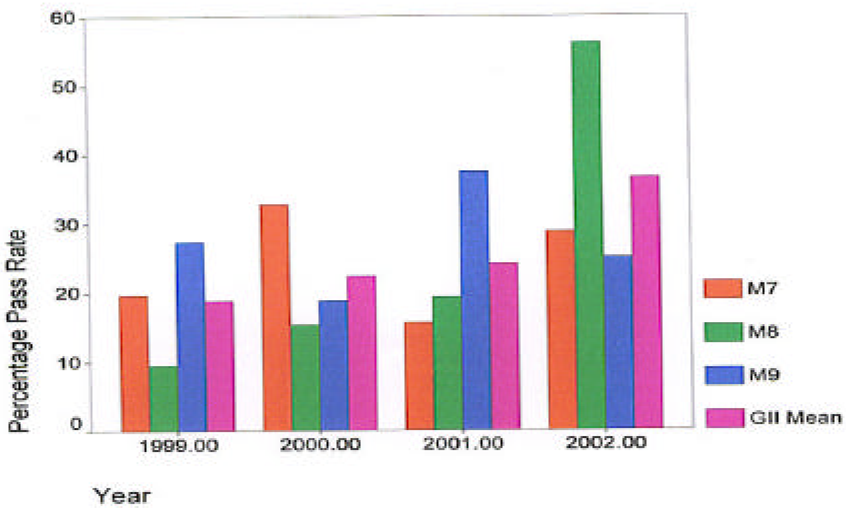
From mid 1999 the networks of GII all carried the CAMI software.

5.2.4.4 Performance of GIII schools

Bar Graph of the Number of Passes at M7, M8 and M9 from1999 - 2002



Bar graph 6 Bar Graph of the Pass Rate at M7, M8 and M9 from 1999 - 2002



The results of GIII schools are recorded on the grid, in rows 41-50 (appendix M). In Bar graph 5 and 6, the 1999 results should be ignored because the MICSECS at GIII schools only became operative from the middle of 2000.

Despite dips in 2000, M8 and M9 displayed positive tendencies in their pass rate and number of passes. M7 shows increases in the pass rate and number of passes in 2000 and 2002. When the percentage pass rates and number of passes of M7, M8 and M9 are compared with the corresponding successive yearly means (which indicate a positive tendency) M8 and M9 display increases proportionate with these means.

During the three year period 2000-2002, 162 out of 622 ***(26%)*** *of the candidates entered by the GIII schools wrote and passed the matric mathematics (s g) examinations.*

*The network at M8 was irreparably damaged at the end of 2000 and consequently all activities in the MICSEC ceased. If the results at M7 and M9 were considered apart from M8 then over the 3 year period 117 out of 437(26.7%) was successful at*GIII..*

From mid 2000 the networks of GIII all carried the CAMI software.

5.2.4.5 A Comparison of the Performances of learners at *GI, *GII AND *GIII

Over the four year period a total of 112 (30%) out of 373, 189 (38.2%) out of 495 and 136 (25.9%) out of 525 passed grade 12 mathematics (s g) at *GI, *GII, and *GIII respectively giving an overall total of 437 (31.4%) out of 1393. In headcounts, 77 (69%) and 24 (21.4%) more learners passed grade 12 mathematics (s g) at *GIII and *GII respectively than *GI.

Over the three year period, 75 (30%) out of 253, 132(38%) out of 348 and 117 (27%) out of 437 passed matric mathematics (s g) *GI, *GII and *GIII respectively giving an overall total of 324 (31.2%)) out of 1038. In headcounts, 57 (76%) and 42 (56%) more learners passed matric mathematics (s g) at *GIII and *GII than at *GI.

A Table of the Average (Mean) number of Learners who passed Grade 12 Mathematics (sg) at *GI, *GII and *GIII during the 3 and 4 year periods

	M1	M2	***GI Mean**	M5	M6	***GII Mean**	M7	M9	***GIII Mean**
00-02 3 yrs	18	7	**13**	20	24	**22**	17	22	**19**
99-02 4yrs	16	12	**14**	23	25	**24**	16	18	**16**

A cross group comparison of the performances of the MICSECS of *GIII and *GII with *GI indicate the following regarding the average (mean) number of passes. Over the 3yr and 4yr periods M5, M6, M7 and M9 performed better than M1 or M 2. Consequently the 3yr and 4yr means of *GII and *GIII exceeded that of *GI. In headcounts during the three year period for every 13 learners that were successful in matric mathematics (s g) at the *GI, 22 and 19 were successful at the *GII and *GIII respectively. During the four year period, for every 14 successful learners at the *GI, 24 and 16 succeeded at each of *GII and *GIII.

5.2.4.6 A Quantitative Analysis of the Matric mathematics (s g) results obtained at the MICSECs using the SPSS11 program

The SPSS11 computer program was used to calculate the t-test values for the mean pairs of the number of learners who passed Grade 12 Mathematics (sg) during the 3 year and 4 year periods respectively. The following are the t values for the three year period:

Pair	M1-M5	M1-M6	M1-M7	M1-M9	M2-M5	M2-M6	M2-M7	M2-M9
t:3yrs	-.276	-.804	.212	-1.067	-1.799	-1.591	-.630	-.610

From t-tables for the 3 year period with degrees of freedom 2 and a significance at the 0.05 level (two tail), t = 4.303. All the absolute t values determined for the three year period are less than 4.303. Prof M Ogunniyi of the School of Science and Mathematics Education was consulted on the 9th June 2005 to interpret these results. He concluded that an interpretation of these results was not possible because the used samples were non-homogeneous and the situation from which the data was derived did not adhere to acceptable rigid procedures.

A description of the SPSS11 procedure and the t and r values calculated for the 3 and 4 year periods are however included in appendix N

5.3 DISCUSSION OF FINDINGS

In this section the data collected and listed in 5.1 and 5.2 respectively will be discussed. The research questions, formulated in the context of the three areas of the conceptual framework outlined in 2.3, will again serve as the points of departure for this discussion

5.3.1 The impact CAL on the role of the participating educators

To appreciate the impact of the implementation of CAL on the role of the teacher the salient aspects of the actual implementation of this intervention strategy need to be revisited and what is meant by the role of the teacher needs to be elucidated.

The implementation of the MICSEC2000 program: Paragraph 4.2.2 describes the implementation of the MICSEC2000 program during its experimental stage and underlines how participating educators and learners were initially trained on site to maintain and effectively use the technology made available to them. The transference of the necessary technical and teaching skills (i.e. the incorporation of mathematics and physical science software into the classroom activities) were facilitated by the project technician and the project coordinator respectively.

Section 4.6 depicts the guidelines that developed from these initial experiences and its implementation in the second and the third stages of the program. This implementation occurred in three phases. The *introduction phase* occurred in the On Campus Computer Supported Educational Centre (OCCSEC). Educators and learners attended lectures and workshops and completed practical work on the computers in this facility. A *'self-help' phase* followed in MOCSEC which was then stationed at one of the participating schools. The *consolidation phase* finally transpired in the completed MICSEC. The table in 4.6.4 indicates the process used to evaluate the desired outcomes of each phase. During the establishment of some of the MICSECs, due to various circumstances, it was not always possible to strictly adhere to these guidelines and the contingencies described in 4.8 were effected.

The role of the teacher: Certain expectations of behaviour that determine the role of an incumbent are associated with any teaching position or office. Owens (1981: 69) describes an organisational role generally as "a psychological concept dealing with behaviour enactment arising from interaction with other human beings". He comments that role incumbents are "actors" who interpret their role subject to what they bring to that role. Role conflict arises when incumbents are confused over what is expected of them in a role and how they perceive it. Generally a teacher employed by the WCED works in a fairly strict bureaucracy of super-ordinates (circuit manager, principal, deputy-principal, department head etc) and subordinates (educators) and a high degree of role conflict is to be expected.

The perceptions of participating educators to the items of E1 of CALEPQ-M

This discussion will attempt to identify emerging trends and patterns from the responses of the participating educators to E1 of the CALEPQ-M in the context of the implementation of the program and its impact on their expected and perceived roles. In 5.1.4 three broad areas of the role of the teacher are grouped.

Educator responses to the first group of items: Item 1 appraised the *expected* role of the teacher. Generally the expected role is determined by the teacher's employer who enumerates him or her in accordance with a prescribed set of conditions of service. The mean pair of the experimental and control groups for this item were (4.6, 4.3). All participating educators thus either strongly agreed (17) or agreed (15) that CAL does not replace the educator. This could imply that participants of each group bore cognisance of the expected autocratic role imposed on them by the education authorities. Furthermore they perceived that the implementation of CAL to be supportive i.e. it did not intrude on or erode their expected role as educators.

Low mean pairs of (2.9, 2.7) and (3.1, 3.4) for the E and C groups to items 5 and 7 were returned. This could be interpreted as an indication that many educators in both groups were uncertain that the use of computers in their lessons changed their roles to *tutors* or co-*learners*. This uncertainty could mean that for many of the participating educators the idea that a teacher could become a *tutor* or co-*learner* during CAL lessons conflicted with their perceived role of a teacher.

Higher mean pairs of (3.8, 3.9); and (3.4, 3.5) were calculated for items 6 and 8. The former indicated that many agreed that the use of CAL during lessons changed their roles to *facilitators* at times. This positive response could indicate that teachers rated the role of 'facilitator' on par with that of 'educator'. The second mean pair tends more toward uncertainty than agreement. When responding to this item respondents possibly confused the term *manager* with 'circuit manager' (previously school inspectors). The speculations made regarding responses to items 5, 7 and 8 appear to contradict those in made in 5. 2. 1. It should be added that the deductions in 5.2.1are based on the percentage of respondents who strongly agreed or agreed.

Educator responses to the second group of items: Items 2, 3 and 4 appraised the educators' perception as to how the implementation of CAL increased some aspects of their workload. Mean pairs (3.1, 2.8) for item 2 indicate a probable degree of uncertainty amongst the experimental and control respondents. From this it could be deduced that many of the participating educators were so engrossed with the technology that they did not mind or were unaware of the obvious increase in preparation and teaching time for CAL lessons.

Mean pairs of (3.4, 3.8) for the two groups indicates that slightly more educators in the control group perceived that CAL required more *creative teaching*. Item 4 which required educators to respond to whether the implementation of CAL stimulated them to *reflect on meaningful ways in which mathematics can be taught returned* a mean pair of (4.1, 4.4). From this it could be inferred that the impact of CAL motivated many participating educators of both groups to such cognitive activity.

Educator responses to the third group of items: Item 9, which refers to the *educator/learner relationship*, returned both an experimental and control mean of 3.5. Item 10 returned a mean pair of (2.4, 2.7). From these statistics it appears that many educators were uncertain that the implementation of CAL made *student assessment more difficult.*

Conclusion: The mean of the means of the 10 items of E1 are 3.8 and 3.9 for the experimental and the control groups respectively. These statistics suggest that overall most of the participating educators agreed with many of the 10 items that *Computer-Assisted Learning impacted positively on the role of the teacher*.

5.3.2 The Impact of CAL on Student Motivation

It needs to be emphasised at this juncture that the E2 scale of CALEPQ-M appraised the observations of educators of the impact of CAL on student motivation of students who perceived CAL positively (Hartley, 2001: 141). The items of E2 differentiate three areas in which the use of CAL could motivate positively orientated learners.

Responses to Items 1 and 2: These items each returned mean pairs of (4.4, 4.1) for both the experimental and control groups. The mean of above 4 for each group affirms the finding in 5.2.2 that the two groups of educators either strongly agreed or agreed that the intervention strategy in which the positive perception of CAL by learners resulted in *improved motivation* and *better attitudes to the learning of mathematics.*

Responses to items 5, 7, 8 and 6: Mean pairs of (4.2, 3.5), (4.2, 3.6), (3.8, 3.7) and (4.4, 4.1) were returned for the responses of the experimental and control groups to items 5, 7, 8, and 6 respectively. The means for these items of the experimental group averaged 4. This implies that as learners perceived the *relevance of mathematics* (item 5) they *persisted in attaining solutions to problems* (item 7). Consequently a*nxiety* *decreases* (item 8) and the learners *enjoyed mathematics* (item 6). The lower means of the control group to a lesser extend endorse this tendency but more educators were uncertain that this was occurring.

Responses to items 3 and 4: Mean pairs of (4.1, 4.4) and (4, 4.1) were returned for the responses of the experimental and control groups to these items. From these statistics it could be inferred that educators observed that as learners became more relaxed their *self confidence increased* (item 3) and they *were challenged to do their best* (item 4).

Conclusion: The mean of means of the 8 items were 4.1 and 4 for the experimental and control groups respectively. These statistics suggest that overall most of the participating educators agreed with most of the items of E3. It can hence be concluded that their perception of *the impact of CAL on student motivation was positive.*

5.3.3 The impact of CAL on some immediate achievements of learners on student learning

Items 1, 4, 7, 8, 9 and 10; 2, 5, 6, and 3 of E3 cover two specific areas in the learning process. In this study the items of E3 verbalise a few immediate outcomes of these learning areas and educators appraised the achie vement of learners of these outcomes.

Educator responses to the first group of items: Mean pairs of (3.9, 4.1); (3.6, 3.6); (4.2, 4.2); (3.9, 4.3), (3.7, 3.7) and (4.2, 4.1) were calculated for the experimental and control groups respectively. Each of these means is greater than 3.5 and hence it can be inferred that most educators in each group agreed that CAL *improved learning, increased the rate of learning, resulted in more active learning, individualised learning, learning was applied in the absence of computers* and *visualisation learning was enhanced by visualisation*. Positive responses of only 10 and 8 (59% and 53%) to item 4 however contradict this generalisation and indicate that many educators were either uncertain or disagreed that CAL increased the rate of learning.

The mean pairs do not appear to differ much and this implies that there was no significant difference in the experimental and control groups' response to these items. Educator responses to the second group of items: The mean pairs of the experimental and control groups were (4, 3.7); (3.8, 4); (4.2, 3.8) and (4.1, 3, 7) respectively for these items. These means are 3.7 and greater. It can hence be inferred that most of the educators of both groups agreed that during CAL sessions: *cognitive awareness increased, flexibility in thinking increased, interpretation of results became more important and reasonableness of output became important.*

It should be noted however that 40% of the respondents of control group were uncertain or disagreed that CAL increased flexibility in thinking or that through visualisation it enhanced learning.

Conclusion: The mean of the means of the 10 items of E3 are 4 and 3.9 for the experimental and the control groups respectively. These statistics suggest that overall most of the participating educators agreed with many of the 10 items that CAL *impacted positively on student learning.*

5.3.4 The long term achievements (outcomes) of CAL used in the MICSECs as indicated by the matric mathematics results of participating learners.

The outcomes of participating schools in the 1999-2002 matric mathematics examination formed the criteria against which the success of the MICSEC2000 program in addressing the problem formulated in Chapter1 was measured. In 5.2.4 these result were compared qualitatively for individual and groups of MICSECs over a 4 year and a 3 year period.

These results will now be discussed in the context of the actual results of the WCED and the National Education Department (NED). However, before this can intensively be dealt with certain relevant aspects of the Grade 12 mathematics syllabus, the prescribed structure of examination papers, continuous assessment and the actual examination process need to be elucidated.

5.3.4.1 The Grade 12 Mathematics Syllabus, the prescribed structure of examination papers, continuous assessment and the actual examination process:

The content of the standard 8-10 (grade 11-12) syllabus, implemented by the WCED in 1996, still forms the core syllabus on which both the higher and standard grade matriculation examinations are based. The 1999 and 2000 WCED matriculation mathematics examinations consisted of two three hour papers:

First Paper Algebra 75%, Differential Calculus 25%; *Second Paper* Trigonometry 40%, Analytical Geometry 25%, Euclidian Geometry 25% and a General question which covered more than two of any of the given sections 5%-10%. Each section was allowed a +/- 5% latitude. (WCED Syllabus for Mathematics Higher and Standard grade, 1996: 6)

From the year 2001, however, the examination in Mathematics, Physical Science, Biology, Accounting and English Second Language were centralised and national examinations for these subjects were introduced (NED, 2002: 6.1). In mathematics the core syllabus was retained and the two papers were formatted with marks allocations as follows:*1st Paper* Quadratic theory (35/25), Graphs (30/25), Remainder Theorem (10/10), Indices & logs (30/25), Sequences & Series (30/25), Diff Calculus (50/35) and Linear programming (15/0); *Second Paper* Analytical Geometry (50/40), Trigs (84/60) and Euclidean Geometry (66/50). The first number in each bracket is the marks allocated for higher grade mathematics with latitude of +/- 5 being allowed for each section. (NED Instruction Document Mathematics, 2000: 1-4)

An added contingency to the matriculation mathematics examination in 2001 was the continuous assessment (CASS). CASS is an on site on going process in which educators employ various assessment techniques to determine the performance of their learners. The CASS mark now forms 25% of the promotion mark and is regulated by the *Umalusi* statistical model (NED, 2002: 5).

Subject to *Umalusi* regulations the Senior Certificate examination presently written in South African High schools is subject to almost strict military precision with secrecy and confidentiality being required at various operation levels. Question papers are set, moderated and approved after which they are printed and distribution to the various examination centres. They are then released at the date and time of the specific examination and subject to various controls within the examination room. Answer books are then marked and moderated. The checked and moderated marks are placed on mark sheets from which are inserted into a computer programme and adjusted according to accepted examination procedures. All these processes are subject to strict re-checking and security controls.

5.3.4.2 The Broader Picture: A scrutiny of the mathematics examination results of MICSEC schools in terms of the actual WCED and National results

In this discussion the year **2000** will form the 'base year' as it heralded the end of the provincial control of certain key subjects in the matriculation examination.

The general performances of previously historically disadvantaged schools during the 2000 matric examinations are indicated in section 1.5. Two ex- DET schools housing M4 and M8, which formed part of this study, had success rates of below 40% and were classified by the WCED with 17 other schools as dysfunctional. The other three other ex-DET schools had pass rates of less than 60% and were part of many others that were targeted by the WCED for its special intervention strategies. The average pass rates in mathematics (sg) at the five ex DET schools were below 20%.

By contrast the five ex- HOR schools, which are the other five schools of this study, averaged a success rate between 60% and 80% with a pass rate of more than 34% in mathematics (sg). These average pass rates in mathematics were, however, below the provincial pass rate for that year but the pass rate attained at M2 and M10 exceeded the provincial pass rate. The provincial pass rate, however, should be treated circumspectly because it is an adjusted statistic. It is common departmental practice to convert a category of higher grade failing marks to standard grade and some standard grade failing marks to 'lower grade' and to reflect these as standard grade 'passes'. The departmental practice of adding 5% to candidates whose home language is not the languages of examination questions is another contentious component of this adjustment.

The average performance of the 5 ex- HOR MICSEC schools was better than the national average for this year.

2001 was for the reasons already mentioned a watershed year. During this year the continuous assessment mark (25% of the examination mark) was formalised and became a candidate's official year mark. This meant that with the addition of the already mentioned 5%, most candidates at ex- DET schools wrote the 2001 mathematics matriculation examination with 30% of their final mark pre-determined. The average pass rate in mathematics sg of all the MICSECs was 23.5%. The average obtained by the ex- DET MICSEC schools (24%) was not significantly different to the average of 25, 4% (WCED, MST Strategy, 2002:4) obtained by the fifty other ex DET schools in the Western Cape. From this low percentage pass rate it is obvious that the 'built in advantage' did not appreciably increase the performance of learners at ex- DET schools. There was a large difference between the average pass rates in mathematics (sg) between the ex-

HOR MICSECs (27%) and the average of the other 151 ex HOR schools (43%) of the Western Cape. A contributing factor to this low pass rate at the ex- HOR MICSEC schools could have been that at the end of 2000 most of these schools experienced various teacher vacillations.

In **2002** the national success rate in the matriculation examinations improved by 7.2% and national mathematics (sg) pass rate increased by 10.9% (Ministry of Education, 2002: 7.1). The five ex DET and five ex HOR MICSEC schools showed corresponding increases of 6% and 10% in their mathematics pass rates respectively. Julie (2004) in a report for Umalusi determined whether a decline in the degree of difficulty in questions was apparent in both the higher and standard grade mathematics examination papers for the years 1993, 1999 and 2003. They divided a question paper into three challenge levels very similar to an inverse of Bloom's taxonomy. They then compared the contents of a 'National' (NEB) and an Independent Examination Board (IEB) first and second standard grade and higher grade paper at these three levels for years 1993, 1999 and 2003. In the first standard grade papers they perused they found an increase of more than 20% in the level 1 content and an increase of about 9% in level 2 content for the years 1999 and 2003. During the same periods only 20 and 4 marks (a decrease of 80%) were allocated to Level 3 questions. The second papers manifest a similar trend for levels 1 and 2 for 1999 and 2003.

5.4 SUMMARY AND CONCLUSIONS

5.4.1 A Synopsis of the process of this Appraisal

The goals of the National Plans for Higher Education (2001) brought to fresh attention **the problem of the need to assist learners/schools particularly in**

township and rural Western Cape areas improve their performance in grade 12 (matric) mathematics.

In this thesis it has been repeatedly mentioned that since 1982, the Outreach Project of the University of the Western Cape through various computer supported services has been assisting grade 12 mathematics learners and educators at previously disadvantaged Western Cape high schools. The MICSEC2000 program, initiated in 1998, is the most recent computer enhancing service intervention strategy implemented by the Outreach Project to address this problem. In this chapter this intervention strategy was appraised utilising the process of program evaluation espoused in chapter 3 based on the *inputs of participating educators*.The methodology (5.1) employed in the appraisal process did not directly evaluate the *intended* program of MICSEC2000. The *implemented* and *perceived* program representations were interrogated by two separate research questions and the *achieved* program by two other research questions. The research instrument used in this interrogation was the Computer Assisted Learning Educator Perception Questionnaire- Mathematics (CALEPQ-M). The Instrument consists of three scales i.e. E1 (ten items), E2, (eight items) and E3 (ten items). It is a modified version of the last three of four scales of the Computing Technology Utilisation/Impact Questionnaire. The final mathematics examination results of learners who participated in the program from 1999 to 2002 were used as long term outcomes in the appraisal. The results of this appraisal are presented and critically discussed in 5.2 and 5.3

5.4.2 Significant Findings and Implications of the Appraisal of the MICSEC2000 Program

Central to this study are the results and their implications around the last three program representations of the theoretical framework. These are the implemented program (as it affected the role of participating educators) the perceived program (the learning experiences of the learners) and the achieved program (the short and long term learning outcomes of the participating learners). Further results and their implications of the research question/s used to interrogate each program representation will now be detailed.

5.4.2.1 The Implemented MICSEC2000 Program

- How did the *implementation* of CAL impact on the *role of the educator*?

The MICSEC2000 intervention strategy is essentially a CAL "drill and practice" grade 11-12 mathematics computer software package which was immediately accessible to participating educators to *implement*, at their discretion, in their daily lessons. The Likert-like items of E1 primarily elicited responses from the educators as to how *their implementation* of CAL impacted on their role as educators. The conclusion reached in 5.3.1 suggests that many agreed that the *implementation* of CAL impacted positively on their role as educators. Cognisance should, however, be taken that 24% of the experimental group and 22% of the control of the participating educators were not part of this generalisation. The table of educator responses (5.2.1) to items of E1 further indicates that an average of 12 out of the 32 (37.5%) educators registered uncertain, disagree and strongly disagree to items 2, 3, 7 and 9. To accommodate this discrepancy the general conclusion in 5.3.1 should read as follows: Many of the participating educators agreed that *Computer-Assisted Learning impacted positively on the role of the teacher*. Some, however, were uncertain, disagreed or strongly disagreed that this was the case.

5.4.2.2 The Perceived MICSEC2000 Program

- How did educators *perceive* CAL as indicated by its impact on *student motivation*?

The items of E2 did not appraise the perceived program representation per se but its impact on the motivation of learners who perceived CAL positively. Furthermore the items 5, 7, 8 and 6 have been placed in a particular order because they can be considered as intervening variables (Owens, 1981: 107), generated by CAL, which would motivate learners to specific immediate outcomes. It is in this context that further implications for the means of the items of E2, recorded for both the experimental and controlled groups, will be discussed.

The more than 4 means of items 1 and 2 indicates that the two groups perceived that the CAL intervention strategy generated a learning climate conducive to *improved motivation of learners* and *better attitudes to the learning of mathematics.*

This occurred because the intervention variables 5, 7, 8 and 6 were activated during CAL lessons resulting in more motivated learners. Thus as learners realise the *relevance of mathematics* (item 5) they were motivated to *persist in attaining solutions to problems* (item 7). *Anxiety decreased* (item 8) and the learners started *to enjoy mathematics* (item 6). At the end of this process the *self confidence of the learners increased* (item 3) and they *were challenged to do their best* (item4).

The means for items 5, 7, 8 and 6 of the experimental group were all over 3.8. These results imply that the perceptions of the participating educators concurs with the suggested linear series of intervention variables (items 5, 7, 8 and 6) and consequently they perceived learners to be more relaxed and that they were enjoying the mathematics lessons. The means of the control group were lower. However it can be concluded that they endorse this tendency despite some educators being uncertain.

It should also be noted that 11 and 12 were uncertain or disagreed with items 5 and 8.

5.4.2.3 The Achieved MICSEC2000 Program

- What were some of the *immediate achievements* of learners as indicated by the impact of CAL on *student learning*?

In 5.4.2.1 it is apparent that many of the participating educators responded positively to the implementation of the MICSEC2000 program particularly how it impacted on their role as teachers. Similarly in 5.4.2.1 many of the participating educators indicated a positive impact on student motivation of learners who perceived CAL favourably. From this positive attitude of educators to the implemented program and the positive attitude of learners to the perceived program, resulting in learners being better motivation it can be predicted that positive outcomes or achievements would ensue.

Items 1, 4, 7, 8, 9 and 10 of E3 address some immediate general outcomes educators endeavour to attain in daily teaching sessions. Overall CAL assisted in a number of these immediate learning outcomes being attained. However, 14 (43.75%) and 9 (28%) uncertain, disagree or strongly disagree responses were recorded for items 4 and 9. Thus some educators indicated that *learning did not take place in less time* nor *could students apply their learning in the absence of computers*

Items 2, 3, 5 and 6 on the other hand represent particular immediate cognitive outcomes that can be realised when CAL is employed in mathematics lessons. In 5.3.3 it is indicated that from the high means of both groups these outcomes were realised to some extent. It should be noted that an average of 6 of the total number of respondents 32 (18.75%) were uncertain about each of these items.

Item 3, i.e. *reasonableness of output becomes important* does not entirely appear to be a cognitive process but for the sake of convenience it has been placed in this group.

- What were the *long term achievements (outcomes,)* as indicated in the matric mathematics examination of participating schools, due to the use of CAL**?**

In 5.2.4.5 group comparisons of the performances of the learners of the MICSECs at *GI, *GII AND *GIII are made for a three year period (1999-2001) and a four year period (1999-2002). The computer networks of the MICSECs at *GII and *GIII carried the mathematics software while the networks at *GI did not. Over the 3 year period the final year matric mathematics results at *GII and *GIII were 69% and 46% better than that of *GI. Over the 4 year period the results were 71% and 14 % better. At this stage it needs to be mentioned that two of the schools of *GI were ex-HOR schools and one was an ex-DET school. The two schools of *GII were ex –HOR schools and the two schools at *GIII were ex-DET schools. The mean number of passes as indicated in 5.2.4.5 and the calculated percentages above indicate *GII performed better than *GIII over the two periods. A factor that could possibly have negatively influenced the results of the MICSECs at *GII was that the mathematics software became available a year after it was installed at the *GIII MICSECs.
In 5.3.4.2 the performances in Mathematics (sg) of the MICSECs at the ex-DET schools were compared with the performances of the MICSECs of the ex-HOR schools for the years 2000, 2001 and 2002. These results were then compared with the results of the WCED. For each year the average success rate of the ex-DET increased by about 5%. Despite being about 4% higher than the ex-DET schools for each year, the average success rates of the ex-HOR schools decreased by 7% in 2001 and then increased by 10% in 2002. The average success rates of most of these schools were less than the average success rates of the WCED for each of these years.

5.4.3 Limitations of this Appraisal

The following anomalies in one way or another impinged negatively on the appraisal process of the MICSEC2000 program.

5.4.3.1 The MICSECs established at each participating school

Because most of the participating schools serve impoverished communities the coordinator of the Outreach Project had to raise the necessary funding for each individual endeavour. In each case the funds obtained were sufficient to supply only the barest essentials needed to develop each MICSEC. Most of the computers installed were refurbished and many were prone to malfunctioning. Each computer network was hence a very rudimentary computer assisting environment. Consequently a regular, dependable and continuous interaction of the educators, the mathematics software and the learners could not always be ensured. This problem was aggravated by the limited number of software programs (10) made available in each computer room.

5.4.3.2 The instrument used to appraise the MICSEC2000 program

This study is probably the first which evaluated the perceptions of educators of a computer centred intervention strategy in the Western Cape. Consequently no standardised questionnaires were available to assess how teachers would appraise the MICSEC2000 program. The CALEPQ-M instrument was thus developed from the last three of four scales of the Computing Technology Utilisation/Impact Questionnaire used by Rochowicz (1996). However, the scales of this instrument exhibited numerous limitations when it was used in this appraisal. E1 is restricted to examining only how the implementation of CAL impacts on the role of the teacher. Other issues e.g. the present unhealthy educational departmental practice of excluding educators in the planning of an intervention strategy etc are not addressed.

E2 does not directly address an educator's perception of how learners perceive the MICSEC2000 program. Items of this scale are directed at the perceptions of educators of the motivation of learners who were positively orientated to CAL. The scale does not interrogate those learners who are apathetic or who are negatively disposed to

CAL. Immediate and long termed outcomes in teaching and learning are inextricably linked and therefore the items of E3 should not have been restricted only to immediate outcomes.

5.4.3.3 The participants of the Appraisal

The major participants of the appraisal were essentially the mathematics educators who were required to evaluate the three program representations of the MICSEC2000 Program. Of the sixteen educators who formed the experimental group only seven were the original managers of the MICSECs. Three of the seven have unfortunately been lost to mathematics teaching. The teaching experience and qualifications of the participants of both the experimental and control groups differ widely. This could have influenced their responses to many items of the three scales of the questionnaire.

5.5 RECOMMENDATIONS FOR FURTHER RESEARCH

Numerous concerned organisations including the WCED have launched various computer assisting intervention strategies to assist learners at the various stages of the learning and teaching of mathematics. Not many have been researched or evaluated and have been merely imposed on the teaching fraternity. It is recommended that educators be included in the planning of all future computer enhancing programs in mathematics. It is further recommended that the instrument used in this study be modified and refined to exclude all the limitations listed in 5.4.3.2. If it is still inadequate then an entirely new questionnaire should be compiled.

It is hoped that the modus operandi adopted in this appraisal would serve as a useful paradigm or template to evaluate all existing and planned intervention programs in mathematics teaching and learning.

It is finally suggested that the process of program evaluation (i.e. appraising the *intended*, *implemented*, *perceived* and achieved program) would be a useful tool to evaluate all bridging programs (not necessarily using communication information technology) in mathematics at tertiary institutions.

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APPENDICES

CHAPTER 2

A: Relevant Annual Reports of GFRC and SSME of the Outreach Project

B: 1998 Vacation School Planning and Learner Responses

C: FDE (2000) Course Outline and Examination Questions for Mathematics

D: Certificate Award Ceremony for Promising Matric Learners in Mathematics

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E: A tabulated summary of the important features of some of the articles in the JCMST from 1989-2003

F: The Computer-Assisted Learning Educator Perception Questionnaire-Mathematics, (CALEPQ-M) for grade12 mathematics educators

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G: Proposals for Funding A MICSEC

H: A Program for the Official Opening Of a MICSEC

I: A Photo Gallery of the MICSECs established by the Outreach Project 1998-2001

J: A Concise Overview of my Experience as a Teacher

K: An example of a worksheet (Introduction to differentiation) and a 'workshop-lesson' outline

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O: Table II: t and r values for the number of passes obtained at MI and then M2 matched against the number of passes obtained at MICSECS 4 to 9.

APPENDIX A

Annual reports of GFRC and SSME of the Outreach Project

- **Proposals for an Instructional Computing Services Dissemination Project**
- **Instructional Computing Development Projects at the University of the Western Cape 1982-1987**
- **Educational Computing: The UWC Experience**
- **Goldfields Sciences and Mathematics Resource Centre 1992-1993**
- **GFRC: Annual Report 1992**
- **Outreach Project: Annual Report 1996/ 1997**
- **Outreach Project: Annual Report 1998/ 1999**
- **Outreach Project: Annual Report 1999/ 2000**
- **Outreach Project: Annual Report 2000/ 2001**

(Note: For copyright reasons appendix A has not been reproduced. The information is available at the Outreach Projects' offices.)

UNIVERSITY OF THE WESTERN CAPE

PROPOSAL FOR AN INSTRUCTIONAL COMPUTING SERVICES DISSEMINATION PROJECT

Prof. A.J.L. Sinclair

Director of the UWC Teaching Centre
University of the Western Cape

Prof. R.J. Kansky

Instructional Computing Consultant
University of Wyoming

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INSTRUCTIONAL COMPUTING DEVELOPMENT PROJECTS AT THE UNIVERSITY OF THE WESTERN CAPE 1982 - 1987

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Director of the UWC Teaching Centre
University of the Western Cape

Prof. R.J. Kansky

Instructional Computing Consultant
University of Wyoming

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EDUCATIONAL COMPUTING:
The UWC Experience

Part 1:
THE OUTREACH PROGRAMME

by

M.C. Mehl and A.J.L. Sinclair

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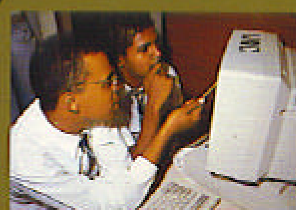
GOLD FIELDS SCIENCE AND MATHEMATICS RESOURCE CENTRE

1992/1993




University of the Western Cape

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GOLD FIELDS SCIENCE AND MATHEMATICS RESOURCE CENTRE

ANNUAL REPORT 1992

CONTENTS

University of the Western Cape

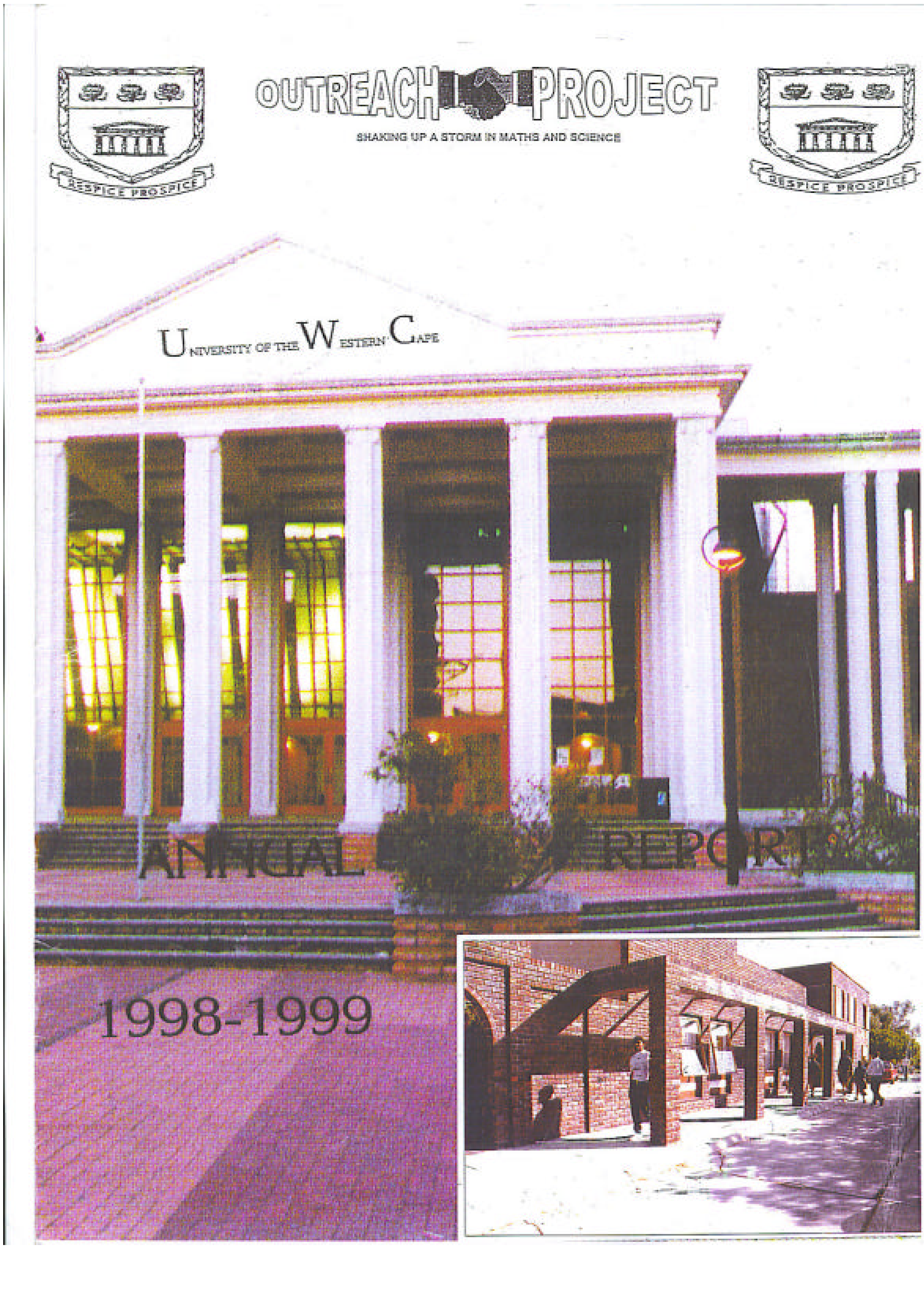
School of Science and Mathematics Education
Goldfields Resources Building
University of the Western Cape

OUTREACH PROJECT

SHAKING UP A STORM IN MATHS AND SCIENCE

ANNUAL REPORT 1997 - 1998

Sponsored By
FNB, ANGLOVAAL, HERMAN OLTHAVER TRUST, AECI, BP ENERGY AFRICA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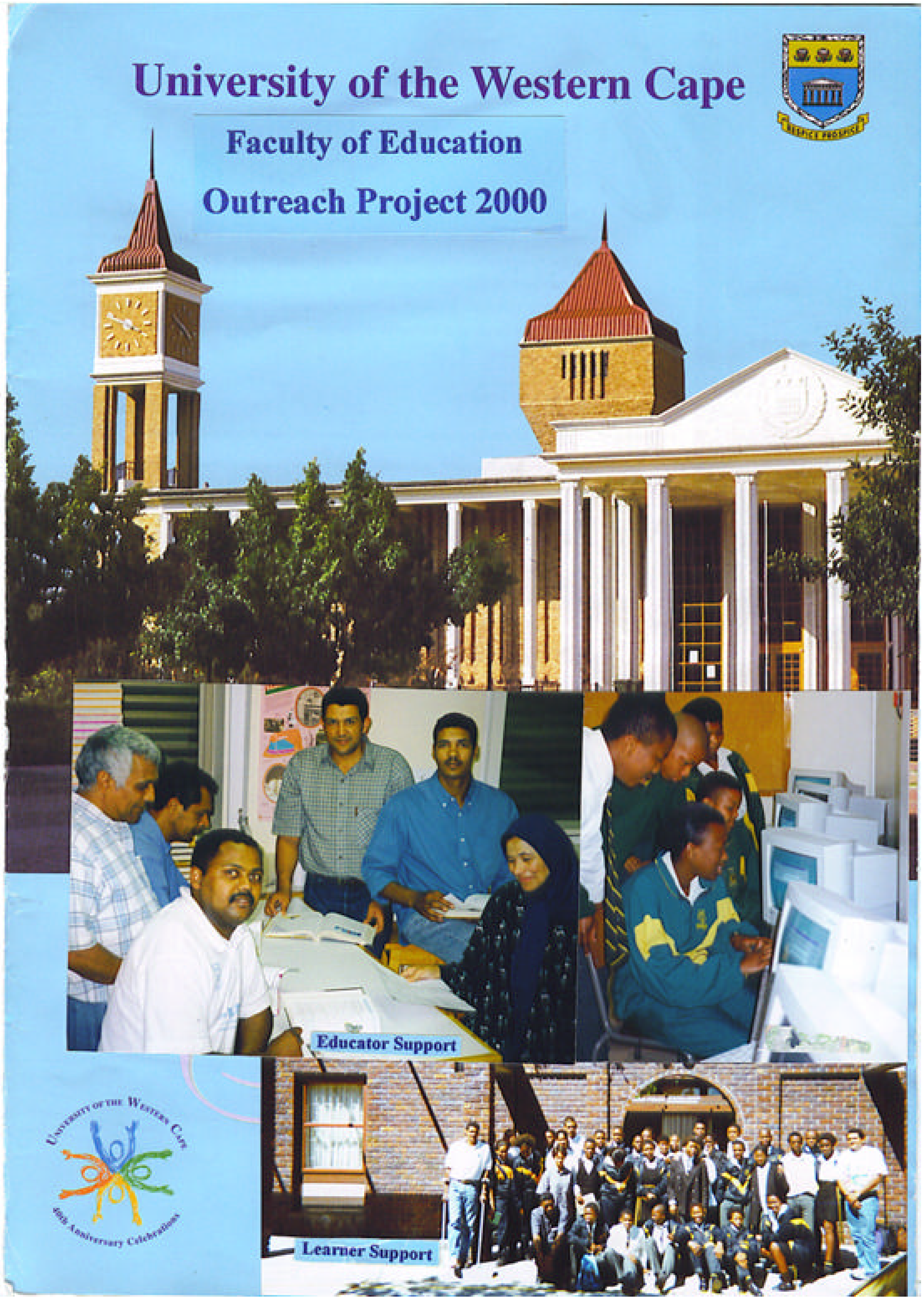
SHAKING UP A STORM IN MATHS AND SCIENCE
RESPICE PROSPICE
UNIVERSITY OF THE WESTERN CAPE
ANNUAL REPORT
1998-1999


University of the Western Cape
Faculty of Education
Outreach Project 2000
Educator Support
Learner Support

APPENDIX B

Outreach Project 1998 Vacation School

- **Winter School Program**
- **Winter School Application Form**
- **Winter School Registration Form**
- **Comments by Students**
- **Certificate of Attendance**
- **Report of Directorate of SSME**

Winter School Programme

1998

Presenter Mr J Jacobs , Mr A van Breda

Tutors: Q Gysman, A Prins

A Henny V Jeaven

	SESSION 1 (09HOO - 10H30)	SESSION 2 (UHOO - 12H30)
Monday		
Subject:	Physical Science	Mathematics Series,
Topic	Movement, Energy.	Sequences
Tuesday		
Subject:	Mathematics	Physical Science
Topic	Graphs	Inorganic Chemistry
Wednesday		
Subject:	Physical Science	Mathematics
Topic	Newton's Laws	Trigonometry
Thursday		
Subject:	Mathematics	Physical Science
Topic	Analytical Geometry	Chemical Equilibrium

WINTER SCHOOL APPLICATION FORM / AANSOEKVORM
6 JULY 1998 - 9 JULY 1998

SCHOOL NAME / SKOOLNAAM: Kasselsvlei Secondary

NAME / NAAM: Serena Thomas

HOME ADDRESS / HUISADRES: 12 Aaron Figaji Crescent
Marlowe Estate, Bellville

POSTAL CODE: 7530

TELEPHONE NUMBER: 951 - 3689

SEX / GESLAG: Female

HOME LANGUAGE / HUISTAAL: English

MATH % / WISK % - DEC/DES '97: 33,3% (HG) JUN. '98 35% (HG)

PHYS.SC % / N.SKEI % - DEC/DES '97 53,2% (HG) JUN. '98 53% (SG)

What do you intend doing after Matric / What do you plan to study?
Wat beplan jy na Matriek?/ Watter studierigting wil jy volg?

Cost & management Accounting OR
Internal Auditing

What are your expectations for the Winter School Programme?
Wat is jou verwagtinge vir die Winter Skool Program?

I want to improve on my math skills and understand Physical Science better. So my expectations are that this programme will look at problem students have and not just give brief explanations and expect us to understand.

UNIVERSITY OF THE WESTERN CAPE
OUTREACH REGISTRATION FORM
1998

NAME: CHARLENE DICKSON

ADDRESS: 69 La Provence Way
Westridge
Mitchells Plain
7798

TEL: 34 04 63

SCHOOL: Westridge High

UNDERTAKING

PARENT / GUARDIAN

I, MRS. L. DICKSON hereby declare that my son / daughter may attend the OUTREACH Programme, presented by Gold Fields Resource Centre, at UWC, every week.

Signed: [signature] Date: 06. 05. 1998

PUPIL

I, MRS. L. DICKSON hereby declare that I will attend the abovementioned programme on a regular basis. I understand that only a written excuse by parent / guardian will be accepted stating the reason for my absence.

Signed: [signature] Date: 06. 05. 1998

OUTREACH WINTER SCHOOL 1998
Comments by students   Day 1 Session 1

1. "I think this session was very good and I understand the work we have done so far much better."

2. "It was very good and uplifting. I would like a bit more Afrikaans."

3. "It refreshed my memory and made the topic seem logical."

4. "I really enjoyed the session very much. Thanks a lot. I understood the lesson."

5. "Ek het die les baie geniet, maar daar was ie genoeg van my moedertaal gebruik nie, maar andersins was die les baie interessant. Baie dankie."

6. "Dit het momentum beter verduidelik. Ek het net deurmekaar geraak aangesien dit meestal in Engels was."

7. "I like this section because I didn't know when I'm doing problem which equation I must use."

8. "Ek dink dit was n goeie poging. Jy het n paar dinge baie duidelik gemaak, maar ek is ontevrede oor die engels. Dit was baie genotvol."

9. "It was interesting and fun. It was very different from school and I think that I understand better. The kids do not respond much and I am very shy, but I will try much harder tomorrow."

10. "Ek het dit geniet, maar ek sal dit waardeer as jy ook Afrikaans ook sal praat."

11. "Ek sal die les meer verstaan as dit in Afrikaans gedoen word."

OUTREACH WINTER SCHOOL 1998
COMMENTS BY STUDENTS
DAY 2 SESSION 1

1. Die sessie was baie lekker, ek het dit geniet. Ek het ook die werk verstaan en ek dink Joey gee baie lekker les. Die werk op die komper was makliker as gister sin, seker omdat ons met parabole en reguitlyne gewerk het. Ek sal graag daarvan hou om weer op die komper te werk, al is dit net vir tien of vyftien minute. Baie dankie Joey vir die wonderlike les wat jy aangebied het. Ek het dit baie waardeur.

2. Die klas wat ek vandag bygewoon het, het vir my baie meer insig gegee oor die parabool en reguitlyn grafiek. Dit het vir my meer insig laat toon veral die vergelyking tussen parabool en reguitlyn. Ek is nou meer verseker van my werk en het ook een van my onsekerhede geoorkom. Dit het my Wiskundige kennis meer opgebou en ek weet in nabye toekoms sal ek met meer selfvertrou my werk doem en goeie punte behaal.

3. I think the maths for the day was very useful for us and the one who gave it to us is very helpful and he likes to make some jokes in between the lesson. I would like the Outreach people to buy some more books because I would want of those books too, not because of the brilliant answers in the book. I would also like more of the Outreach students to come and help because, the two who do help is not enough and we as the pupils are a lot. They cannot help everybody at once and the time is very costly. Time is also money. I would like some supper at 12h00 not coffee and biscuits.

4. Die les oor grafiek was baie in "detail" wat ons nie oor gaan op skool nie. Ek dink as ons meer van so n houding by die skool kry sal die werk nie so verveeld wees nie en omdat ons in ons n son n maklik deur hulle ondersteen word help dit baie.

5. Why are you bombarding me with your silence. I didn't know there are still creatures such as you on earth. You are my prayers answered but you are not what I have hoped for. Do you want me to get into your mood or would you rather step into mine? It seems to me your problems resemble to those in my life but remember anyone who get into my life is there on own risk so beware of the big fat Taxi Queen who is driving along midnight. Just one remark; how would you rate me on a scale from wonderful to marvelous. I thought we should believe I one faith, one goal and have lunch.

6. Die sessie was "okay" gewees. Ek het iets nuuts geleer by Andre, hoe om te toets of jy hou grafiek reg geskets het. Die grafiese optelmasjien was interressant al het ek nie geweet hoe on dit te gebruik nie. Ek voel ook lekker omdat ek n regte antwoord gegee het en n prys daarvoor gekry het wat my meer gaan aanmoedig om harder te werk vir die einde van die jaar, want dit sal die grootste prys vir my wees wanneer ek slaag die einde van die jaar.

7. I really learned a lot today. I had some difficulties with some sums that I did not understand but thanks to you guys I can solve it. I used to get confused with my formulas and where to use which one, but now I know a method how to figure it out.

8. Die klas was baie lekker, kie tyd gaan te gou somtyds en die aanbieder kan n prys wen vir "entertainment". Die enigste probleem wat ek het is dat, as ons werk doen dan gaan ek oor dit die volgende dag, maar ons gaan nie in die klas oor dit nie. Ek weet die tyd is min , maar wanneer ek werk voltooi, wil ek weet of dit reggedoen is. Dankie.

9. Today the session was about mathematics. The issue discussed was Graphs. It was very enlightening and interesting even though I knew half the stuff well already. The examples shown were similar to ones which were in the examination but not as difficult. I think it is really nice that the tutors are always ready to help you and explain something if you have no idea what is going on. The main guy spoke loud enough and funnily enough unlike my teacher at school. He actually made sense and I knew what was happening. It was not as boring as I thought it would be. It's been great.

10. Vandag se klas was interessant. Ek het baie geleer van die grafieke. Ek weet dat die res van die week ook lekker gaan wees. Dit wat ek hier leer gaan my baie help in die eksamen. 'Joey kom hou by Dlorida skool, ek weet dan day ons sommer A's sal kry. Hou aan waarmee jy besig is en God seen. Nogmals baie, baie dankie vir alles wat ons kan keer en inneem.

11. Today's lesson was very interesting as we got to learn many new things like working with a calculator that automatically draws graphs and also how to solve two equations simultanaeously. I also like our lecturer very much because he has a hood sense of humour, but I don't like his takkies because it is a bit outdated and dirty. I did miss working on the computers today and hope that we will have a chance tomorrow. I don't like graphs very much so the lesson was not that interressting to me.

12. Die oefeninge wat hulle doen is te maklik. Hulle moet probleme uit vorige eindeksamen vraestelle saam ons doen. Dit is n goeie idee om in groepe te werk.

13. Today's session was very interesting though I feel it should be made longer so that we can recap on the work, do a little exercise and then get into more heavy stuff. At some point I hot stuck and it's mostly because I'm thinking that the sum is difficult and it's actually quite simple. I never believed my teacher when she said the only way to conquer Maths is to practice it everyday and I found that out now during this exam, and last year November. So I have made a vow to myself to do at least 2hrs of Maths per day.

14. Dit was baie lekker, omdat n paar dingevir my duidelik gemaak was. Ek het nie die parabool so lekker verstaannie, maar met u hiperaktiewe styl is alles skielik duideliker. Dit is ook die eerste keer dat ek met die gekyktydige oplos van twee vergelykinge by grafiek te doen gekry het. Dit is ook vir myduideliker. Ek het nog nooit so lekker klas gekry nie. Ons meneer is baie eentonig en onvriendlik. Hy is stil, vervelig en gee die werk net soos hy dit in die boeke ken. Hy gee niks ekstra nie. Hy is eenvoudig. U is baie ingesteld on wiskunde vir mense vriendeliker en selfversekerd aan te bied. Dit is wat ek soek van iemand. U maak Wiskunde opwindend en u sorg dat ons dit geniet. Ek sal graag he dat u my verder sal moet help. Dankie.

15. Not bad, better than school (which sucks) and okay on an intelligent level (something strange at my school). Better than having a 130-kilo teacher punching holes in the blackboard (that's my maths teacher) and completely enligntening. Would love to get my hands on one of those fancy calculators and am willing to wash your car for a weed – if you have one, that is. But back to the point of me writing this note; really good class, very good lesson. And so on and so on. But it's now 11;40 – you're keeping us for overtime.

16. Dit was baie interressant om hierdie dinge te leer wat n mens nooit van geweet het nie. Die maniere hoe n mens by n probleem uitkom is so maklik as wat jy gedinnk het. Hierdie is regitig baie fantasties en n mens leer ook baie. Jy sen dinge en hoor dinge waarvan jy nog nooit van geweet het nie of gehoor het nie en dit maak jou oe oop en jy dink as jy net dit gedoen het of dat jou probleem opgelos sal word. Hierdie nuwe dinge wat n mens leer is baie behulpsaam in lye en nood .

17. We started from basics. Graphs. It was like a revision. I regained the knowledge I had lost during the holiday period. It was good to remember because it will help me in the coming term. How simultaneous equations fits into finding points of intersection, the standard form of graphs, know to find

the y intercepts and the x intercepts and how to sketch it in a graph. It was a good session.

18. Eerstens het ek dit baie geniet. Dit was baie interressant. Die manier waarop dit aangebied was, was baie verstaanbaar. Ek het parabole gehaat, maar ek dink dat ek nou van parabole begin hou. Ek geniet elke sessie verskriklik baie. Dit was wonderlik om nuwe dinge te leer. Ons het nog nie parabole gelyktydig opgelos nie, maar dit was nogal interessant. Dit was verskriklik opwindend.

19. I am very happy being here and I enjoyed the lesson, but sometimes I felt lost, like I couldn't understand anything, but luckily some of my "friends" could help me. The lesson was interesting and it was helpful; but some sums were a bit ' difficult", to understand because our teacher teaches it differently, at least I had the knowledge to continue like I usually do at home. I must stop writing now otherwise I'll die. I don't have anything to say except I'm tired and interval should arrive now. Please make him stop...please you are killing me. Oh yes 20 seconds left...19, 18, 17, 16, 15, 14, 13, 12, 11, 10, 9, 8, 7, 6, 5, 4, 3, 2, 1 and up.

20. Vandag se sessie oor die parabole was baie interessant en doelgewys. Ek het nooit geweet hoe om die interpunksie van punte uit te werk nie, maar vandag het ek geleer hoe om dit te doen. Die fasiliteerders hier is baie hulpvaardig en verduidelik dit baie duidelik. Die parabole is een van die ontwerpe wat ek nie juis baie van hou nie maar van vandag af dink ek gaan ek hoe aie meer van parabole hou. Die klasse wat hier aangebied word vind ek baie hulpvaardig en sal ek dit graag weer in die toekoms wil by woon. Ek will net he ons moet meer werk en minder praat.

21. This session was nice because I now know how to draw a straight line graph and the parabola and the teacher was very nice to me. If I didn't understand a thing they made me to understand it clearer.

22. Ek het baie geleer uit hierdie sessie van grafieke veral by die trek van die reguitlyn het ek baie geleer. Die parabool was nog n groot probleem wat ek nooit van hehou het in my vroeer standerd, maar uit vandag se les weet ek nou uiteindelik hoe om die parabool te trek. Ek het dit baie geniet. By interseksie het ek altyd vas gehak, maar nou verstaan ek dit veel beter as vantevore. Dit was weereens baie lekker en opwindend.

23.

UNIVERSITY OF WESTERN CAPE
OUTREACH
WINTER SCHOOL
JULY 1998

THIS IS TO CERTIFY THAT

HAS ATTENDED THE

MATRIC

SCIENCE AND MATHEMATICS

VACATION PROGRAMME

at the School of Science and Mathematics Education

Gold Fields Building

University of the Western Cape

....

Presenters:
J Jacobs
A van Breda

....

Project Coordinator

B Isaacs

Sponsored by BP

UWC PRINTING

22 July 1998
Prof M Ogunniyi
The Director
School of Science and Mathematics Education

Report: **Outreach 1998 Winter School, Mathematics and Physical Science for Matric / Grade 12 Students**

Date: 6th (Monday) - 9th (Thursday) July 1998

Presenters / Tutors

Presenters: Mr J Jacobs (Mathematics)

Mr A van Breda (Physics / Chemistry)

Tutors: Messrs. Q Gysman, A Henney

V Jeaven, A Prins

Workshop 1 (Thursday: 25 July, 10h00) Messrs. A van Breda, J Jacobs, A Snell and B Isaacs met, discussed and finalised the topics to be presented at the Winter School. The Winter School Programme crystalised from this workshop. The underlying objective of each session and that of the Winter School in general, would be that mathematics and physical science are enjoyable activities.
Workshop 2 (Wednesday: 1st July, 10h00) : Mr Jacobs and van Breda interviewed and prepared the tutors / assistants for the topics they intended presenting at the winter school. This workshop lasted three hours.

Typist / Cashier: Ms B Isaacs

Photographer: Mr R Polman

Finances

Receipts		Payments	
B.P Sponsorship:	R18 900	Deposits (UWC)	: R18 900.00
		Cheques	: R 240.00
Registration fees:		Course Material	: R 200.00
Cash	R545.00	Refreshments	: R 600.00
Cheques	R240.00	Cleaning	: R 150.00
		Traveling	: R 40.00
		Presenters	: R 1 600.00
		Tutors	: R 1 900.00
Total	R 19 685.00		R 23 630.00

Remarks

The B.P. Sponsorship cheque (R 18 900.00) plus registration fees paid in the form of cheques (W.E Mc Pherson and Florida Sec. School) were paid in at finances.

Registration fees received in cash (R 545.00) plus petty cash of R300.00 were used to pay for refreshments, cleaning and traveling. (R 790.00)

The co-ordinator initially paid for the course material (R200.00) which he later claimed from finances.

The presenters were reimbursed at a rate of R30 (after tax deductions) per hour and the tutors assistants at R12 (after tax deductions) per hour.

An amount of R120.00 is still owing to the photographer, Mr R. Polman. A claim will be submitted as soon as his account is received.

APPENDIX C

FDE (ACE) 2000

- **Course Outline for Mathematics for Teaching I and II**
- **Example of a Question paper for one of the Modules**

Extract of the Application to introduce a Further Diploma in Education: Mathematics
Dated 20 November 1995

7.1 OUTLINE OF CURRICULUM CONTENT OF MATHEMATICS FOR TEACHING I

7.1.1 COLLEGE ALGEBRA AND TRIGONOMETRY

Unit 1: Algebra
Unit 2: Limits of Functions
Unit 3: Trigonometry

7.1.2 DIFFERENTIAL CALCULUS

Unit 1: Rate of Change
Unit 2: Derivatives
Unit 3: Applications of Derivatives

7.1.3 INTEGRAL CALCULUS

Unit 1: The Indefinite Integral
Unit 2: The Definitive Integral
Unit 3: Applications of the Definitive Integral
Unit 4: Transcendental Functions
Unit 5: Techniques of Integration

7.1.4 VECTORS AND GEOMETRY

Unit 1: Elements of vector algebra
Unit 2: Geometry
Unit 3: Analytical geometry / Quadratics

7.2 OUTLINE OF CURRICULUM CONTENT OF MATHEMATICS FOR TEACHING II

7.2.1 LINEAR ALGEBRA

Unit 1: Propositions
Unit 2: Relations and Functions
Unit 3: Linear Algebra

7.2.2 FURTHER CALCULUS

Unit 1: Functions of Several Variables
Unit 2: Curves and Surfaces
Unit 3: Double and Triple Integrals
Unit 4: Series

UNIVERSITY OF THE WESTERN CAPE
UNIVERSITEIT VAN WES – KAAPLAND

JUNE EXAMINATIONS 2000
FUTHER DIPLOMA OF EDUCATION : MATHEMATICS

MATHEMATICS FOR TEACHING 1

TIME : 2 HOURS TOTAL MARKS : 100

1. Answer 5 question out of each section.
2. Ensure that you read the questions thoroughly and that you answer the questions clearly.

SECTION A
(A minimum of 5 questions must be answered in this section)

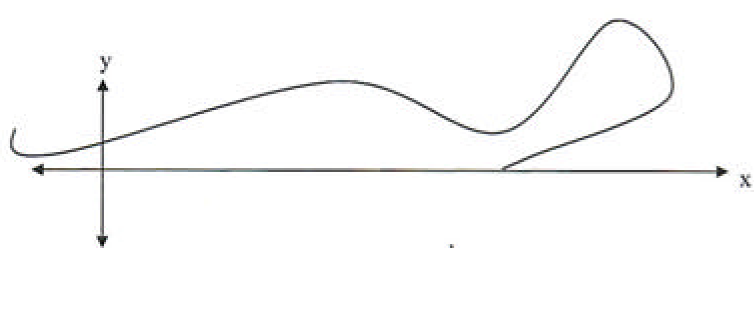
1. (a) Decide whether each of the following descriptions is that of a function. Give a reason for your answer.

(i)

X	1	0	1	2
Y	-3	2	6	4

(ii) $A = Br^2$ Where A is the area of circle and r is the radius

(iii)



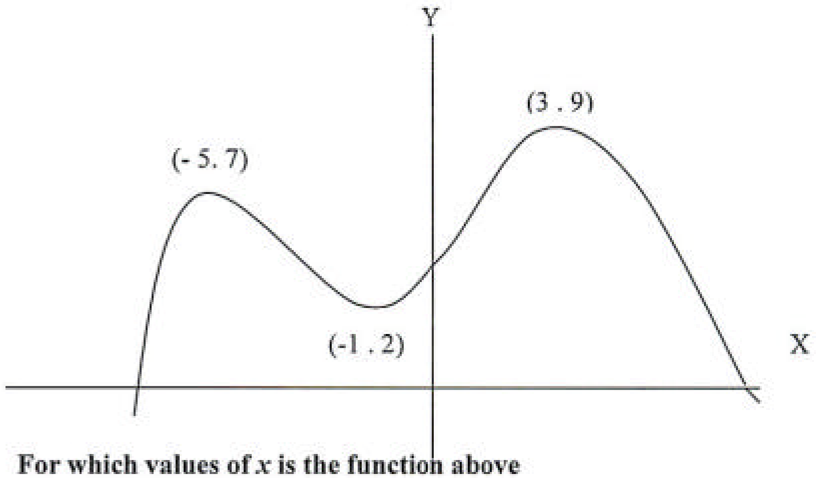
(5)

(b) Having left home in a hurry, you'd only gone a short distance when you realized you hadn't turned off the oven, and so you went back to do so again. You set out again, slowly at first, then increasing your speed after you made up your mind that your house would still be in one piece when you got home.

Sketch a graph of your distance from home as a function of time.

(5)
[10]

2.



For which values of *x* is the function above

(a) positive:

(b) negative:

(c) increasing:

(d) decreasing:

(e) concave up:

(f) concave down

(g) at a local maximum

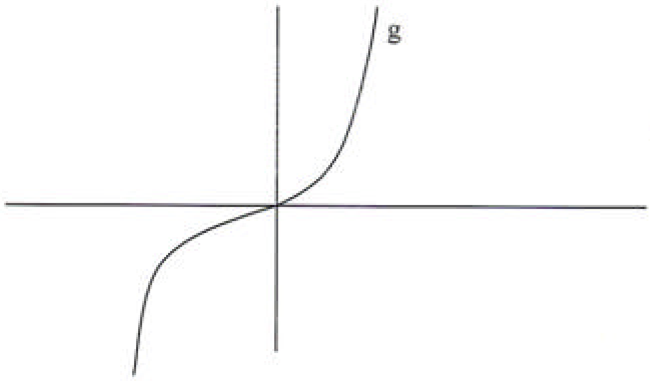
(h) at a local minimum

(I) at a absolute maximum

(j) at a absolute minimum

(1 x 10)
[10]

3. **Match each equation with its graph. Give a reason for your choice in each case.**



(a) $y = x^5$ (b) $y = 2^{-x}$ (c) $y = \sin x - 1$

(d) $y = x^8$ (e) $y = \log_8 x$

(2 x 5)

[10]

4. Given $f(x) = \dfrac{1}{x-1}$ and $g(x) = \sqrt{x}$

(a) Write down the domain of $f(x)$ and $g(x)$.

(b) Is $f(x)$ even or odd.

(c) Write down the domain of (i) $f(x) + g(x)$

(ii) $\dfrac{f(x)}{g(x)}$

(d) Find the function (i) $f \circ g$

(ii) $g(f(x))$

(e) What can you deduce from d (i) and d (ii) (2 x 5)

[10]

5. Questions (i) to (v) are multiple choice questions with one correct answer. Just write down the correct answer.

(i) **The function** $f(x) = \left[\frac{1}{4}\right]^{x}$

(a) is an increasing function of x.
(b) is only defined for x > 0.
(c) Can never be negative.
(d) Has a minimum at x = 0.

(ii) If $f(x) = e^{x}$, which of the following lines is an asymptote to the graph of f
(a) y = 0
(b) x = 0
(c) y = x
(d) y = -x

(iii) **Which of the following is true about** $f(x) = ln(x)$

(a) Its graph is concave up and lim ln $(x) = +\infty$

(b) Its graph is increasing and the y – intercept is 1
(c) If x > 1, it takes positive values.
(d) Its graph is decreasing

(iv) Solve for x **in** $(e^{x} + 1)(e^{x} - 4) = 0$.
(a) x = ln(-1) and x = ln(4)
(b) x = ln (4)
(c) x = ln (-1)
(d) No solution

(v) The domain of the function $f(x) = x^2 \, In(4 - x^2)$ **is a**
(a) x , R
(b) (- ∞ ,2)
(c) (- ∞ ,2) and (-2, + ∞)
(d) (-2 ,2)

(2 x 5)
[10]

6. **The graph of f is given. Answer the following questions**

(a) Find each limit, or explain why it does not exist.

(i) $\lim_{x \to 2^+} f(x)$

(ii) $\lim_{x \to 3^+} f(x)$

(iii) $\lim_{x \to 3^-} f(x)$

(iv) $\lim_{x \to 4} f(x)$

(v) $\lim_{x \to 0} f(x)$

(b) State the equations of the horizontal asymptotes.
(c) State the equations of the vertical asymptotes
(d)At what numbers is *f* discontinous.

(2 x 5)
[10]

SECTION B

(A minimum of five questions must be answered in this section)

1 (a) On the graph provided mark:

(i) $f(4)$. (1)

(ii) $f(4+h)$ (1)

(iii) $f(4+h) - f(4)$ (1)

(iv) h *for* $h > 0$ (1)

(v) Use (i) to (iv) above to show the line with slope: $\dfrac{f(4+h) - f(4)}{h}$ (1)

1 (b) Use FIRST PRINCIPLES to find the derivative of f

if $f(x) = \sqrt{x}$. What is the domain of this derivative?

(5)

[10]

2 (a) The graph of g is shown. State with reasons, the numbers at which g is **not** differentiable.

(6)

2 (b) The graph of the derivative f^{1} (not f) is given below:

(i) On what intervals of x is *f* increasing ? (1)

(ii) On what intervals of x is *f* decreasing ? (1)

(iii) At what values of x does *f* have a local maximum ? (1)

(iv) At what values of x does *f* have a local minimum ? (1)

[10]

2. Complete the following:

(a) $d / dx \ (cx^{k}) = \ldots\ldots\ldots\ldots$ (*c* is a constant) (1)

(b) $d / dx \ (Be^{x}) = \ldots\ldots\ldots\ldots \ (B = 22 / 7)$ (1)

(c) $\dfrac{d}{dx}\left[\dfrac{f(x)}{g(x)}\right] = \dfrac{\ldots\ldots\ldots\ldots - \ldots\ldots\ldots\ldots}{(g(x))^2}$ (2)

(d) If $d / dx \ (\sin x) = \cos x$ and $d / dx \ (\cos x) = -\sin x$ then :

$d / dx \ (\tan x) = \dfrac{\ldots\ldots\ldots + \ldots\ldots\ldots}{\ldots\ldots\ldots\ldots} = \ldots\ldots\ldots\ldots\ldots\ldots$ (4)

(e) Given that $d / dx \ (a^{x}) = a^{x} \ln a$
then : $d / dx \ (e^{x}) = \ldots\ldots\ldots\ldots\ldots$ (2)

[10]

4. Differentiate the following functions:

(a) $f(x) = x^2 + 2/x^2$ (3)

(b) $g(x) = (x + 2)^8 . (x + 3)^6$ (3)

(c) $h(x) = \frac{x + 2}{x - 1}$ (4)

[10]

5. Consider the function $f(x) = x^4 - 6x^2$

(a) (i) Find out for which values of x f is increasing and decreasing.
(ii) Find all local maximum and minimum values of f.
(iii) Find the values of for which f is concave up and concave down.
(iv) Find all inflection points. (6)

(b) Using the information in (a) above with other relevant information, sketch the graph of f. (4)

[10]

6 (a) (i) Sketch the graph of the function: $f(x) = e^x$ (1)

(ii) Using the sketch in (i), sketch $f^{-1}(x)$ (1)

(iii) Using the sketch in (ii), draw a rough graph of $g(x) = \ln(x - 1) - 1$. (3)

(c) Find simpler expressions for

(i) $\ln e$ (1)

(ii) $e^{3 \ln 2}$ (1)

(d) Differentiate: $\ln(e^x)$ (3)

[10]

7. A farmer has 24 000m of fencing and wants to fence of a rectangular field that borders a straight river. He needs no fence along the river what are the dimensions of the field that has the largest area.

[10]

APPENDIX D

CERTIFICATE AWARD CEREMONY

- Schools/ Learners who received certificates
- Format of Certificate Awarded to learners

CERTIFICATE OF EXECELLENCE AWARD CEREMONY

Thursday 27 September 2001

HOST SCHOOL: DIAZVILLE HIGH SCHOOL

BIOLOGY

HIGHER GRADE:	CARIN ASTON	(Diazville High)
	ASHWILL SMITH	(Weston High)
	MELANIE CROZIER	(Robinvale High)
	CHARLENE LIEDEMAN	(Saxonsea High)
	JACQUES TREADWAY	(Atlantis High)
	....	(Proteus High)
	GIDEON KOCK	(Wesbank High)
	MERWEDE LIEDEMAN	(Schoonspruit)
STANDARD GRADE:	LINDSAY FARAO	(Diazville)
	MIQUETTE DODDS	(Weston)
	JANICE DAVIDS	(Robinvale)
	ASHLEY KRUYWAGEN	(Saxonsea)
	RAMON FESTER	(Atlantis)
	....	(Proteus)
	BRADLEY ARENDSE	(Wesbank)
	SALOME MENTOOR	(Schoonspruit)

MATHEMATICS

HIGHER GRADE:	CARIN ASTON	(Diazville)
	ASHWILL SMITH	(Weston)
	CHARLTON PETERSEN	(Robinvale)
	ASHLEY KRUYWAGEN	(Saxonsea)
	FERNANDO NIEUWVELDT	(Atlantis)
	....	(Proteus)
	HELEZEEN ARENDSE	(Wesbank)
	ANNEEN BASSON	(Schoonspruit)
STANDARD GRADE:	CHESTER ACHILLES	(Diazville)
	RONEL PAPIER	(Weston)
	BERNADINE SOLOMONS	(Robinvale)
	CHARLENE LIEDEMAN	(Saxonsea)
	ILHAAM BOOLEY	(Atlantis)
	....	(Proteus)
	ANESTRA ARENDSE	(Wesbank)
	ROWAN SMITH	(Schoonspruit)

PHYSICAL SCIENCE HIGHER GRADE:	CARIN ASTON	(Diazville)
	ASHWILL SMITH	(Weston)
	DONAUVIN BEZIEK	(Robinvale)
	ASHLEY KRUYWAGEN	(Saxonsea)
	JACQUES TREADWAY	(Atlantis)
	....	(Proteus)
	NICHOLAS MARAIS	(Wesbank)
	ANJA VAN DER MERWE	(Schoonspruit)
STANDARD GRADE:	LINDSAY FARAO	(Diazville)
	GAYLEN CORAIZEN	(Weston)
	ELMARENCIA BENAS	(Robinvale)
	CHARLENE LIEDEMAN	(Saxonsea)
	PERCEWELL LEWIS	(Atlantis)
	....	(Proteus)
	MAURESHIA APRIL	(Wesbank)
	BERENICE KRIEL	(Schoonspruit)

UNIVERSITY of the
WESTERN CAPE

Certificate of Excellence

awarded to

GRANT VAN DIEMAN

[PROTEUS HIGH]

in

MATHEMATICS STANDARD GRADE

The Outreach Project with the Science Faculty
of the University of the Western Cape
has taken cognisance of your exceptional performance in
Grade 11 and presently Grade 12 Mathematics Standard Grade

You are congratulated on your excellent achievement and we strongly encourage you to pursue a career in this area of knowledge after completing your secondary schooling.

Date issued
27 September 2001

Professor Jan van Bever Donker
Dean: Faculty of Natural Sciences

A place of quality, A place to grow

UNIVERSITY *of the*
WESTERN CAPE

Certificate of Excellence

awarded to

JEREMY SOMERS

[STEYNVILLE HIGH]

in

PHYSICAL SCIENCE HIGHER GRADE

The Outreach Project with the Science Faculty
of the University of the Western Cape
has taken cognisance of your exceptional performance in
Grade 11 and presently Grade 12 Physical Science Higher Grade

You are congratulated on your excellent achievement and we strongly encourage you to pursue a career in this area of knowledge after completing your secondary schooling.

Date issued
27 September 2001

Professor Jan van Bever Donker
Dean: Faculty of Natural Sciences

A place of quality, A place to grow

APPENDIX E AND F

E: A summary of Articles in the JCMST 1989-2003

F: CALEPQ- M: E1: The Impact on the role of the Teacher

E 2: The Impact on Student Motivation

E 3: The Impact on Student Learning

APPENDIX E

List of Research Articles Listed in the Journal of Computers in Mathematics and Science Teaching relevant to the use of technology in maths education

Vol	Author/s	Math Topic/ Level	Target Group	Software	Results/Conclusions
9(1) 1989	M Burke	Geometry/ Fractals	teachers	Logo	Prepares students for ideas like ‘asymptotes’
9(1) 1989	M Ediger	Math Curriculum	General Mathematics Audience		Schools should incorporate computers in math lessons
9(1) 89/90	JE Owens	Classroom Technology Course	Preservice Secondary Teachers	MathCad, Geometric Supposer	The course was introduced to prepare teachers in computer-use in secondary maths
9(2) 89/90	PLounesto et al	Complex No Vectors etc	Tertiary Students	CLICAL	Both suitable for graduate and undergraduate courses
9(3) 1990	PT Judson	Calculus 1	Tertiary Students	CAS	Students are freed from routine tasks and do conceptual tasks
9(4) 1990	Jl Flake	General	Preservice Secondary Teachers		Integration of computers into math teaching with attitude and belief shift
9(4) 1990	R Nachmias & AArcavi	Alternate way to do linear functions	All	PAR	Students relieved of graphing & calculations Able to explore higher level maths issues
10(1) 1990 **(A)**	RMcGivney	Finite Math	Tertiary Students	Software developed by Kemeny & Kurtz	Successful1 completion of a 14 wk compulsory unpopular course
10(2) 90/91	WJ Egnatoff	Fractals	Secondary Teachers	Various	Suggested to be used by teachers for advanced student projects
10(2) 90/91	Tirosh & Tirosh et al	Division with divisor greater	Preservice Elementary	Tutoring Computer	Increased awareness to divide

(A)		than dividend	Teachers	Program	by smaller number. Improvement in doing word sums
10(2) 90/91 10(3) 1991 **(A)**	JH Mathews LP McCoy	2^{nd} order Diff Equations Geometry	All High Ability School students	CAS in MACSYMA, muMATH Geometric Supposer	Tedious computations is minimised The experimental group scored better in the application and higher level aspects of final examination
10(4) 1991	HJ Becker	General	All		Twice as many math & science teachers used computers in 1989 than in 1985
10(4) 1991	PT Judson	Calculus I	Tertiary Students	Maple	The Computer Lab was a great success for student learning and interaction
11 1992 11 1992 **(A)**	JR Morris RTilidetzke	School Algebra & Geometry College Algebra	Prospective Teachers College students	Geometric Supposer, True Basic & Derive Addison-Wesley	Written computer experiments were made available for preservice teachers No significant difference in mean scores was found between the control and experimental groups
11 1992	HB Thompson				
11 1992	H Schuman	Geometry	High school Audience	CABRI-Geometre	New possibilities for learning geometry e.g. (241)
11(3/4) 1992	EAKaljumagi	General	Teachers	AniST, Mathematica	Computer animation can become a practical & powerful aid
12(10) 1993	EK Schoaff	Algebra Geometry	Teachers & students	Spreadsheet Graphing & geometry program	A general step by step procedure is described using computers & graphic calculators
12(3/4) 1993	SAbramovich & I Levin	Combinatorics	High school Audience	Microsoft Excel 3	Students are introduced to the art of counting without counting with visual imagery

1994	M Alkalay	Functions: shifting, stretching etc; Inverses; polynomials	Teachers	Software developed by Kemeny & Kurtz	There were no change in attitudes in students to math & computers when computers are used for independent exploration
13(3) 1994 **(A)**	MR Wilson & CM Krapel	Graphs of functions	Teachers	T1-82* Graphics Calculator	Other areas of research e.g. 'the qualitative aspects of knowledge construction of students using GC'
13(3) 1994	P Horwitz & W Feurzeig	mappings	High school audience	Multimap	With minimal guidance such phenomena as limit cycles, eigenvectos, bifurcations etc can be discovered
13(4) 1994	WASzymanski	Geometry	High school students	Mathematica,	The use of symbolic computerised packages is advocated as an aid in teaching geometry
14(1/2) 1995	DPShepardson	General	General Mathematics Audience		The need to integrate ICT in math (& science) teaching had become imperative
14(1/2) 1995	R Day	General	General Mathematics Audience		Maths educators are shown to connect to resources in mat education
14(3) 1995	S Dugdale et al	Algebra	General Mathematics Audience	Computer & Calculator software	Reform curricular goals are examined and the contribution of technology to reconceptualising algebra is considered
5940	S Abramovich	Advanced topics in discrete Math	Students	Microsoft Excel 4	Students are shown how to be involved in comparing the results of modelling integers with different combinatorics
14(4) 1995	MJ Fleener	Teacher attitudes about	Teachers	CASIO 700 Graphic**	Teachers who believed that

(A) CG1		calculators		Calculator	conceptual mastery was essential and those who did not before GC should be introduced, differed on many items
15(3) 1996	RB Clariana	Fifth Grade Mathematics ILS instruction	Fifth Grade learners	Jostens Learning Corporation mathematical products	The cohorts that received the Integrated Learning System(ILS) obtained modest positive gains on standardised tests
15(3) 1996	HGK Hummel & H Smit	Distance Computer practical for Fourier transformations	Tertiary students	Computer program developed by OU of Netherlands	The course is partially computer delivered in which 'realistic maths' is emphasised
15(3) 1996	D Vidakovic	Inverse Functions	Tertiary students	ISETL based software	On the basis of the genetic decomposition for the concept of inverse function an instrument was developed
15(4) 1996	S Abramovich & G Brown	Problem solving (open ended)	Preservice Teachers	'Software triple': spreadsheet, grapher & dynamic geometry	It is indicated in a technologically rich environment, a given problem serves as a stimulus for mathematical exploration
15(4) 1996	KB Smith	Linear programming	Preservice Teachers	Derive	The use of guided exploration and conjecturing activities allowed students to discover mathematical principles and solve problems
15(4) 1996 **(A)**	JA Rochowicz	Calculus	Tertiary Instructors		The use of computers & calculators is having an impact upon many facets of the course
16(4) 1997 **(A)**	M Tharp et al	Miscellaneous	261 math & science teachers	Graphing** Calculators	Overall , participants views changed

CG2					significantly in favour of viewing the CG as a thinking tool
16(4) 1997	M Eisenberg & A Nishioka	Geometry (Polyhedral models)	Middle School students	Hypergami	The software is designed to design, explore, decorate and study a variety of 'paper' polyhedral models
(A) CG3	LA Simonsen & TP Dick	Miscellaneous	High school students	HP-48s** Graphing Calculators	Teacher perceptions of the advantages of GC uses were instructionally related.
16(2/3) 1997 **CG4**	E Simmt	Quadratic Functions	Six Senior High School Teachers	Graphing** Calculators	Computers are not readily available in most classrooms. GC's - inexpensive and portable. Each teacher acted in the context of his/her philosophies of math & math ed
16(1) 1997	R Zazkis & C Gunn	Set theory	Elementary School teachers	ISETL based software	A constructivist view yielded complexities in understanding.
16(1) 1997	N Zehavi	Algebra Remediation	Junior High school Students	Derive	Using partly solved examples and replication of tasks enabled students improve. The also understood how one part of an algebraic expression related to the whole
16(4) 1997 **CG5**	ML Tharp et al	General	Grade 6-12 Math &Science Teachers	Graphing* Calculators	Participant's views changed significantly. GCs enhanced conceptual thinking
17(2/3) 1998	B Hudson	miscellaneous	13-14 yr olds	World Of Numbers multimedia package	Groups of 14 year olds consistently, unsupervised interacted with one another. The students seemed to see a purpose (meaning) in the

					activity itself.
17(2/3) 1998	V Parvate et al	10^{th} Standard syllabus	Senior High School Students	Mathemagic	A preliminary study with the software indicated effective remediation
17(2/3) 1998	S Gerber et al	8thGrade Math Project	8thGrade Students	Internet	Students saw the Internet as an encyclopaedia. They needed time to 'feel' the net. Their search strategy differed. The project Was not very successful in fostering a deeper appreciation for the use of mathematics
18(1) 1999	JS Robertson	General Math	General Mathematics Audience	The Web	The set of linked sites - the Web changes continually and that includes the teaching and doing of maths
18(1) 1999	AManoucherhri	Miscellaneous	Middle & High Schools	Use of Computers to enhance math reform	The data indicated that teachers used computers mainly for drill and practice
18(1) 1999 **CG6**	MMerriweather et al	Algebraic word problems	8^{th} Grade	T1-82 GC**	Rule-based students used an equation as opposed to non rule-based students who used a numeric to solve algebraic word problems
18(1) 1999 **(A)**	DL Roberts et al	Geometry	High school students	Geometry Inventer	The control group scored higher in both instances. Not all software may be beneficial in teaching certain topics in geometry
18(4) 1999	MC & JW Steele	Mathematical Word Problems	Students with learning difficulties	DISCOVER	The article reviews the literature on word problems instruction and describes the DISCOVER

19(1) 2000	S Abramovich	Number Theory	Pre service teachers	Spreadsheets	Concepts - > problems – > computational environment
19(2) 2000	J Moor & R Zazkis	General	Virtual classroom	www (web)	Virtual classroom on the web is relatively low. Knowledge of what influences students' learning in a virtual classroom is just beginning to emerge
19(3) 2000	R Allen & et al	Geometry	High School students & teachers	GEDRev Cabri	Analysis and solution of a nontrivial construction problem provides the setting for explaining the individual components and how they work together to construct dynamic figures.
20(1) 2001	R Monson K Judd	Calculus	High school & Tertiary student	Web-based Calmaeth	Systems diagnostics in calculus is given. This virtual tuition is replacing mechanical aspects of traditional teaching
20(2) 2001 **(A)**	R Pierce & K Stacey	First year math	Tertiary Students	CAS	Student attitudes to the use of CAS are positive and appreciated it for exam purposes. Changed pedagogical use of CAS had no change in achievement
20(3) 2001	S Dugdale	Functions	General Math Audience	Spreadsheets	A familiar model was expanded into apparent chaos. Spreadsheets provided the tools to solve the new problem

21(3) 2002	MR Khadivi	General	General Math Audience	Mathematica (version 4)	Effects of technology to construct solutions to Type II problems are surveyed
22(1) 2003	YCook	School mathematics	School students	Linear Kid	The computer plays the role of student & coach. The software was tested at 2 US schools
22(2) 2003	C Crawford E Brown	Mathematical Manipulatives	Mathematics Educators	www (web)	Educators can utilise digital manipulatives, which are similar to manufactured ones.
22(3) 2003 **CG7**	SM Gningue	Graduate Math Course	Middle & high school teachers	T183 PLUS GC,* Geometers Sketchpad	Professional development in computing technologies can be effective in changing teachers' attitudes and beliefs
22(4) 2003	M Alagic	Miscellaneous	General Math Audience	ICT based environment	

THE OUTREACH PROJECT OF SSME OF UWC

THE COMPUTER-ASSISTED LEARNING EDUCATOR PERCEPTION

QUESTIONNAIRE- MATHEMATICS (CALEPQ-M)

The enclosed questionnaire consists of three sections E1, E2 and E3, and appraises the perceptions of **<u>Mathematics Educators</u>** on the impact of using computers on the **role of the educator, on student motivation** and **on student learning** respectively**.**

YOU ARE KINDLY INVITED TO PARTICIPATE IN THIS SURVEY.

Carefully read each item in each of the three sections of the questionnaire and register your response by circling <u>only one</u> of the numbers 1, 2, 3, 4 and 5. *For example if you circle 4 of item 1 of section E1, you agree with the statement.*

	SD	D	U	A	SA
1) The use of computers in the mathematics classroom does not replace the educator	**1**	**2**	**3**	**4**	**5**

You are also requested to supply the information in the table below

Where is your school located?	
To which grades do you teach maths?	
Are you computer literate?	
Do you use computers in your teaching?	
How long have you been teaching maths?	
What qualifications do you have in maths	
How old are you?	
What is your gender?	

THANK YOU VERY MUCH FOR PARTICIPATING IN THIS SURVEY

MR A SNELL WILL COLLECT ALL COMPLETED QUESTIONAIRES

AFTER 7 DAYS

THE CALEPQ-M

E1 THE IMPACT ON THE ROLE OF THE TEACHER

Please indicate your **perception** of the degree of the impact of using Computers in mathematics lessons **on the role of the educator** by circling SD-strongly disagree, D-disagree, U-uncertain, A-agree, or SA-strongly agree.

	SD	D	U	A	SA
1) The use of computers in the mathematics classroom does not replace the educator	**1**	**2**	**3**	**4**	**5**
2) The use of computers in mathematics instruction requires significantly more time from the educator.	**1**	**2**	**3**	**4**	**5**
3) The use of computers in mathematics instruction requires more creative teaching on the part of the educator	**1**	**2**	**3**	**4**	**5**
4) The use of computers in mathematics instruction requires reflection on meaningful ways in which mathematics can be taught	**1**	**2**	**3**	**4**	**5**
5) The role of teacher changes to that of a tutor	**1**	**2**	**3**	**4**	**5**
6) The role of the educator changes to that of a facilitator	**1**	**2**	**3**	**4**	**5**
7) The role of the educator changes to that of a co-learner	**1**	**2**	**3**	**4**	**5**
8) The role of the educator changes to that of a manager of student self-directed learning	**1**	**2**	**3**	**4**	**5**
9) The educator /learner relationship becomes more personal	**1**	**2**	**3**	**4**	**5**
10) Assessment of student learning becomes more difficult	**1**	**2**	**3**	**4**	**5**

E2 THE IMPACT ON STUDENT MOTIVATION

Please indicate your perception of the degree of the impact of using computers in mathematics lessons on **student motivation** by circling SD-strongly disagree, D-disagree, U-uncertain, A-agree, or SA-strongly agree.

AS A RESULT OF USING COMPUTERS

	SD	D	U	A	SA
1) Student motivation improves	**1**	**2**	**3**	**4**	**5**
2) Better attitudes towards the learning of mathematics develop	**1**	**2**	**3**	**4**	**5**
3) Students self-confidence increases	**1**	**2**	**3**	**4**	**5**
4) Students are challenged to do their best	**1**	**2**	**3**	**4**	**5**
5) Mathematics becomes more relevant to the student	**1**	**2**	**3**	**4**	**5**
6) Students enjoy doing mathematics	**1**	**2**	**3**	**4**	**5**
7) Students are more persistent in attaining solutions to problems	**1**	**2**	**3**	**4**	**5**
8) Mathematics anxiety decreases	**1**	**2**	**3**	**4**	**5**

E 3 THE IMPACT ON STUDENT LEARNING

Please indicate your perception of the degree of the impact of using computers in mathematics lessons on **student learning** by circling SD-strongly disagree, D-disagree, U-uncertain, A-agree, or SA-strongly agree.

AS A RESULT OF USING COMPUTERS

	SD	D	U	A	SA
1) Learning improves	**1**	**2**	**3**	**4**	**5**
2) Cognitive awareness increases	**1**	**2**	**3**	**4**	**5**
3) Reasonableness of output becomes important	**1**	**2**	**3**	**4**	**5**
4) Learning takes place in less time	**1**	**2**	**3**	**4**	**5**
5) Flexibility in thinking increases	**1**	**2**	**3**	**4**	**5**
6) Interpretation of results from problems is necessary	**1**	**2**	**3**	**4**	**5**
7) More active learning takes place	**1**	**2**	**3**	**4**	**5**
8) Learning is individualised	**1**	**2**	**3**	**4**	**5**
9) Students can apply their learning in the absence of computers	**1**	**2**	**3**	**4**	**5**
10) Visualization enhancing the learning of mathematics	**1**	**2**	**3**	**4**	**5**

APPENDIX G

Proposals for Funding

- Herman Ohlthaver Trust: MICSEC 4
- First Rand: MICSEC 5
- Energy Africa: Teacher Development Centre

HERMANN OHLTHAVER TRUST APPLICATION FORM

All the information required on this form will be used in the process of making decisions about the allocation of funds:

SECTION ONE: ORGANISATION DETAILS	
Name of Organisation	OUTREACH PROJECT (UNIVERSITY OF WESTERN CAPE)
Postal Adddress: Outreach Project Goldfields Resource Centre University of the Western Cape Private Bag X17 BELLVILLE 7535	**Physical Address:** Goldfields Resource Centre University of the Western Cape Modderdam Road BELLVILLE
Tel.: (021) 959 2680 (021) 959 2681	**Fax:** (021) 951 2602 **E-mail address:** asnell@cse1.uwc.ac.za
Bank Details: Standard Bank of S. A. **Bank Code:** 03-1210-40	**Type of account:** Trust a/c, 071966900 **Account No.:** Entity 335915
Contact Person: Brian E L Isaacs	**When was the organisation established:** 1982
Members of the Board of the Organisation:	**Brief description of the Project in this application:** Project Y2K is an intensive computer assisted educational programme of the Outreach Project offered to grade 11 and 12 mathematics and science teachers and learners. The programme is designed in conjunction with the Science and Education Faculties of the University of the Western Cape. It is proposed to present the programme in waves of 12 weeks each throughout 1999.

Briefly describe the organisation's history

The Outreach Project was started in July 1982 at UWC. Originally the Project was to have a life expectancy of only 4 years but its success coupled with community pressure ensured its continued existence. During this 16 year time span, computer assisted education for specifically mathematics and science education was refined. Project Y2K has combined the experience and expertise during 1998 to focus on community outcomes and has established two fully autonomous and self -sustaining computer based educational units, known as MICSECs (Mini Computer Supported Educational Centres), on the Cape Flats.

What is the organisation's vision, mission and focus?

Vision: To increase the number of technicians, scientists and engineers in order to successfully complete With the global community.

Mission: In line with the Mission statement of UWC this project is committed to excellence in teaching, learning and research and responding in critical and creative ways to the needs of a society in transition.

Focus: To make the best technology available so the teachers and learners of mathematics and science can be equipped to succeed at these subjects at tertiary level.

SECTION TWO: PROJECT DETAILS

2.1 What is the overall Objective of the Project?

Project Y2K aims by the year 2000 to have established 10 fully functional, self sustaining MiCSECs that will serve 50 secondary schools in the Western Cape. This will create the opportunity for 2000 grade 12 learners to profit from at least two hours' exposure to computer assisted education on a daily basis.

2.2 Who are the beneficiaries of the project?

Grade 11 and 12 mathematics and science teachers and learners at historically disadvantaged schools in the Western Cape.

2.3 What specific outcomes doe the project aim to achieve and by when?

	Outcomes	Deadline
1	Training of 20 teachers in computer assisted education and technology (First wave)	14-02-99
2	Procure, deliver, install and operate MICSEC 3 to serve 5 schools (200 learners) in Belhar.	31-03-99
3	Preliminary evaluation of MICSEC 3 effectiveness	30-04-99
4	Training of 20 teachers in computer assisted education and technology (Second wave)	30-05-99
5	Procure, deliver, install and operate MICSEC 4 to serve 5 schools (200 learners) in Khayelitsha.	30-06-99
6	Preliminary evaluation of MIC SEC 4 effectiveness.	30-07-99
7	Training of 20 teachers in computer assisted education and technology (Third wave)	30-08-99
8	Procure, deliver, install and operate MICSEC 5 to serve 5 schools (200 learners) in Macasser/Strand	30-09-99

9	Preliminary evaluation of MICSEC 5 effectiveness	30-10-99
10	Final evaluation of MICSEC programme for 1999	31-12-99

2.4 Describe the project:

Project Y2K is one of a number of projects planned for execution by OUTREACH in 1999. It will focus primarily on teachers and learners of grade 12 mathematics and science – in schools situated in traditionally disadvantaged communities – the objective of the project is to provide a support programme through computer assisted education. For 1999 Project Y2K will consist of three intensive training programme enumerated as items 1,4 and 7 of paragraph 2.3 above.

Apart from enabling teachers to become proficient in the optimal use of computer assisted mathematics and science educational lessons, the training aims to raise teacher confidence levels in dealing with technologically advanced teacher aids such as computer hardware, operating systems and software. This should have additional spin-offs in terms of daily lesson preparation in the classroom.

Once teachers are trained in the appropriate techniques, a MICSEC will establish to serve a ccluster of five schools.

2.5 How will the project be implemented and by whom?

The Y2K The project will be implemented by the coordinator and staff of the OUTREACH PROJECT

Phase 1. (4 weeks) Conducted in the On Campus Computer Supported Educational Centre (OCCSEC) Teacher and learners will attend a prescribed cycle of lectures, workshops and practicals.
Phase 2. (4 - 6 weeks)This phase of the programme will be conducted off campus: The mobile computer unit now called the Mobile Computer Supported Educational Centre (MOCSEC) will be stationed at one of the five schools. Learners and teachers of the five schools will have an opportunity to use the MOCSEC on a weekly roster basis. This part of the programme will be monitored and controlled by an off campus facilitator who will make weekly reports to the co ordinator of the Outreach Project.
Phase 3. (2 weeks) It is hoped to establish a Mini Com puter Supported Educational Centre (MICSEC) at one of the five schools. When such a centre is established and becomes operative it will function in the same way as the OCCSEC and MOCSEC. At this stage the final objective of the programme will be realised and Project Y2K will be initiated at another five cluster of secondary schools.

2.6 How will the outcomes of the project be evaluated?		
Phase of Programme	**Outcome/s**	**Evaluators**
One (OCCSEC activities)	The degree to which teachers and learners have acquired an understanding and mastery of the technology operative in OCCSEC	Co ordinator Specialist of the education and science faculties of UWC
Two (MOCSEC activities)	The outcomes of this phase will be determined by the implementation of the outcomes realised successfully at OCCSEC	Off Campus facilitator, Principals of Schools and Educational Subject advisor
Three (MICSEC activities)	A particular outcome of MICSEC will be the creation of a specialised area of educational research	Research teams favoured by the director and UNESCO chair holder of South Africa, Dean of the Faculty of Education

2.7 What are the key success indicators of the success of the project?

Short term success indicators: This is generally the measure of the performance of learners in the matric exams and more important the number qualifying for math / science orientated programmes at tertiary institutions.

Long term success indicators: The total success of the project is however indicated by the sum of the successes at the end of each phase of the programme and can be determined as follows:

Phase1: During this phase both teachers and learners are placed in a structured environment. The degree to which they acquire the necessary skills and the manner in which they integrate these with the subject matter as well as the enthusiasm they manifest to move to the next phase will be a key indication of the success of this phase.

Phase 2: The environment of this phase is diffused and an indication of the success attained is the manner in which the leadership ability and the innovative potential of a individual has developed.

Phase 3:Community response and interest aroused to keep the MICSEC viable and sustainable is the most important indicator of success at this final stage.

2.8 What is the budget for the project?

Projected On Campus Expenditure	**77 150.00**
OCCSEC Expenditure	
Transport of learners	36 000.00
(1 bus per day for 12 weeks @ R600 per day)	
Computer Maintenance	25 000.00
(25 PC's & Server @ 1000 per annum)	
Software Procurement, Licence & Installation (CAMI)	6 400.00
Software maintenance	750.00
(25 PC's x R30 per annum)	
Vat and other indirect costs	9 000.00
Projected Off Campus Expenditure	
MOCSEC	**87 100.00**
Computer hardware replacement	60 000.00
(8 PC's, Cabling, Installation, etc.)	
Computer Maintenance	15 000.00
(15 PC's + Server @ R1000 p.a. each)	
Software Procurement & Installation (CAMI)	650.00
Software maintenance	450.00
(15 PC's x R30 per annum)	
Vat and other indirect costs	11 000.00
Estimated cost for one MICSEC	**144 578.20**
Cabling of School Lab	5848.20
1 Dedicated PC server	8450.00
MS NT server licence and client licence	4560.00
20 x PC's for client based server	126 600.00
Vat inclusive	
TOTAL	**308828.20**

REQUEST TO FUND A DEDICATED SERVER AND A NETWORK OF TWENTY COMPUTERS URGENTLY REQUIRED BY THE EERSTE RIVIER HIGH SCHOOL i.e. MICSEC 5

The Secondary Schools of the Blue Downs area (Silversands, Fountain Village, Malibu Village, Tuscany Glen, Kleinvlei, Forest Heights, Forest Glade, Meltonrose, Blackheath,The Conifers, Hillcrest , Rosedale ,Eerste River etc) was targeted this year by the Outreach Project as an area in urgent need of educational support and assistance. After discussions with the senior Science/ Maths teachers of the various High schools in the area it was determined that the Eerste Rivier High was the most suitable venue from which the educational support and remedial structures of the Outreach Project could be launched and developed.

The first phase in the initiation of a MICSEC in a particular area is implemented as follows. MOCSEC, the mobile unit is stationed at the decided venue. It becomes the hub of all envisaged Outreach activities. However, Blue Downs is generally a high risk area where vandalism and burglary is a common occurrence and past experience have shown that when MOCSEC is stationed in such areas it becomes the target of such activities.

A collective decision by the staff of Outreach, the Principal and Maths/ Science staff of Eerste Rivier resulted that the computer network of MOCSEC was transferred to a secure room at the Eerste Rivier High.

This temporary MICSEC has been serving the schools in the surrounding area since mid August of this year and all Outreach activities has been supervised by Mr. C Hanson, the Deputy Principal of the school.

MOCSEC needs to be moved to Vusisizwe High School in Worcester at the end of October 1999 to initiate MICSEC 7. The Eerste Rivier centre will then be in urgent need of a replacement computer network.

The total cost of this replacement network is R168 000 and includes the following:

Dedicated Server	8450.00
20 PC's	126 600.00
Cabling of laboratory	14 000.00
NT server licensing	4560.00
CAMI Educational Software	14 390.00
TOTAL	**168 000.00**

You are kindly requested to sponsor the cost of implementing this replacement computer network. If this sponsorship is provided by FNB, MICSEC 5 will be named: **THE FNB MINI COMPUTER CENTRE FOR SECONDARY SCHOOL MATHS AND SCIENCE EDUCATION.**

We look forward to your expeditious response.

....

Brian E L Isaacs
Outreach Coordinator

OUTREACH PROJECT

SCHOOL OF SCIENCE & MATHEMATICS EDUCATION

PROPOSAL FOR FUNDING: TEACHER / LEARNER DEVELOPMENT COURSES

1 INTRODUCTION

U W C was the first institution in the RSA to implement a successful computer supported educational programme ... a full year ahead of the Human Science Council recommendation. This endeavour crystalized in the OUTREACH PROJECT in Science and Mathematics education in 1982 with the primary objective of utilizing "... instructional technology to improve education (particularly grade 12 mathematics and physical science) at all levels."
It is only through consistent financial support of faithful sponsors/funders that the activities of the OUTREACH PROJECT has continued to successfully address the imbalances in Science and Mathematics Education producing excellent results for almost two decades. We are proud to once again report on the successes of the activities of the project during 1998.

OUTREACH SUCCESSES, 1998

2.1 ON CAMPUS ACTIVITIES

OCCSEC (On Campus Computer Supported Educational Centre)

The programmes conducted in this facility together with successes achieved are the following:

High School Programme

The following secondary schools utilised the science and math grade 12 computer assisted courses offered by OCCSEC. They are listed in descending order of the results obtained in the matric examination of the WCED.

Portlands:	**89.7%**	Cedar:	**84%**	Manzomthobo:	**74%**
Immaculata:	**89%**	Symphony:	**83%**	Maccassar:	**62%**
Zandvliet:	**85%**	Westridge:	**76%**	Harry Gwala:	**59%**

This yields a collective pass rate of 79.9 which is on par with the Western Cape Education Department's (WCED) pass rate of 79%

Computer Assisted First Year Mathematics (CAMFA)

Math 114/124 is a course unique to UWC and provided for first year students (with standard grade math) considered to be "at risk". During 1998 all students (74) enrolled for this course used the OCCSEC facility for practical, tutorial and revision session.**80%** of these students passed Math114 and **60%** Math 124 yielding a total result of **70%** for this first year Mathematics course.

Vacation High School Programme

About 150 hours were spent - during the July vacation, Saturday mornings in August and the September/ October vacations - to provide a special, intensive revision programme in Math and Science for + - 200 grade 12 learners. **Of these 95% successfully completed the WCED's matric examinations and 30% attained a full matriculation exemption. With seven obtaining A's in mathematics. This reflects a pass rate which is more than 10% above the WCED's pass rate and number of exemptions.**

2.2 Off - Campus Activities

MOCSEC (Mobile Computer- Supported Educational Centre)

The Mobile Computer Supported Educational Centre (MOCSEC) is an integral part of MICSEC2000 (a programme aimed at making computer supported education available to 2000 matric mathematics and science learners by 31 December 2000). Where a cluster of five schools has been identified on the basis of educational need, MOCSEC is stationed at the central school and the learners and teachers of the whole cluster are given the opportunity to use the facility on a weekly roster basis.

This Facility was stationed in the Paarl area for the greater part of 1998. The 1998 matric results of schools which used the facility are as following:

Klein Nederburg (99.1%), New Orleans (95%), and Noorder Paarl (74%).

The Total Result being 89% i.e. 10% above the WCED average.

Presently, MOCSEC is stationed at Stellenzicht High in Jamestown, It serves as central school to the following nearby schools: Cloetesville, Kayamandi, Lückhoff and Weber Gedenk. These schools serve children from essentially farming communities.

2.3

MICSEC (Mini Computer Supported Educational Centre)

The first MICSEC to have grown out of the MOCSEC experience was established at Manzomthobo High School at Mfuleni near Blackheath. This Pilot MICSEC contains a system of 15 computers with a server, together with a normal OCCSEC software. It forms the centre of a cluster of 5 schools in the Mfuleni area. A second MICSEC was established in August 1998 at Cedar High, Mitchells Plain and formed the centre to the following high school cluster: Lentegeur, Woodlands, Portlands and Westridge. These two facilities about 450 Gr 12 Science and Mathematics learners of the ten different schools that attained an average pass rate of more than 80%

MICSEC 2000 is an ambitious project which aims by the 20001 to have established 10 fully functional Mini Computer (Math / Physical Science) Educational Centres. It focuses primarily on teachers and learners of grade 12 mathematics and science – in schools situated in traditionally disadvantaged communities – the objective of the project is to provide a support programme through computer assisted education.
Apart from enabling teachers to become proficient in the optimal use of computer assisted mathematics and science education lessons, the training aims to raise teacher confidence levels in dealing with technological advanced teacher aids such as computer hardware, operating systems and software. This should have additional spin-offs in terms of daily lesson preparation and classroom activity.

Once teachers are trained in the appropriate techniques, a MICSEC is established to serve a cluster of 5 schools. 10 teachers and 20 grade 12 learners are selected from a five-school cluster. They then attend a four-week course of a prescribed cycle of lectures, workshops and practicals.

It is for this initial phase of the MICSEC 2000 project that funding is required.

The estimated cost for one Teacher / Learner Developmental Course is R36 000 and we intend to have three such courses during the year 2000 this will amount to R 108 000.00

You are kindly requested to fund one of these courses to the amount of R36 000.00

Yours sincerely

Brian E. L. Isaacs

OUTREACH PROJECT CO-ORDINATOR

Projected Budget 2000: MICSEC Teacher / Learner Coursework

1.	*Material used by teachers / learners*	
	Notes etc.: *30 x R150.00*	*R 4 500.00*
2.	*Transport*	
	Transporting teachers/ learners *R650.00 x 20*	*R13 000.00*
	Other transport (visitation to schools to liase *With principals, teachers, parents)*	*R 2 000.00*
3.	*Promotions*	
	Advertising	*R 800.00*
	Events (diploma ceremony)	*R 200.00*
	Refreshments	*R 2 000.00*
4.	*Computer usage*	*R 2 000.00*
5.	*Office Expenses (typing of notes, binding,* *Paper, etc.)*	*R 2 000.00*
6.	*Allowances fees*	
	Presenters @ R50 per hour	*R 6 000.00*
	Assistance @ R25 per hour	*R 2 000.00*
	Cleaners @ R10 per hour	*R 1 000.00*
7.	*Vat and Indirect Costs*	*R 500.00*

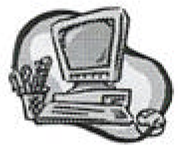
TOTAL COST OF TEACHER / LEARNER COURSEWORK ***R36 000.00***

APPENDIX H

A Programme for the Official Opening of MICSEC


First National Bank
How can we help you?
MATHEMATICS & SCIENCE
COMPUTER CENTRE
LAUNCH 5 DECEMBER 2001
MANZOMTHOBO
First National Bank
How can we help you?
MATHEMATICS & SCIENCE
COMPUTER CENTRE
LAUNCH 5 DECEMBER 2001
MICSEC 4
LANGA
MICSEC 7
VUSIZIZWE
MOCSEC
BLUE DOWNS GRADE 11
MATHS AWARD CEREMONY
MICSEC 5
OUTREACH PROJECT
MICSEC 9
THE MICSEC 2000 PROGRAMME
LENTEGEUR
MICSEC 6
sappi
MICSEC 8
HARRY GWALA
UNIVERSITY OF THE WESTERN CAPE
FACULTY OF EDUCATION
OUTREACH PROJECT

PROGRAMME



1. **WELCOME**
   Ms Jooste (Gov. Body)
   Mr J Odendal (Cirt. Man.)

2. **THE MICSEC PROGRAMME**
   Mr B Isaacs (UWC – Outreach)
   Mr C Hanson (Eersteriver High)

3. **SHORT ADRESS**
   Prof. H D Herman (UWC)

4. **SONG ITEM**

5. **CERTIFICATE AWARD CEREMONY**
   R Smith (Princ. Subj. Advisor)
   S Slingers (UWC – Science)

6. **MATHEMATICS DEPARTMENT UWC**
   Prof. R Fray (Chair)

7. **PROCESSION TO COMPUTER ROOM UNVEILING OF PLAQUE**

8. **THANKS**
   Principal – Mr T Esterhuizen

9. **FINGER LUNCH**

THE MICSEC 2000 PROGRAMME

OUTREACH off-campus activities presently centre primarily around two contingencies: the traditional Mobile Computer Supported Education Centre **(MOCSEC)** and the new innovative Mini Computer Supported Education Centres **(MICSEC)**.

MOCSEC has been in use since the inception of the Project. For the past 2 years *MOCSEC* has been inactive but has served as a test bed for the establishment of the more permanent ***MICSEC*** structures.

MICSEC* 2000** is an ambitious programme, which aimed by 2001 to have established 10 fully functional self-sustaining *MICSEC's* that would be available to 50 high schools in the Western Cape. This exercise has as ultimate objective the creation of the capacity for 2000 grade 12 learners to profit from at least 2 hours exposure to computer assisted *Mathematics* and Physical Science education daily. This objective has been fully realised, ***since May 1998, about 200 'resurrected', refurbished or new computer units together with 10 dedicated application servers have been strategically placed at 10 fully networked centres.

The **FNB Computer Centre** at Eersteriver High has been operative since August 1999. Presently it has undergone the following upgrading: Wall plugs have increased from 7 to 21. New tabletops have been acquired. The network capacity has been increased from 16 to 32. Ten stand-alone stations consisting of 10 refurbished CPU's, 10 new monitors, keyboards and mouses have been installed.

Outreach staff:	Brian Isaacs	(021 9592681)
	Adrian Snell	(021 9592680)
	Mark Peters	(021 9592997)

GUEST LIST

FNB: ....

UWC: Prof. Herman (Ed), Prof Fray(Sc),
Representatives of TLTU & SANTED,
Ms S Slingers(Faculty Officer, Sc)

WCED REPRESENTATIVES:
Mr J Odendal
Mr R Smith

PRINCIPALS, MATHS EDUCATORS & GRADE 11 LEARNERS OF THE FOLLOWING HIGH SCHOOLS:
Forest Heights, Malibu, Blackheath, Kleinvlei
Manzomthobo

PRINCIPALS OR THEIR REPRESENTATIVES OF THE FOLLOWING PRIMARY SCHOOLS:
Spurwing, Beverly Park, Stratford

REPRESENTATIVES OF THE COMPANIES WHO HAVE FAITHFULLY SUPPORTED THIS SCHOOL

A SPECIAL WORD OF THANKS TO THE FOLLOWING:
Mr M Barnard (office of development UWC) who negotiated and secured the funding for this computer centre.
Profs Herman and Fray for their time and Loyal support to the Outreach Project.
Mr T Esterhuizen in allowing the Outreach staff access to his school.

APPENDIX I

Photo Gallery of MICSEC established by the Outreach Project

- **MICSEC 1**
- **MICSEC 2**
- **MICSEC 3**
- **MICSEC 4**
- **MICSEC 5**
- **MICSEC 6**
- **MICSEC 7**
- **MICSEC 8**
- **MICSEC 9**
- **MICSEC 10**

MICSEC1

The first off-campus Outreach Mini Computer Lab was a collaborative effort with the UWC Community Health Project. The server of this 9 node star topology network was loaded with a limited amount of Quest mathematics exercises and physical science software developed at UWC.

MFULENI 1998

ROCKLANDS 2004

MICSEC2 (Mitchell's Plain 1998)

This 9 node network, similar to the lab at Mfuleni was designed to be multi functional centre. All the equipment was donated by the Computer Centre of UWC. Three groups of clients involved in different tasks could simultaneously use this lab.

MICSEC3 (Bishop Lavis 1998)

This 25 node star topology network was constructed along the inner perimeter of the room. This was a collaborative effort between the school and the Project. The innovative development gave the room a multi-function flexibility and the capacity to be developed into a multi media centre.

BISHOP LAVIS 2004

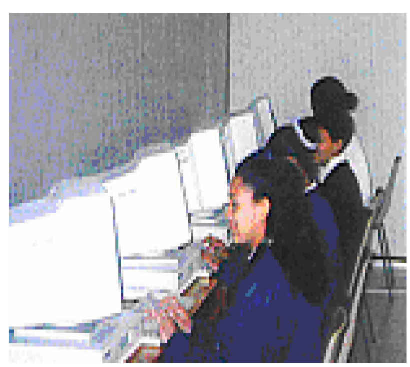
IMPLEMENTATION OF THE 2nd STAGE OF THE MICSEC PROGRAMME

LANGA 1999

MICSEC4: A 20 node star network topology, with 19 computers and a dedicated server, was constructed and the facility officially opened on 01/08/99.

20 Pentium 1 computers were installed

MICSEC5: A 30 node star network topology was installed. 15 netstations with a dedicated was functional in this facility from 1/10/99. The IT equipment salvaged from MOCSEC was fitted in the facility. In 2002 this facility was upgraded and 30 Pentium 2 computers installed.



EERSTE RIVER 1999

LENTEGEUR 1999

MICSEC6 The school had a functioning computer room with about 15 stand alone computer stations. A 30 node star network topology, partly sponsored from Project funds was installed in this room.

MICSEC 7 and MICSEC 8

The theoretical component of the educator training of this program was incorporated in the ACE program (or the other post graduate programs for which some participating educators had registered at UWC). These educators were also required to do a minimum of 5 sessions on the Matric Class program. To prepare the learners of the Oliver Tambo Drive and Zweletemba schools to be optimally prepared to utilise the facility that was erected at their schools. It was made compulsory for them to attend the nearest Outreach Matric Class for one full school term.

Both centres were fitted with 30 node star network topologies.

OLIVER TAMBO DRIVE (2000)

ZWELETEMBA (2000)

MICSEC 9 and MICSEC 10

KHAYALITSHA (2000)

DIAZVILLE (2001)

Distance from all the operating Outreach Project services was the primary obstacle encountered during the establishment of the MICSECS at these schools. The training of educators and learners in the necessary computer skills and the integration of the mathematics and science software into the school curriculum was similar to the process followed when MICSEC2 was established. While the Project technician managed the construction of the computer centres at each school, the coordinator facilitated the training program of the educators and learners on site. MICSEC9 was opened in September 2000 boasting 20 new Celerons. The erection of MICSEC 10 was delayed till 2001 because funding only became available then. A 30 node star network was installed. 20 refurbished computer with a low processing dedicated server started operating from mid August 2001. **In 2003 all computers were replaced with Pentium 2 PC's.**

APPENDIX J

A Concise Overview of my Experience as a Teacher

A CONCISE OVERVIEW OF MY EXPERIENCE AS A TEACHER

(A PHENOMOLOGICAL REFLECTION)

Experience the best teacher (or is it?).
I have been teaching mathematics and physical science at grade10-grade12 level since 1967. My career as a teacher of these subjects can probably be divided into three phases. Generally, however, due to the iniquitous laws imposed by the apartheid regime my teaching career was restricted to educational institutions in so called 'Coloured Township Areas'. I worked and lived (and still do) in such areas and have experienced at all levels how the school education system for 'coloureds and blacks' was a subsystem of the broader socially engineered system of apartheid brutally enforced by the Nationalist Party (since 1948) and its colonial predecessor. This oppressive political ideology was devised to effectively and consistently exclude 'non-white' South Africans from Higher Education. This marginalisation became particularly apparent/evident in the subjects that I taught. At the schools where I taught there was a consistent acute lack of suitably qualified educators coupled with a deficiency of adequate equipment and facilities. The problems arising from these imbalances were compounded by a high learner-educator ratio in the classroom coupled with a low per capita expenditure by the state.
Despite the meagre salary, my rapid climb of the corporate ladder from senior teacher (1969, Grassy Park High) to vice principal (1972, Bellville South High) then too deputy principal (1974, Bishop Lavis High) and finally to principal (1979, Morester High; 1989, Eros School) can probably be ascribed to my academic qualifications in mathematics. However, I found myself in a situation where I was rarely able, because of the continual acute shortage of mathematics teachers, to find a substitute for my duties in the classroom. Consequently in these promotion posts I was repeatedly required to handle a full mathematics-teaching program while still having to manage and lead an ever-increasing group of people with a range of problems, which was as diverse as their chequered academic backgrounds. In most instances my teaching/management duties was in a ratio 3:1. This forced me into a situation where I found myself compelled to do most of my administration duties after school hours and during weekends.

My teaching experience at 'normal 'high schools.
Initially teaching mathematics to learners, the majority of who came from the township milieu, was a perpetual frustrating yo-yo experience. In most instances after I had taught a lesson or marked a test, I would invariably find myself emotionally at the lower end of this yo-yo experience. On many occasions I would literary be 'sitting in the valley of despair' beseeching the Good Lord to show me how I could make the subject matter become more meaningful to my charges and in so doing derive more joy and satisfaction from my endeavours.

I discovered that the majority of my learners literary froze with anxiety when they were required to solve problem under my supervision (or in examinations). What was the most frustrating about these experiences was that in most instances the learners merely had to reproduce in most instances, the same or similar algorithms that we had repeatedly done in class. Many learners complained that during these experiences they appeared to suffer from what they described to be 'mini nervous breakdown'. During these episodes their minds in most instances went 'completely blank'.

These difficulties appeared to be typical psychological threat-anxiety-defence sequences probably caused by many years of unpleasant experiences with mathematics and the people who taught the subject (the cause root I became convinced of being a general negative attitude to the subject). This resulted in incongruence in what they could do and what was expected of them during the mathematics teaching-learning process.

As time passed, however, I gradually became acquainted with the 'baggage' of the township learner. I realised that most 'township' children are prisoners of their socio-economic circumstances. These circumstances compel them to etch out an existence at the lowest rung of the economic ladder. 'They live in crowded, noisy environments, and even in the case of very concerned and loving parents, they often feel to be underfoot. Greater conflict with adults and siblings result in them being frequently on the negative receiving side than their 'normal' peers' (Frostig & Maslow, 1973: 27). Predominantly, the early experiences in the home, motivation for present school learning, and goals for the future of these students are such that they handicap them in schoolwork (Bloom et al, 1967: 4). Consequently their out –of- school educational encounters and materials are paltry. Invariably in all instances they are in the process of outstripping the limited educational levels of their parents.

Children living in such socio-economic milieus are generally plagued by feelings of insecurity, inadequacy and worthlessness.

As products of dysfunctional homes many of them find themselves entwined in various vicious cycles of abuse. Alcohol, substance and sexual abuse are some of the multitudes of abuses that characterise township living and to which these children are perpetually subjected. [With the increase of unemployment over the last few years innocent 'township' children have particularly increasingly become the victims of the abuse of their parents, older siblings, drug syndicates, gangs, rapists, paedophiles and a wide variety of unstable people who dwell on the fringes of such societies].

This then was the type of learner with whom I interacted (and with whom I still interact) on a daily basis. Adolescents, in the natural process of adapting or adjusting to their own physiological and psychological changes and needs, yet being forced to assume the role of adults. Teenagers deeply involved in criminal activities playing the role of innocent schoolchildren. Immature minds probably being deformed as they schemed and connived the next step in their survival. In many respects they were craving care, attention, security and acceptance, which was in stark contrast to the cold rigid set of mathematical rules and algorithms I was daily seeking, almost autocratically to impose upon them.

As I gradually became aware of the contradictions and inconsistencies of my work environment coupled with the apparent futility of my labours, I realised that it was necessary for me to change my teaching style and make the mathematics I was teaching more relevant and meaningful to the circumstances of my young audience.

At this stage of my professional development I was profoundly influenced by the work of the therapeutic psychologists, L.M. Brammer and E.L. Shostrom. The self-theory approaches of C. R. Rogers, forms one of the theoretical foundations of their creative synthesis approach which they coined 'actualising counseling', particularly attracted my attention. Central to the thinking of Rogers is the personality construct, the self.

"A dynamic organisation of concepts, values, goals and ideals", this construct is suggested to govern the behaviour of a person. Self-theorists further assume that all individuals have biologically determined innate positive growth potential and hence the ability to solve their own problems. This self-actualising power is purported to be culturally determined by significant others (parents, peers, teachers etc).

I incorporated these ideas into my teaching methodology assuming that if my encounters with my learners was characterised by a trusting climate developed by sincerity, warmth, acceptance and sensitive empathic understanding, the threat-anxiety-defence reactions in their experiences with mathematical material would be reduced or entirely removed. In this manner I gradually introduced a psychological support component into my teaching endeavours.

I consciously forged relationships characterised by attitudes of honesty, trustworthiness, and genuine concern i.e. a support program of sensitivity and encouragement (Brammer & Shostrom, 1977: 56) with all of my learners who showed a particular interest in or had an inclination to mathematics.

At the beginning of each year I embarked on a major endeavour "to identify, a sizeable group of socio-economically deprived students who could with appropriate continual effort be enabled to complete secondary (mathematics) successfully. These students were offered special instruction programs, tutorial help as needed, increased counselling, and help on the basic skills and tool subjects" (Bloom et al: 370).

In the classroom I repeatedly openly commended and affirmed their slightest positive contribution to a lesson or discussion. In my classroom walks-about whenever I discovered that somebody was solving a proble m in an alternative creative manner I would encourage him or her to share these insights with the rest of the group. In this way I endeavoured to re -establish the self-confidence, self-image and self worth of many of the learners with whom I interacted.

This process of adapting my teaching style to the needs of the learners (i.e. making my mathematics teaching learner-centred) was at most times a long and arduous process. I however continually and repeatedly reminded my learners (especially the matriculants) that a good pass particularly in mathematics would open up a world of opportunity for them.

In so doing I subtly encouraged them to realise that by developing a good foundation in school mathematics, they were establishing a "window of opportunity" for themselves. If used constructively and purposefully this could develop into the springboard from which they could launch themselves into a better socio -economic level and consequently a better lifestyle. My efforts at most times were not plain sailing.

Initially my endeavours were met with suspicion and at times disdain. I balanced my 'sensitivity in the class program' with a 'sensitivity to the learner's world' activity. During these exercises I gathered confidential information about each learners personal interests, siblings, parents and significant (important) others from the school psychologist or during personal home visitations. In this manner I developed a mental, personal profile of the pertinent characteristics of all the learners I thought would successfully complete matric mathematics at the end of each year.

I gradually moved away from my initial sterile, formal method of teaching mathematics and progressively added this psychological supportive component to my practical teaching in the classroom. This support endeavour was intentionally aimed at learners who exhibited acute feelings of inadequacy and insecurity and displayed excessive anxiety during teaching sessions. The objective of this exercise was to prevent these learners from transferring these feelings to their learning of mathematics and further complicating matters for themselves.

In these endeavours I was consciously attempting to change the negative 'mind-set' many learners have of the mathematics teacher. Learners were guided to realise and perceive that the mathematics teacher was not a cold authoritative transferor of knowledge but 'a sensitive point of reference/ a pillar of strength' that was both aware of and sensitive to their particular excess anxiety and discomfort during the learning process.

The calm, accepting demur (manner) displayed by the teacher if employed positively could become a powerful supporting medium that can allay feelings of hopelessness and the feeling that their excessive anxiety is unique.

[Rather rudimentary, but this was in my opinion the best support structure I could develop and found pragmatic at this stage of my professional development. I later discovered that such an intervention of support could be refined into a model, which could be utilised for the social upliftment of young persons living in the most adverse socio-economic circumstances. Stated alternatively and more broadly: A sustained feeling of success and satisfaction in mathematics, which has been made relevant to a person's circumstances and presented in a supportive manner could develop into a vehicle through which that person could be motivated to extricate himself from a mediocre socio-economic situation to a better mode of living.]

My teaching experience at schools for the ‘physica lly challenged’

Never in my wildest dreams did I ever imagine that I would land up in what was formally called special schools for the “handicapped. The then educational authorities decided this phase of my teaching career when they deemed it necessary to transfer me to such schools from 1984. It was later that I realised that in being at these schools I was encroaching on what could best be described as the last bastions of ‘white dominance’ in what use to be termed ‘Coloured Education’. The white hierarchy that was slotted into the prominent positions in the staff structures of these institutions lived in the lap of opulence and spared themselves no luxuries.

On the positive side it was at these schools that I was introduced to the decided value of a well-planned support program (executed by specialists in all components of the program) in educating persons who were limited in some way or the other by physical constraints. Functioning as state-aided institutions these schools (each with it’s own predominantly white governing body) existed as idyllic undiscovered peaceful islands of education in the sea of instability and uncertainty that governed the ‘normal’ black and coloured public school scenario that characterised that period.

Each of these ‘special institutions’ had been planned and developed as a miniature self-sustaining separate village (typical of the apartheid ideology) to fulfil the unique needs of a particular ‘handicapped type’. A further apartheid refinement was that the special schools under the control of the now defunct ‘House of Representatives’ were inferior replicas of special schools controlled by the white department.

The Athlone School for the Blind

For about a year I was exposed to the Braille method of reading and communication, and the manner by which blind and partially sighted persons did arithmetic and later mathematics.

Eros Cerebral Palsy School

P. Poonsamy (1984 :) gives a detailed report of the development and structure of this institution since it's inception on 2nd September 1969. He describes a cerebral palsied child as "a child who received an injury or infection of the brain before, during or after birth. It can also be caused by an injury to the head in a fall, a bad accident or at play. Brain damage results in defects of the neuromotor system and the child may show disturbances in perception, thinking and emotional behaviour. These disturbances may prevent the normal learning process." (194). The Eros Cerebral Palsy School is a special institution established by the Western Cape Cerebral Palsy Association in collaboration with the then Department of Interior to cater for the needs of educable 'non-white' cerebral palsy persons classified as athetosic, spastic and ataxic. The institution houses a pre-primary, primary and secondary school. Placement at this school is through a referral after an assessment by a team consisting of a psychologist, a speech therapist, an occupational therapist and a physiotherapist. Learners attending the school are either resident at the well-equipped hostel or reach school daily through a well-organised school run bus service.

When I arrived at the institution in 1986 an extensive hostel that would house 100 Cerebral Palsy individuals was in the process of being constructed. On completion of the building extensions the school roll was about 800 (with half occupying the new hostel). The staff complement consisted of 120 persons (this included the management and administration staff, educators and remedial teachers, doctors and paramedicals, psychologists, social workers, nurse aids, drivers and cleaners).

The secondary school made provision for both academic and practical direction of study. Remedial teaching is an integral aspect of the learning process in the Eros school endeavour with educable cerebral palsy learners.

A unique experience at these schools for me was that in all facets the school and all its' contingencies were designed in such a manner that it addressed all possible problems the learner would experience in the learning process. The process of referrals were initiated as early as possible so that the cerebral palsy child could immediately be eased into the well organised, carefully monitored medical, educational and therapy program.

Self-theorist hypothesise that the 'concept of the self is a learned attribute' that 'starts at birth differentiating steadily through childhood and adolescence like an unfolding spiral'. The self is purported to take 'on various subjective attributes in the form of "I am" (his nature), "I can" (his capacities), "I should or should not" (his values), "I want to be" (his aspirations). An individual experiences feelings of adequacy, security and worth if he/she perceives congruence (consistency) between the picture of himself and his behaviour. (Brammer & Shostrom: 46-47).

As a result of his physical 'abnormalities', the cerebral palsy person develops a "versteurde EK-beeld "(distorted self-image). This distortion becomes manifested in the form of learning problems in reading, writing,, spelling, arithmetic, etc, that can be traced to faulty perceptualising and conceptualising. Pedagogical support is aimed at changing this distorted self –image by a series of programmed activities that is intended to edify the total person (i.e. the somatic, the psychic and the intellect) (Basson, 1970: 29-31)

Tutoring first-year mathematics students at the UWC

‘The mathematical powers of many of our incoming 1st year students are underdeveloped, resulting in their inability to cope with the demands of our regular, first year curriculum, M111/121 (Kannemeyer L 1996:3). The Mathematics Department of the University of the Western Cape classified the majority of these students to be ‘at risk’ because many of them possessed the lowest entry qualification (an E symbol in Higher Grade and a D symbol in Standard Grade mathematics respectively) in matric mathematics. Failure of such students to cope with 1st year mathematics was generally ascribed to a ‘backlog in content and weakness in algebraic manipulation’.

The 1st year syllabus was consequently adapted to include an extensive section of aspects of school algebra and an introduction to set theory. To counter the expected and actual poor performance of M111/121 course students, the Mathematics Department set up various measures such as the introduction of ‘small group tutorials’, extra lunchtime lectures and an extra period per week. These measures were aimed at reducing the deficit many students had in high school mathematics. They also indicated a bold attempt to bridge the gap in the knowledge and readiness between the students who did Higher Grade and those who did Standard Grade Mathematics (a course in matric mathematics offered by the Western Cape Education Department for learners who would not necessarily do courses at university level) at school level.

When I became part of the Mathematics111/121 program 1996 as a senior teacher-tutor the ‘major pedagogy underpinning the course ‘was the following. A ‘seasoned’ professor was responsible for the formal lectures and third-year or post-graduates students, under the guidance of a tutorial co-ordinator, conducted the small group tutorial sessions. It became apparent that these sessions were not attaining their desired outcomes because the student tutor/mentors lacked the insight and time to do their tasks effectively. Replacing or supplementing these students with experienced matric mathematics teachers (so it was surmised) would not only stabilise this aspect of the program but would improve the success rate.

I considered that part of my personal in-service program was to ascertain what was occurring in the lecture room. When I sat in some lectures I made the rather startling discovery that the mode of delivery was not very different from that to which I was subjected to about 30 years earlier (a straight jacket I was attempting to escape). Lectures were still the traditional frontal verbal monologues (which in some instances deteriorated into academic soliloquies) in which the speaker dispersed his/her 'highly-processed and at times over-simplified examination fodder' to a mute, passive and bored audience.

I experienced little joy in the 'small group tutorial sessions'. Initially they started off well with regular, relevant discussions chaired by the course co-ordinator and the small group tutorial co-ordinator. These discussions were held once weekly during the Monday lunch hour to workshop inter alia general problems students experienced and how these difficulties could be collectively addressed by the lecturer and tutors. As time progressed these talks deteriorated into a time slot in which verbal and written instructions were issued. The 'small group tutorial sessions' were contained in weekly issued written instructions and structured as follows. Each tutorial was a revision/consolidation of lectures of the previous week and scheduled to start at 14h00 and concluded at16h30 from Mondays to Thursdays. The session was divided into 5 activities. An initial presentation and discussion (50 min) was followed by a review (of the homework of the pervious week, 15min) and then a monitored work period (students worked on selected problems from relevant sections, 45 min). Prescribed homework (students were issued with group and individual homework that served as assignments) and finally a tutorial exercise (a short test, 20 min) ended each session.

The structure of the small group tutorial sessions was such that they were designed to supplement the lectures and tended to perpetuate the modus operandi of the lectures. Student activity was included but restricted to passive, prescribed procedures that did not encourage constructive discussion and individual or group discovery. Moreover most of the student had either poor rural or deprived township backgrounds. The 'whole scenario' reminded me of my initial experiences as a beginner-teacher and I was once again plagued by an unpleasant 'sinking feeling'.

By contrast the lectures/workshop procedures adopted in the Mathematics 114/124 course spearheaded by Larry Kannemeyer appeared to be oozing with activity and life.

This 'comprehensive intervention course developed and implemented by Kannemeyer in 1993 was a 'Foundation course', aimed to assist students categorised as being 'at risk'. This course consisted of two modules, the syllabi of which were identical to Mathematics 111/121. Students were identified for this course by their failure to meet the minimum criteria of an inclusive 'placement test' together with interviews and their matric results. They were required, if they wished to enrol for a first year mathematics course to register for Mathematics 114/124 and limited to 2 other subjects for a 1st year B. Sc. Course. They received 10 lecture sessions per week in Mathematics 114/124(together with a compulsory afternoon lecture/workshop.), 4 lectures more than their Mathematics111/121 counterparts.

Kannemeyer's methodology is a direct protest against the sterile counter-productive and authoritative style 'traditional lecture'. His 'workshop/lecture' effectively reconstructs the learning environment furnishing it with a technological aspect that stimulates the student to ‘engage in more meaningfully with mathematical concepts’.

The workshop-lecture as advocated by Kannemeyer impinges on the ‘social’ tendency of what he terms the ‘meaning mathematical activity’. This ‘doing of mathematics’ effectively occurs in a ’cognitive apprenticeship relationship’ forged between ‘old-timers’ (experienced professional mathematicians) and ‘newcomers’ (aspirant mathematicians), the ‘legitimate participants in the community of practice of mathematics’.

The lecturer, in his role as ‘old-timer’ is expected both to facilitate and manage the student centred subject matter and to induct those who are able to ‘take on the role as of local old-timers’. In this manner a ‘local intellectual community’ of freely interacting (i.e. consultation, collaboration and discussion and the sharing of ideas) individuals and groups is created (Kannemeyer, 1996.).

Effective learning depends much on the quality of the relationship between the educator and learner/s with the basic attitudes of the educator being highly significant. The attitudes of acceptance and understanding have considerable consequences for the climate generated during the teaching process.

The climate that these attitudes create holds important implications for the learner and how he perceives himself. A key to an effective attitudinal climate is the educator’s assuming the internal frame of reference, which is his attempt to understand the learner by taking the learner’s view of his situation and himself as his frame of reference. The educator must have additional characteristics of warmth, intelligence, flexibility, humility, and willingness to share the responsibility (Brammer & Shostrom, 178).

THEORY DEVELOPS FROM EXPERIENCE

"Theorising is organising fields of experience, and the result of this organisation, unlike a heap of sand, will be gifted with structure, thanks to its origin in connected experiences and the processing that took place when they were organised."

(Freudenthal, 1991: 129).

"Mathematics is different. From the very beginning it has been different. It is the oldest among the sciences. Mathematics was easily invented, as it was simply a question of common sense—only better organised" (Freudenthal, 1991: 9).

"The principal mark of the self-theory group is its postulation of a self concept. A second distinguishing characteristic is the belief in the innate positive growth potential or self-actualising power of the organism" (Brammer & Shostrom, 1977: 53).

Experience the precursor of Theory

Retracing one's steps and attempting to objectively (phenomenologically i.e. laying bare its essences) examine and assess your professional career which (you surprisingly discover) has actually developed into a life task is a daunting and, at times, embarrassing process.

In this pursuit I was forced into the unenviable position to be both the 'objective observer' (if this is at all possible) of my own subjective classroom behaviour (interactions).

I discovered that in my development as an educator, I was simultaneously exposed to all other activities of schooling as I climbed the corporate ladder. I became increasingly aware that the mathematics teaching-learning process is/was one of a host of activities occurring in a school. Besides teaching, the mathematics educator (and an educator of any other subject or subject combination) is/was required to fulfil a variety of other roles in a school other than teaching.

Determined by the type of educational institution I served at a particular stage of my career, I have divided my 'experience' as a mathematics educator into three chronological phases. As I verbalised the salient aspects germane to each stage I was guided by questions such as:

How did I get here? What happened here? What was my teaching style? Did it in any way change in different situations? Did I significantly impinge generally and in terms of the mathematics that I was teaching on the lives of my learners?

I will now endeavour/attempt to tie up things and see whether over the years I fossilised and stuck to the same theoretical assumptions year in and year out, or whether my classroom practise was moulded by some eclectic approach and to what extent I developed a personal unique theory.(Brammer & Shostrom, 1977: 31-34).

Theory: A Novice with his own novel approach

During my early teaching years due to my inexperience (as any novice I am certain!) I lacked the ability to develop a consistent set of assumptions regarding the teaching of mathematics. I embraced no dominant theory, neither did I emulate any revolutionary, current ideas, which advocated a specific manner in which mathematics could or should be taught

At the commencement of each year I was confronted by the same set of expectations and circumstances. These included overcrowded classes, an acute lack of the most basic requirements, a prescribed syllabus I needed to complete, a heavy load of controlled written work tests and examinations, rigorous control by over-zealous, promotion hungry educational departmental officials and a set of success expectation outcomes that was required to be attained.

In hindsight, and if assessed by present scientific criteria, my initial method of teaching could at best be described as very elementary and rudimentary (crude).

It was a "hands-on, functional and results producing approach". It consisted of what could be described as my personal 'bag of tools of the trade' or a 'my cookbook of foolproof recipes'. These 'tools and recipes' consisted of a repertoire of in-sights, procedures and techniques which I 'picked-up' in my interactions with my previous teachers, lecturers and significant others. Added to these were a number of rather crude methods and 'tricks' that I devised and successfully utilised in various situations in my personal encounters as a learner and a student.

I fashioned my method of teaching on the pattern I observed of the manner in which (how) 'unqualified tradesmen' in the informal building trade obtain their experience in a particular trade (be it a bricklayer or a carpenter). The informal 'journey-men' would generally encourage their ' apprentices' to 'steal with their eyes' (better described as learning by looking and then imitating) i.e. they had to, without being noticed, observe what was being done by certificated journey-men and expected to do the same with the minimum of errors. This process had to be repeated 'ad nauseum', until the desired state of correctness or perfection in performing the activity was attained.

Assessed critically, the approach underlying my early classroom practice was unsophisticated and not very scientific. It lacked a specific untested 'structure of hypotheses and generalisations based on experience and experimental studies, (i.e. a basic theory) which had not been or could not be scientifically verified'. It, however, in no way encouraged an indiscriminate 'muddling through' process that needed to be used repeatedly till the correct answer is found. It was neither an uncritical synchronisation of pro cedures and processes that was haphazardly and randomly applied. During the initial stages of my professional development this practical-functional and pragmatic approach proved to be the best vehicle by which I could reasonably attain some of the outcomes required and expected of me by the nomothetic bureaucratic system of which I was a constituent.

Theory, from the simple to the complex

Job satisfaction in teaching high school mathematics apparently appeared continually to elude me. As I analysed my situation I surmised that the primary reason (other than socio-economic conditions) why the majority of my learners failed to make satisfactory progress in mathematics could be traced to an underlying negativism they displayed to the subject. This negative attitude probably resulted in the 'mental block' many learners experienced when they interacted with mathematics subject matter and educators.

The origin of this negativism (I assume) could possibly have been the result of the general (mis)-perception by the public (people/society in general) that because mathematics is a difficult or 'hard', it is best to be avoided by the average person. I suspect that statements like: "I never passed mathematics at school!" "Mathematics was my worse nightmare!" etc expressed by significant others in the lives of learners generally reinforce this attitude of negativism. Other factors contributing to the reinforcement of this attitude are possibly continual and sustained unpleasant experiences with educators of mathematics and the subject matter. Learners plagued by feelings of insecurity, inadequacy and worthlessness (usually indicators of a low - self image), particularly those emanating from a low socio-economic milieu are often acutely affected by such experiences and their negative attitude to mathematics is compounded and thus aggravated.

To address and counter the negative attitude to mathematics and in order to make my 'teaching practise' relevant to my audience I supplemented it with a 'connotive' dimension. This implies that my teaching-learning relationship with my learners became characterised by an intellectual (cognitive) – feeling (connotive) dipole.

[The second dimension assumes that activities generating negative attitudes aggravate a 'defective' or under developed 'self' and this effectively impedes learning].

The inclusion of this dimension in my teaching style was (and still is) aimed at creating and maintaining a support structure that brings about a 'nonthreatening, anxiety-reducing' climate during the mathematics learning-teaching process. To initiate and maintain such a climate during this process it is necessary for the educator to display attitudes of honesty, trustworthiness and genuine concern. It is surmised that at some critical stage in the interaction between the educator and the learner, the learner's 'innate positive growth potential' would come to the fore and like Archimedes would exclaim: "Eureka! Eureka!'

Theory: From the complex to the complex

My 'Athlone/Eros Special School teaching experience made me vividly aware that external extraneous limitations (e.g. limited socio-economic conditions) and physical handicaps or the combination of both all lead to defective or underdeveloped self-concepts. In order for effective teaching to occur, it is necessary that cognisance of the problem of learners with 'defective self images' be taken into account. I realised furthermore that successful teaching and learning was not only confined to the two-dimensional process I had developed but also better outcomes could be attained if I were to merge my approach with other variables into a multidimensional process.

I have mentioned that as I ascended the corporate ladder, my teaching program did not diminish. Under the 'previous regime' the education department functioned merely as the implementing arm of its educational policy. An educator's 'readiness' for promotion was assessed by his/her number of years of teaching and how well he impressed his superiors (principal and inspectors) i.e. how well he understood and played the organisational game. The education department of the day paid scant attention to the administration, supervisory, organisation, and other specific skills needed by educators to successfully execute their duties and responsibilities when they were promoted to senior positions. In my various promotion positions I became acutely aware (despite being able to effectively disguise these deficiencies) of my inexperience, incapabilities and inefficiencies in the areas of organisation and administration and the need to personally equip myself with the requirements to successfully execute the job descriptions of these positions. It was during this process of orientation in my reading that I became aware of the concepts of leadership, management and organisational theory and how they found their way from the 'corporate world' into the 'education world'.

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APPENDIX K AND L

K: An example of a worksheet and a workshop lesson

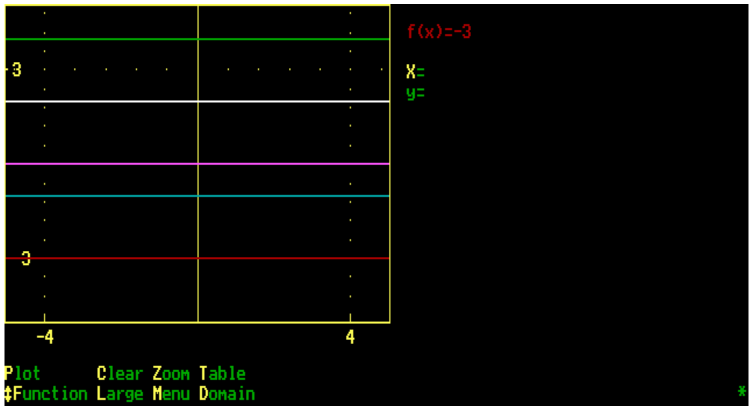
- **An alternative method to sketch Lines and Parabola's**
- **An alternative approach to introducing differentiation**

L: CAMI examples on Differentiation

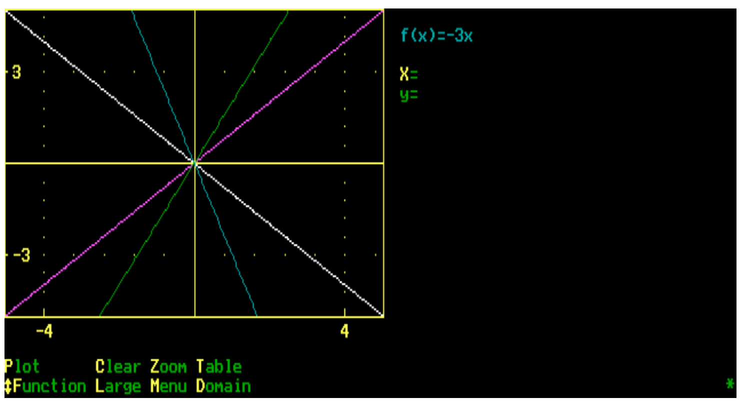
- Introducing Frames
- Examples:
  1. Functional Notation
  2. Average Gradiant
  3. Limits
  4. Continuity
  5. Derivatives; First Principal
  6. The Derivatives of a Function

INTRODUCING DIFFERENTIATION, AN ALTERNATIVE APPROACH

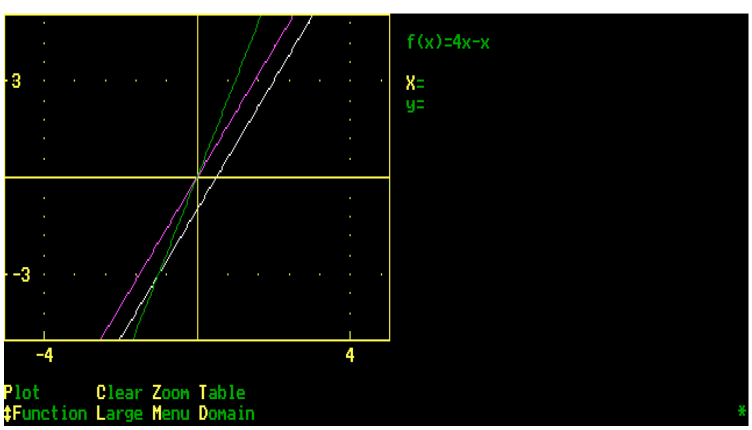
Answers to problems A _ F as given by the **G C** computer program



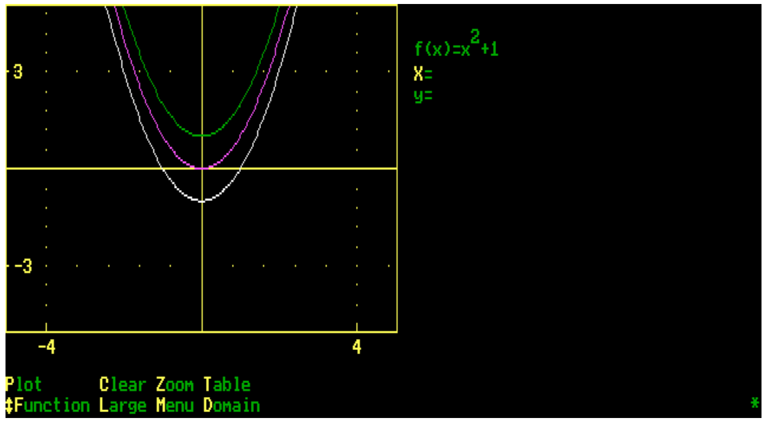
A



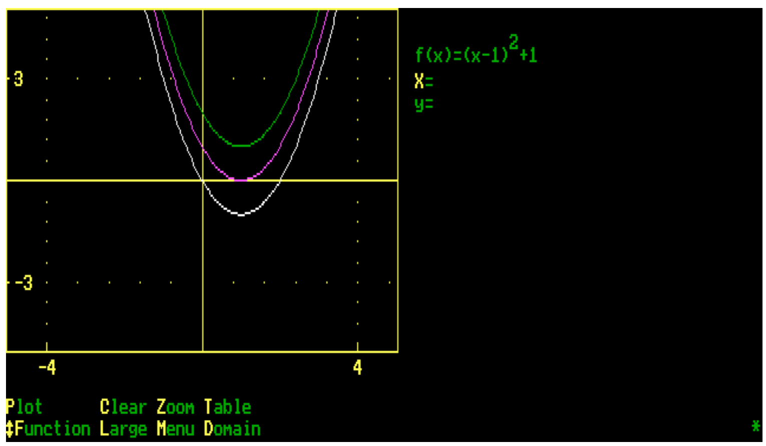
B



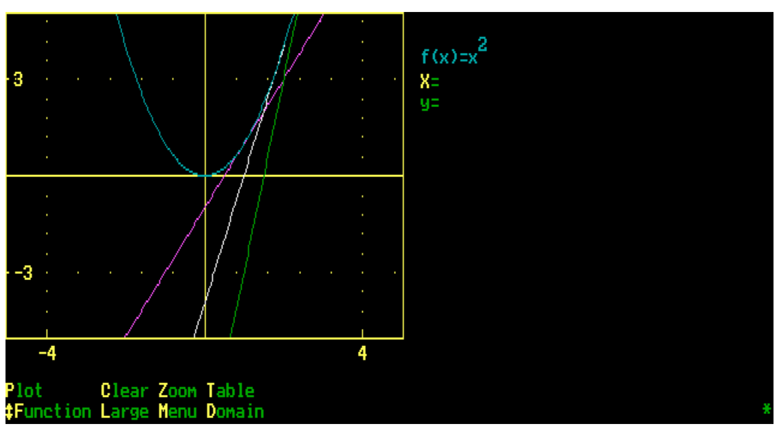
C


f(x)=x2+1
X=
y=
3
-3
-4
4
Plot Clear Zoom Table
Function Large Menu Domain

D


f(x)=(x-1)2+1
X=
y=
3
-3
-4
4
Plot Clear Zoom Table
Function Large Menu Domain

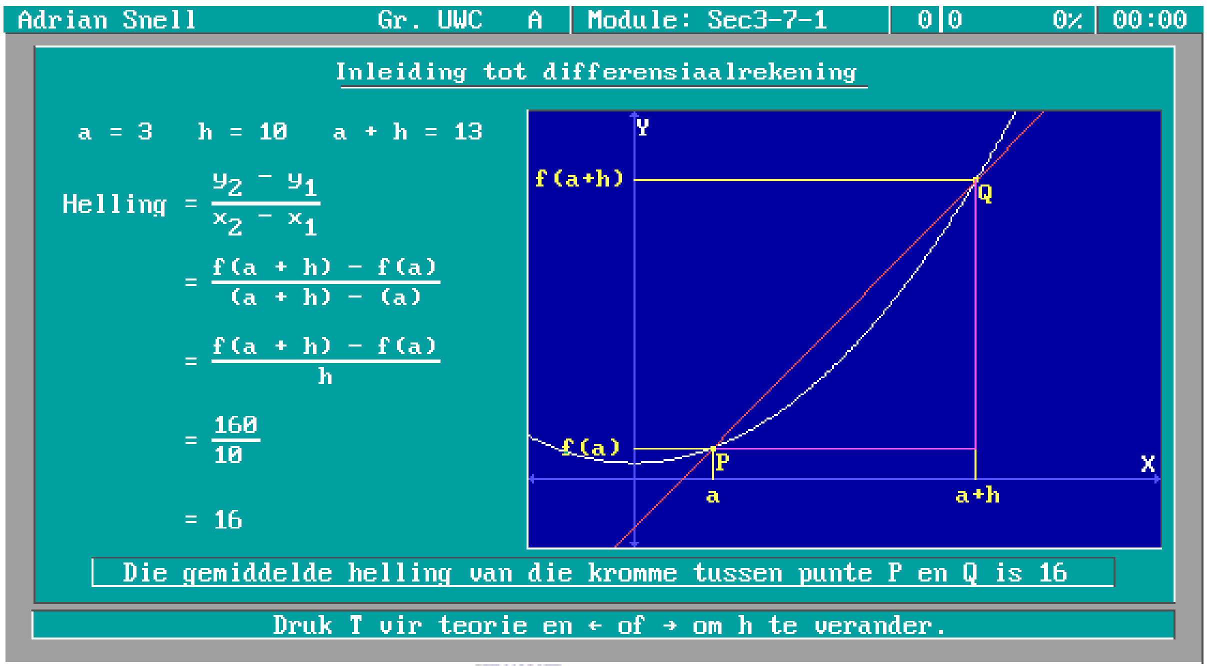
E


f(x)=x2
X=
y=
3
-3
-4
4
Plot Clear Zoom Table
Function Large Menu Domain

F

INTRODUCTION TO DIFFERENTIATION (CAMI SOFTWARE)

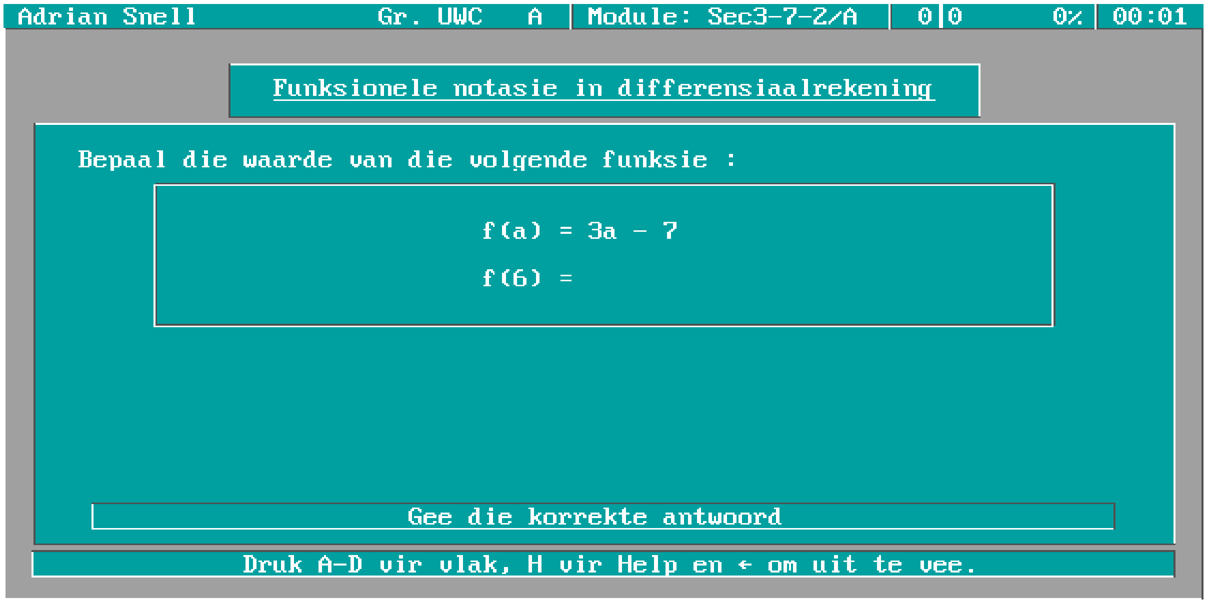
Frame 1 introduces the student to the standard introductory diagram. Secant PQ can be rotated at P to form a tangent on f(x) at P



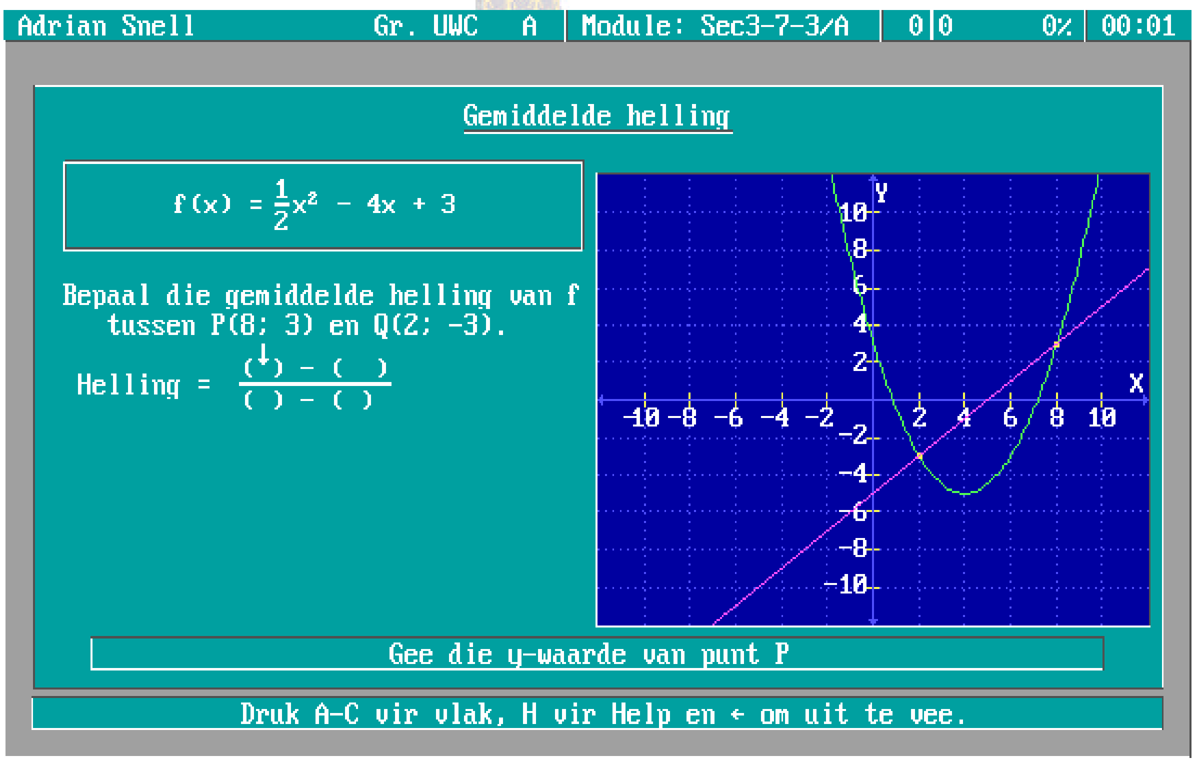
Frame 2 gives a brief, simplified account of differentiation

PROBLEMS USED IN THE CAMI PROGRAM ON DIFFERENTIATION

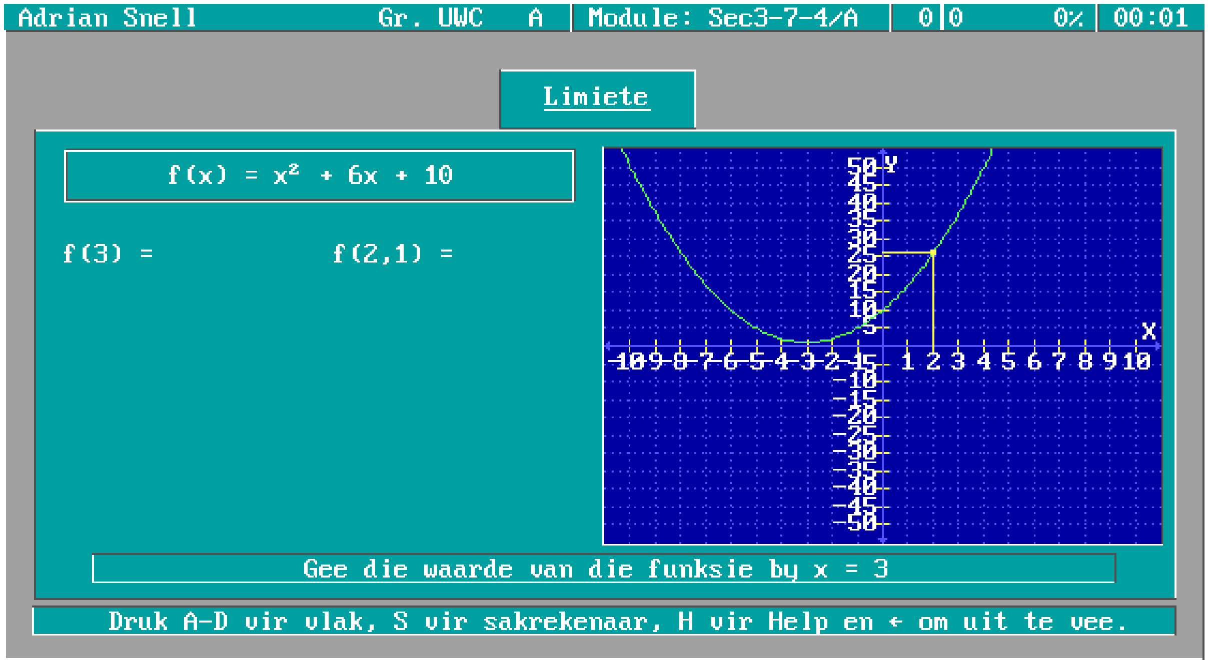
1. Functional Notation



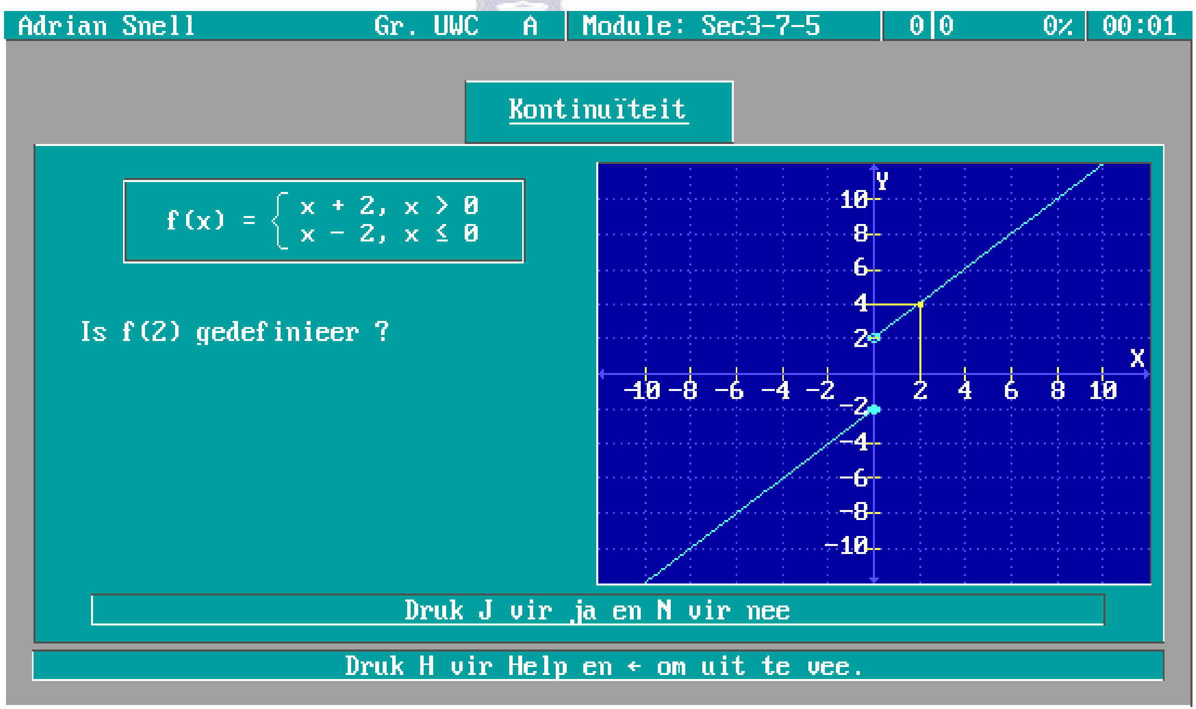
2. Average Gradient



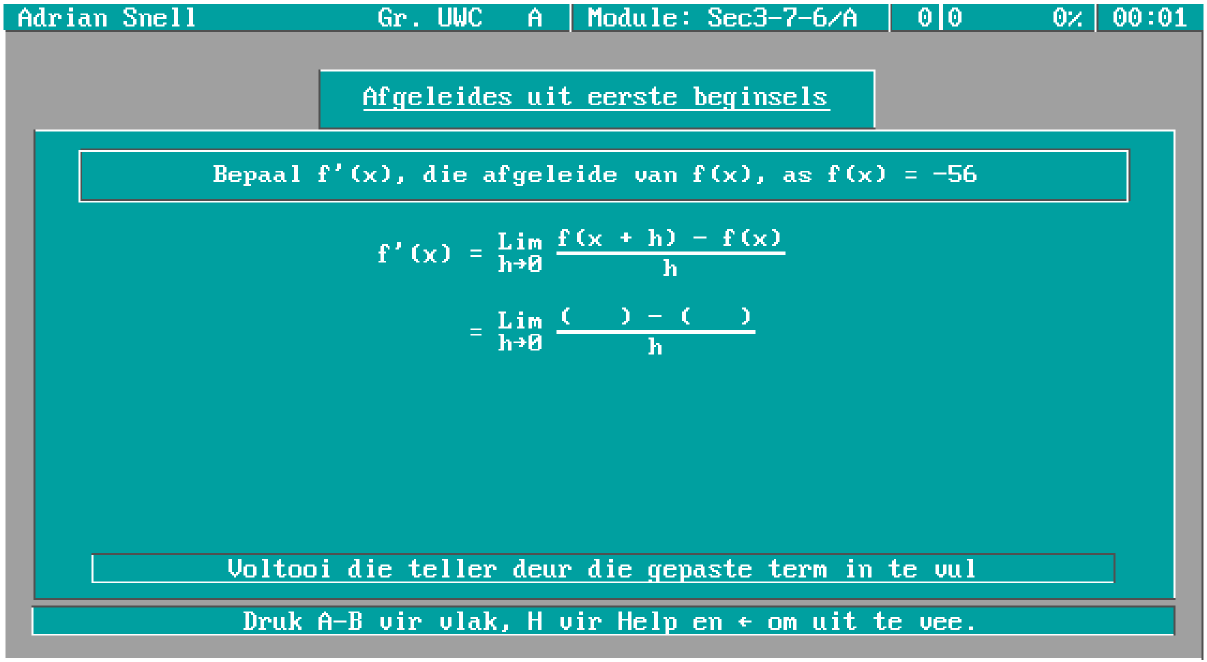
3. Limits



4. Continuity



5. Derivatives: First Principles



6. The derivative of a function

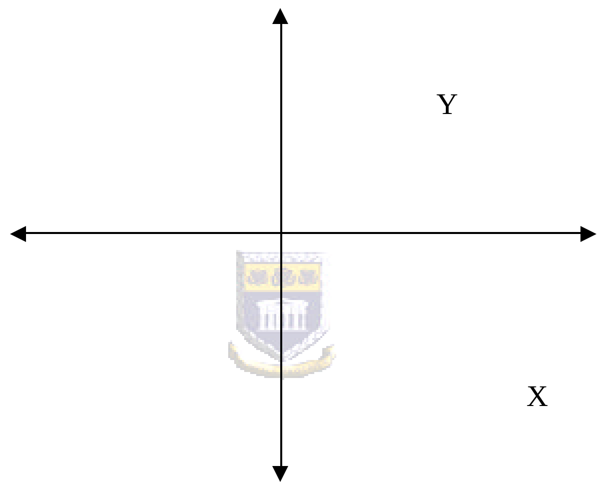
A SAMPLE ‘WORKSHOP LESSON: INTRODUCING DIFFERENTIATION, AN ALTERNATIVE APPROACH

FIRST SESSION (1 HOUR) An alternative method to sketch lines and parabolas

- *1 WHOLE GROUP ACTIVITY (10 minutes) the entire group completes the exercise individually and is allowed to check their answers against the answers obtained by the GC program on their computers.*

A 1 On the axis provided sketch graphs of the following *groups of functions*

(a) y = 0 (b) y = 2 (c) y = 4 (d) y = - 1 (e) y = -3
(Test your answer in each case using the GC program)



Complete the table for each graph of the group

	(a)	(b)	(c)	(d)	(e)
Gradient: m					
Constant: c					

**2 SMALL GROUP INTERACTION AND EDUCATOR CIRCULATION (5 MINUTES) The groups is divided into groups of 5 and discuss the following*

A2 What can you say about the graphs generally?

…………………………………………………………………………………………

Write down a general equation for such a group of linear functions

………………………………………………………………………………………….

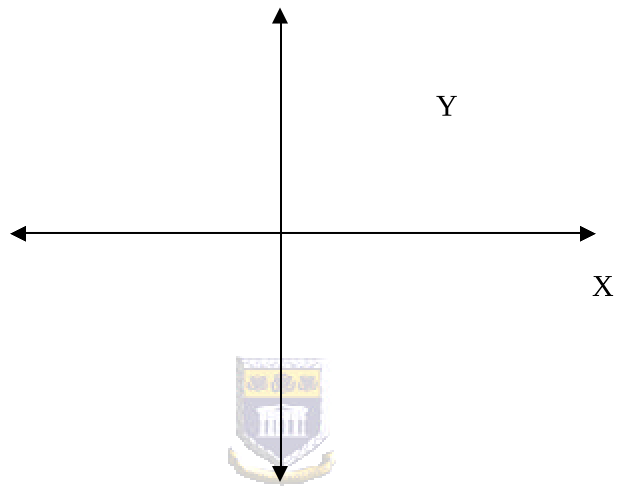
**3 WHOLE GROUP ACTIVITY (10 minutes) : the entire group completes the exercise individually and is allowed to check their answers against the answers obtained by the GC program on their computers.*

C1 Sketch the graph of the following *groups of functions* on the axis supplied.

(i) a) y = x b) y = 2x c) y = ½ x

(ii) a) y = - x b) y = - 3 x c) y = - ½ x

(Test your answer in each case using the GC program)



Complete the following table for each graph of the group

	(i) a	(i) b	(i) c	(ii) a	(ii) b	(ii) c
m						
c						

4 SMALL GROUP INTERACTIONS AND EDUCATOR CIRCULATION
(5 minutes) the group is divided into groups of 5 and discuss the following

C2 What do you observe about the graphs of group (i)

……………………………………………………………………………………

What do you observe about the graphs of group (ii)

……………………………………………………………………………………

Write down a general equation for such a group of linear functions

…………………………………………………………………………….......

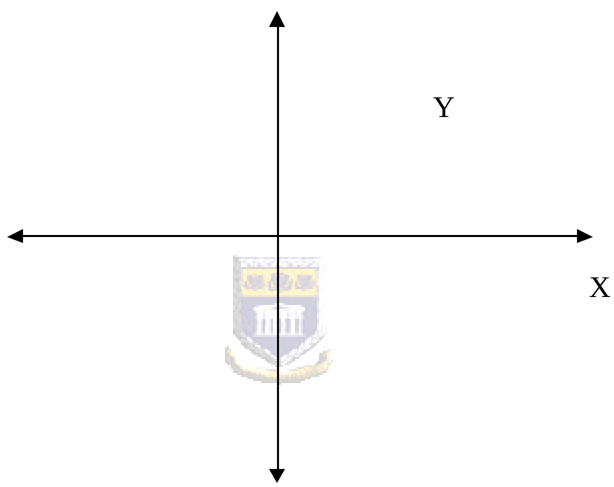
5 PLENARY (10 minutes): Representatives of each group present the results of their discussion and guides learners in the summary of the results.

**6 WHOLE GROUP ACTIVITY (10 minutes) : the entire group completes the exercise individually and is allowed to check their answers against the answers obtained by the GC program on their computers.*

D1 On the given Cartesian system of axis sketch the graph of $y = 2x - 1$ as follows.

(a) Sketch $y = 2x$ (faintly)
(b) By a shift (of $y = 2x$) along the y axis indicate $y = 2x - 1$
(c) In a similar manner draw $y = 4x - 4$

(Test your answer in each case using the GC program)



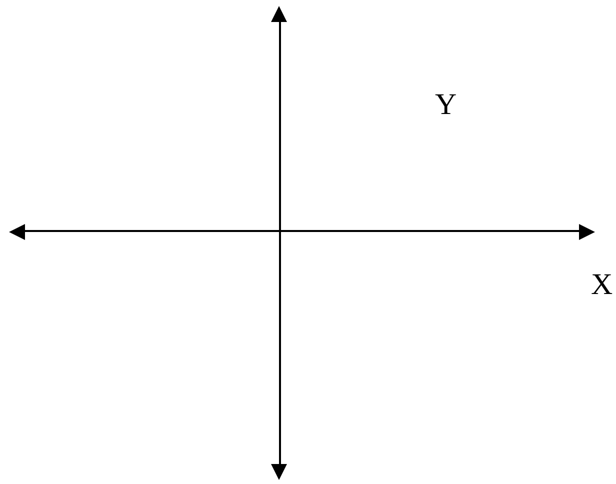
7 SMALL GROUP INTERACTIONS AND EDUCATOR CIRCULATION
(5 minutes) the group is divided into groups of 5 and discuss the following

D2 What do you notice about the value of the gradients of
$y = 2x - 1$ and
$y = 4x - 4$

E With the aid of the accompanying system of the axis sketch the graph of $y = x^2$

(a) By shifting $y = x^2$ along the y axis obtain $y = x^2 - 1$ and $y = x^2 + 1$
(b) How do you think $y = x^2$ should be shifted to obtain:
(i) $y = (x - 1)^2$
(ii) $y = (x + 1)^2 - 1$

(Test your answer in each case using the GC program)



8 PLENARY (10 minutes): The educator co ordinates the discu ssion and guide the learners in their summary of the results. A short lesson is given to summarise and consolidate any new methods employed or concepts discovered.

SECOND SESSION (1 HOUR) An alternative method of introducing differentiation

**1 WHOLE GROUP ACTIVITY (10 minutes): the entire group completes the exercise individually and is allowed to check their answers against the answers obtained by the GC program on their computers.*

F 1 This exercise refers to and is a continuation of question D

On the system of axis supplied draw the following group of graphs:

L_1 : $y = 2x - 1$

L_2 : $y = 4x - 4$

L_3 : $y = 6x - 9$

(Test your answer in each case using the GC program)

**2 SMALL GROUP INTERACTIONS AND EDUCATOR CIRCULATION (5 minutes) the group is divided into groups of 5 and discuss the following*

F2 Complete the following table for $y = x^2$

Y	-3	-2	-1	0	1	2	3
X							

Now draw the graph by P: $y = x^2$ on the same axis.

F3 (i) What do you notice about L_1 and P at x = 1. Record the gradient of L_1 at this point in the table supplied.

(ii) What do you notice about L_2 and P at x = 2. Record the gradient of L_2 at this point in the table supplied.

(iii) What do you notice about L_3 and P at x = 3. Record the gradient of L_3 at this point in the table supplied.

F3 Table of gradients of lines tangent to $y = x^2$

X	1	2	3	4	…. x
Gradient					

**3 PLENARY (10 minutes): The educator co ordinates the discussion and guide the learners in their summary of the results. A short lesson is given to summarise and consolidate any new methods employed or concepts discovered.*

**4 SMALL GROUP INTERACTIONS AND EDUCATOR CIRCULATION*
(5 minutes) the group is divided into groups of 5 and discuss the following.

From this table deduce the formula that will enable you to find the gradient of the line at any point on the function $y = x^2$

* Compare this function (formula) …………………………….. x^2

* What algebraic operations do you think should be performed on x^2 to obtain 2x

……………………………………………………………………………………………
……………………………………………………………………………………………

**3 PLENARY (10 minutes): The educator co ordinates the discussion and guide the learners in their summary of the results. A short lesson is given to summarise and consolidate any new methods employed or concepts discovered. The group is introduced to the notations and general formulae.*

Summary: If $f(x) = x^2$ then $f^1(x) = 2x$, the gradient at x is called the derivative function of $f(x)$.
What are the numerical gradients / derivatives at x^2 at
$x = 1$, $x = 2$ and $x = 3$

Excerise: let $f(x) = x^3$ deduce as above: $f^1(x)$

If $f(x) = x^n$ find a formula for $f^1(x)$ (*n* is any real number)

Notation indicators

1. $f^1(x)$, Dx, d / dx dy / dx

Differentiation rules:

Function	Derivative
$f(x) = k$, k : constant	$f^1(x) = 0$
$f(x) = x^n$; n ? R	$f^1(x) = n x^{n-1}$
$f(x) = k\ x^m$ k : constant m ? R	$f^1(x) = k\ m\ x^{m1}$
$D_x[f(x) \pm g(x)] = D_x[f(x)] + D_x[g(x)]$	

APPENDIX M and N

M: Table I**:** Matric Mathematics (s.g) Results at MICSECs 1999-2002

N: Table II**:** t and r values for the number of passes obtained at M1 and then M2 matched against the number of passes obtained at MICSECs 4 to 9

TABLE 1: MATRIC MATHEMATICS (SG) RESULTS OF MICSECS 1999-2002 (2000-2002)

MISEC		1999	2000	2001	2002	Total(4yrs)	Mean (4yr)	Total(3yrs)	Mean (3yr)
1	Candidates	59	57	60	43	219	55	160	53
	Passes	11	15	20	18	**64**	**16**	**53**	**18**
	% Passes	19	26.3	34	41.9	29.2	29.2	33.1	33.1
2	Candidates	61	33	24	36	154	39	93	31
	Passes	26	11	6	5	**48**	**12**	**22**	**7**
	% Passes	42.6	33.3	31.6	25	31.2	31.2	23.7	23.7
3	Candidates	1	10	14	9	34	9	33	11
	Passes	1	1	4	5	**11**	**3**	**10**	**3**
	%Passes	100	10	28.6	55.5	32.4	32.4	30.3	30.3
GI(1&2&3)	Candidates	121	100	98	88	407	102	286	95
	Passes	38	27	30	28	**123**	**31**	**85**	**28**
	% Passes	31.4	27	30.1	31.8	30.2	30.2	30	30
GI*(1&2)	Candidates	120	90	84	69	373	93	253	84
	Passes	37	26	26	23	**112**	**28**	**75**	**25**
	%Passes	30.8	29	31	33.3	30	30	30	30
4	Candidates	125	103	78	95	401	100	276	92
	Passes	3	4	12	14	**33**	**8**	**30**	**10**
	% Passes	2.4	3.9	15.4	14.7	8.2	8	11	11

5	Candidates	50	28	43	49	170	43	120	30
	Passes	31	16	10	33	**90**	**23**	**59**	**20**
	% Passes	62	57.1	23.3	67.3	52.9	52.9	49.2	49.2
6	Candidates	97	74	72	82	325	82	228	76
	Passes	26	16	16	41	**99**	**25**	**73**	**24**
	% Passes	26.8	21.6	22.2	50	30.1	30.1	32	32
GII(4&5&6)	Candidates	272	205	193	226	896	224	624	208
	Passes	60	36	38	88	**222**	**56**	**162**	**54**
	% Passes	22.1	17.6	19.7	39	24.8	24.8	26	26
GII*(5&6)	Candidates	147	102	115	131	495	124	348	116
	Passes	57	32	26	64	**189**	**47**	**132**	**44**
	% Passes	38.8	31.4	22.6	48.9	38.2	38.2	38	38
7	Candidates	66	64	64	66	260	65	194	65
	Passes	13	21	10	19	**63**	**16**	**50**	**17**
	% Passes	19.7	32.8	15.6	28.8	24.2	24.2	25.8	25.8
8	Candidates	105	56	72	57	290	73	185	62
	Passes	10	2	11	32	**55**	**14**	**45**	**15**
	% Passes	9.5	15.3	19.3	56.1	19	19	24.3	24.3
9	Candidates	22	59	80	104	265	66	243	81
	Passes	6	11	30	26	**73**	**18**	**67**	**22**
	% Passes	27.3	18.8	37.5	25		27.5		27.6
GIII(7&8&9)	Candidates	193	179	216	227	815	204	622	207
	Passes	29	34	51	77	**191**	**48**	**162**	**54**
	%Passes	15	19	23.6	33.9	23.4	23.4	26.1	26.1

GIII(7&9)	Candidates	88	123	144	170	525	105	437	146
	Passes	19	32	40	45	136	27	117	39
	% Passes	21.6	26	27.8	25.7	25.9	25.9	26.7	26.7
10	Candidates	50	25	43	36	154	39	104	35
	Passes	18	14	10	4	**46**	**12**	**2824.2**	**9**
	% Passes	36	56	23.3	11.1		30		27
W Cape	Candidates		18290	17456					
	Passes		9205	9555					
	% Passes		50.3	54.7					
National	Candidates	231200	245497	229075					
	Passes	72200	79631	72301					
	% Passes	**31.2**	**32.4**	**31.6**					
		4	*4*	*4*					
On par		*2*	*1*	*0*					
25+		*0*	*1*	*3*					
20+		*3*	*2*	*3*					
15+		*1*	*2*						
10&less		*10*	*10*	*10*					
Total									

T-Test: Number of Passes at M1 compared with M5, M6, M7 and M9 for the 3yr period

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	M1	17.6667	3	2.51661	1.45297
	M5	19.6667	3	11.93035	6.88799
Pair 2	M1	17.6667	3	2.51661	1.45297
	M6	24.3333	3	14.43376	8.33333
Pair 3	M1	17.6667	3	2.51661	1.45297
	M7	16.6667	3	5.85947	3.38296
Pair 4	M1	17.6667	3	2.51661	1.45297
	M9	22.3333	3	10.01665	5.78312

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	M1&M5	3	-.139	.911
Pair 2	M1&M6	3	.115	.927
Pair 3	M1&M7	3	-.893	.297
Pair 4	M1&M9	3	.979	.132

Paired Samples Test

		Paired Differences				
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper
Pair 1	M1-M5	-2.0000	12.52996	7.23418	-33.1262	29.1262
Pair 2	M1-M6	-6.6667	14.36431	8.29324	-42.3496	29.0163
Pair 3	M1-M7	1.0000	8.18535	4.72582	-19.3335	21.3335
Pair 4	M1-M9	-4.6667	7.57188	4.37163	-23.4763	14.1429

Paired Samples Test

		t	df	Sig. (2-tailed)
Pair 1	M1-M5	-.276	2	.808
Pair 2	M1-M6	-.804	2	.506
Pair 3	M1-M7	.212	2	.852
Pair 4	M1-M9	-1.067	2	.398

T-Test: Number of Passes at M1 compared with M5, M6, M7 and M9 for the 4yr Period

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	M1	16.0000	4	3.91578	1.95789
	M5	22.5000	4	11.26943	5.63471
Pair 2	M1	16.0000	4	3.91578	1.95789
	M6	24.7500	4	11.81454	5.90727
Pair 3	M1	16.0000	4	3.91578	1.95789
	M7	15.7500	4	5.12348	2.56174
Pair 4	M1	16.0000	4	3.91578	1.95789
	M9	18.2500	4	11.55783	5.77891

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	M1&M5	4	-.491	.509
Pair 2	M1&M6	4	.000	1.000
Pair 3	M1&M7	4	-.133	.867
Pair 4	M1&M9	4	.965	.035

Paired Samples Test

		Paired Differences				
					95% Confidence Interval of the Difference	
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper
Pair 1	M1-M5	-6.5000	13.62596	6.81298	-28.1819	15.1819
Pair 2	M1-M6	-8.7500	12.44655	6.22328	-28.5552	11.0552
Pair 3	M1-M7	.2500	6.84957	3.42479	-10.6492	11.1492
Pair 4	M1-M9	-2.2500	7.84750	3.92375	-14.7371	10.2371

Paired Samples Test

		t	df	Sig. (2-tailed)
Pair 1	M1-M5	-.954	3	.410
Pair 2	M1-M6	-1.406	3	.254
Pair 3	M1-M7	.073	3	.946
Pair 4	M1-M9	-.573	3	.607

T-Test: Number of Passes at M2 compared with M5, M6, M7, and M9 for the 3yr period

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	M2	12.0000	4	9.69536	4.84768
	M5	22.5000	4	11.26943	5.63471
Pair 2	M2	12.0000	4	9.69536	4.84768
	M6	24.7500	4	11.81454	5.90727
Pair 3	M2	12.0000	4	9.69536	4.84768
	M7	15.7500	4	5.12348	2.56174
Pair 4	M1	12.0000	4	9.69536	4.84768
	M9	18.2500	4	11.55783	5.77891

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	M2 &M5	4	.387	.613
Pair 2	M2 &M6	4	-.102	.898
Pair 3	M2 & M7	4	-.215	.785
Pair 4	M2 &M9	4	-.860	.140

Paired Samples Test

		Paired Differences				
					95% Confidence Interval of the Difference	
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper
Pair 1	M2-M5	-10.5000	11.67619	5.83809	-29.0794	8.0794
Pair 2	M2-M6	-12.7500	16.02862	8.01431	-38.2551	12.7551
Pair 3	M2-M7	-3.7500	11.89888	5.94944	-22.6838	15.1838
Pair 4	M2-M9	-6.2500	20.50000	10.25000	-38.8701	26.3701

Paired Samples Test

		t	df	Sig. (2-tailed)
Pair 1	M2-M5	-1.799	3	.170
Pair 2	M2-M6	-1.591	3	.210
Pair 3	M2-M7	-.630	3	.573
Pair 4	M2-M9	-.610	3	.585

T-Test:Number of Passes at M2 compared with M5, M6, M7 and M9 for the 4yr period

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	M2	12.0000	4	9.69536	4.84768
	M5	22.5000	4	11.26943	5.63471
Pair 2	M2	12.0000	4	9.69536	4.84768
	M6	24.7500	4	11.81454	5.90727
Pair 3	M2	12.0000	4	9.69536	4.84768
	M7	15.7500	4	5.12348	2.56174
Pair 4	M2	12.0000	4	9.69536	4.84768
	M9	18.2500	4	11.55783	5.77891

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	M2& M5	4	.387	.613
Pair 2	M2&M6	4	-.102	.898
Pair 3	M2 &M7	4	-.215	.785
Pair 4	M2&M9	4	-.860	.140

Paired Samples Test

		Paired Differences				
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper
Pair 1	M2-M5	-10.5000	11.67619	5.83809	-29.0794	8.0794
Pair 2	M2-M6	-12.7500	16.02862	8.01431	-38.2551	12.7551
Pair 3	M2-M7	-3.7500	11.89888	5.94944	-22.6838	15.1838
Pair 4	M2-M9	-6.2500	20.50000	10.25000	-38.8701	26.3701

Paired Samples Test

		t	df	Sig. (2-tailed)
Pair 1	M2-M5	-1.799	3	.170
Pair 2	M2-M6	-1.591	3	.210
Pair 3	M2-M7	-.630	3	.573
Pair 4	M2-M9	-.610	3	.585

*