THE WESTERN CAPE EDUCATION DEPARTMENT

MATHEMATICS, SCIENCE AND TECHNOLOGY STRATEGY

2002 - 2008

CONTENTS

PREFACE

Sustainable development is a challenge in the Western Cape. In order to grow tomorrow, we need to invest in growth today. Our Province has many assets – natural beauty, thriving agriculture and technical expertise. But beauty can be polluted, resources can be drained and skilled people need to be replaced. The first investment we need to make is in our people, especially those in schools. One key area for growth is the development of scientific, mathematical and technological skills of our young people. This STRATEGY outlines a plan to build a strong mathematics and science base in Western Cape schools.

We support the national vision for "a scientifically literate, technologically fluent and mathematically literate society that empowers individuals to participate in the emerging knowledge-based economy and supports sustainable development."

I invite each reader of this STRATEGY, whether you are a learner, parent, educator, or business person, to support this initiative to grow the ability of our Province to provide scientific skills for the ongoing and responsible development of Africa.

André Gaum
WESTERN CAPE MINISTER OF EDUCATION

FOREWORD

We face an enormous challenge to develop strong scientific skills in our young people. A vibrant culture of scientific enterprise will not arise by itself. There are enormous disparities in the performance of our young people, especially in mathematics and science. The potential of talented young people is too precious to waste. The foundations for excellence need to be carefully planned and laid during the early years of schooling.

But on its own the STRATEGY is only a plan. In publishing this strategy, WCED commits itself to dealing with the Mathematics, Science and Technology problems by ensuring redress in education and creating a framework for co-operation in this critical terrain. This strategy will only achieve its goal by consistently following a well-chosen direction over the obstacles which have prevented us from ensuring that every young person has a fair chance to reach for the stars. This STRATEGY seeks redress in education by expanding the base for growth.

The STRATEGY aims at all levels in our schools. It aims to support educators, learners and parents in working for significant achievement in the science subjects in this first decade of the new millennium, and lays a carefully planned foundation for excellence.

Ronald B. Swartz
WCED

THE WESTERN CAPE EDUCATION DEPARTMENT MATHEMATICS, SCIENCE AND TECHNOLOGY STRATEGY

VISION STATEMENT

The Western Cape Education Department's (WCED's) vision is of a scientifically literate, technologically fluent and numerically/mathematically literate society that empowers individuals to participate in the emerging knowledge-based economy and supports the ideal of sustainable development.

MISSION STATEMENT

To increase learner participation and success rates in mathematics, science and technology through enhancing the teaching and learning of science, mathematics and technology in the General and Further Education and Training bands, including LSEN and ABET.

PROBLEM STATEMENT

- The small number of learners who choose Mathematics and Physical Science as subjects in Grade 10.
- The small number of learners taking these subjects at the Higher Grade level.
- The low pass rate in these subjects from Grade 10-12, especially at the Higher Grade level.
- The low numeracy ratings of learners in Primary Schools, according to local and international studies.
- The under-supply of qualified Mathematics, Physical Science and Technology teachers.
- The lack of adequate facilities and resources to ensure effective learning and teaching in these subjects.
- The lack of financial support for qualifying learners to study in these fields at the tertiary level.

1. WESTERN CAPE SENIOR CERTIFICATE MATHEMATICS AND PHYSICAL SCIENCE RESULTS 2001.

Number of learners from Ex Cape Education Department schools ... 12 359 (35.07%)
Number of learners from Ex House of Representative schools ... 17 159 (48.69%)
Number of learners from Ex Department of Education and Training schools ... 5 722 (16.24%)

Number of Ex CED Schools ... 117
Number of Ex HOR Schools ... 151
Number of Ex DET Schools ... 50

SUBJECT OFFERINGS					
SCHOOLS	No. OF SCHOOLS	MATHS HG	MATHS SG	PHYS SC HG	PHYS SC SG
EX CED	117	109	116	109	113
EX HOR	151	70	151	77	132
EX DET	50	22	50	24	49

		MATHS HG	MATHS SG	PHYS SC HG	PHYS SC SG
EX CED	Numbers who wrote	2839	5554	2768	2262
	As a % of SC Candidates	23%	44.9%	22.4%	18.3%
	Numbers who passed	2661	4845	2617	2067
	% pass	93.7%	87.2%	94.5%	91.4%
EX HOR	Numbers who wrote	396	6693	444	2939
	As a % of SC Candidates	2.3%	39%	2.6%	17.1%
	Numbers who passed	259	2901	352	1977
	% pass	65.4%	43.3%	79.3%	67.3%
EX DET	Numbers who wrote	59	4122	61	2334
	As a % of SC Candidates	1%	72%	1.1%	40.8%
	Numbers who passed	28	1048	41	956
	% pass	47.5%	25.4%	67.2%	41%

National Senior Certificate results show that in recent years, the Western Cape Senior Certificate HG and SG pass rates in both Physical Science and Mathematics have compared favourably with those recorded by other provinces. However, the distribution of the WCED Senior Certificate results in the above table reveals that schools in the Western Cape remain significantly divided in terms of achievement in the science subjects.

In summary, the disturbing facts and figures are:

- 68% of all ex Model C Senior Certificate candidates wrote Mathematics.
- 41% of all ex HOR Senior Certificate candidates wrote Mathematics.
- 73% of all ex DET Senior Certificate candidates wrote Mathematics.
- The relatively small number of learners taking Mathematics and Physical Science at ex HOR schools.
- The low number of learners taking these subjects at the HG level.
- The low pass rate at ex HOR and DET schools.

The low participation and pass rates in mathematics and science may be due to problems which arise at lower levels in the education system. In the past four years studies at the Grades 3, 4 and 8 levels have found that learners are performing well below their grade level.

In 2001 the Joint Education Trust conducted the Grade 3 Learner Assessment Study on behalf of the WCED in a random sample of 100 schools. The test covered four strands of mathematics, namely counting and ordering, addition, subtraction and multiplication. The study found that the majority of Grade 3 learners at these schools were not able to accurately complete Grade 3 mathematics items and experienced difficulty with mathematics at Grade 1 and Grade 2 levels. In particular, the study found that some learners' ability in addition is confined to adding two single digit numbers. Learners' capacity to add and subtract numbers decreased rapidly as the numbers involved in the problem increased. Learners struggled particularly with addition of numbers requiring carrying and large numbers of learners were not able to correctly solve items requiring carrying or crossing over the number 100.

The Monitoring Learning Achievement Project (February 2000) was conducted on Grade 4 learners in 14 African countries. Four hundred schools in South Africa were involved and of these 28 schools were in the Western Cape. The findings of the study were that:

- the Western Cape learners achieved an average of 37,9% which was above the national average numeracy mark for Grade 4 learners of 30%.
- the Western Cape learners achieved marks below the other participating countries.
- rural Western Cape schools achieved marks significantly lower than their metropolitan counterparts.

Third International Mathematics and Science Repeat Study (TIMSS-R)

A study of the Mathematics and Science Literacy of Grade 8 learners in 1999 found South Africa ranked last out of 39 participating countries. The Western Cape had the highest average for Mathematics among the provinces with 381 scale points, but this was still significantly below the international mean of 487.

RESPONSE TO THESE CRITICAL INDICATORS: THE WCED MST STRATEGY

In light of the results and findings of the above research projects the WCED will focus on three areas in striving towards its vision of increased participation and success rates in Mathematics and Science. The WCED aims:

TEACHER DEVELOPMENT

To increase the number of capable teachers able to offer effective Mathematics, Science and Technology (MST) education, including the assessment of key MST concepts.

PROVISIONING OF RESOURCES AND LEARNING SUPPORT MATERIAL (LSM)

To provide adequate support and resources, including ICT, to deliver quality Mathematics, Science and Technology education for all learners. In the FET Band this will include establishing and supporting schools which focus on Mathematics and Science.

DIAGNOSTIC TESTING IN GRADES 3, 6 AND 9

To provide detailed information on the nature and location of barriers to learning in MST in order to plan the required interventions.

MANAGING THE MST STRATEGY

The MST Task Team will be chaired by the Director: Curriculum Development and composed as follows:

- 1 representative of the Dinaledi / Science Focus Schools
- 1 representative from the EMDC's
- 1 representative from the Higher Education Institutions
- 1 representative of the Inset Providers' Coalition
- 3 Union representatives

The following officials from the WCED Head Office will also serve on the MST Task Team:

- Chief Education Specialist (Generic)
- Senior Curriculum Planner: MST (including Numeracy)
- Senior Curriculum Planner: Mathematics
- Senior Curriculum Planner: Physical Science
- Senior Curriculum Planner: Technology
- Senior Project Manager: Sciences

In addition, the WCED will engage the services of agencies to manage specific projects. The WCED has established partnerships in developing and delivering MST projects with various funders and NGEOs such as:

- South African Institute of Race Relations (SAIRR)
- South African Institute for Leadership in Industry (SAILI)
- STAR schools,
- The Learning Channel

The WCED will encourage further partnerships via the Service Provider Protocol.

SPECIFIC GOALS AND STRATEGIES FOR THE VARIOUS PHASES

FOUNDATION PHASE

Learner goals

1. To increase numeracy skills: i.e. develop a strong number concept emphasising mental mathematics.
2. To develop learners' spatial relations ability.
3. To focus and stimulate the natural curiosity of learners in the disciplines of Mathematics, Science and Technology.

Strategies to attain goals

Teacher Development – all teachers in the Foundation Phase are to be trained on the National Curriculum Statement for Mathematics

The National Curriculum Statement (NCS) will be implemented in the Foundation Phase in 2004. Teacher training is scheduled for 2003. All Foundation Phase teachers will receive training. This training gives the WCED the opportunity to focus on developing numeracy concepts and skills. Further, as part of their training, Foundation Phase teachers will be provided with a "Teachers' Guide for Foundation Phase Numeracy" and they will be guided in the use of this document and the implementation of the learning programme.

In addition, special projects, e.g. Multigrade Rural School Intervention, will address the needs of teachers in disadvantaged, rural and remote schools.

Resources and Learning Support Material

All schools with Foundation Phase learners will receive packs of equipment to support mathematics, science and technology teaching.
The NCS will be issued to all Foundation Phase teachers.
All Grade 3 learners will receive mathematics learning support material.

Diagnostic testing

Reading and numeracy tests will be administered to Grade 3 learners in all WCED schools. The tests will be administered to 40 learners in each of the schools unless there are fewer than this number of Grade 3 learners in the school. Both the reading and the numeracy tests should be administered in the three major languages of the Western Cape. Testing should be undertaken in late October of 2002, 2004 and 2006.

INTERMEDIATE PHASE

Learner goals

1 To build the initial conceptual framework in MST.
2 To consolidate the basic skills:
   - Mathematics: number concepts, fractions, spatial concepts and data handling.
   - Science: the process skills.
   - Technology: the technological design skills.
3. To ignite learners' feeling of wonder and stretch their imagination towards Mathematics, Science and Technology.

Strategies to attain the goals

Teacher Development – all teachers in the Intermediate Phase are to be trained on the National Curriculum Statement for Mathematics

The NCS will be implemented in the Intermediate Phase in 2005. Teacher training is scheduled for 2004. All Intermediate Phase teachers will receive training. Further, as part of their training, Intermediate Phase teachers will be provided with a "Teachers Guide for Intermediate Phase Mathematics" and teachers will be guided in the use of this document and learning programme implementation.

In addition, special projects, e.g. Multigrade Rural Schools Intervention, will address the needs of teachers in disadvantaged, rural and remote schools.

Resources and Learning Support Material

Learning Support Materials in line with the NCS will be supplied in 2004/5.
New resource material will be made available to schools to support the teaching of science and technology.
The NCS will be issued to all Intermediate Phase teachers.
All Grade 4, 5 and 6 learners will receive mathematics learning support material.

Diagnostic testing

Reading and mathematics tests will be administered to Grade 6 learners in all WCED schools. These tests should be administered in the three major languages of the Western Cape. Testing should be undertaken in late October in years 2003, 2005 and 2007.

SENIOR PHASE

Learner goals

1. To further develop the knowledge base and skills in Mathematics, Science and Technology.
2. To bridge the gap between primary and secondary school effectively.
3. To increase learners' interest in Mathematics and Science, so that they will choose science subjects in the FET band.

At this level the MST STRATEGY is largely based on projects and teacher training courses. The emphasis at this level is to encourage learners to choose Mathematics and Physical Science in the FET band. Subject and career guidance will be encouraged at schools to guide the learners in their choice of subjects. Interest in mathematics and the sciences will be fostered by an annual competition for Grade 7 learners.

Strategies to attain the goals

Teacher Development – all teachers in the Senior Phase are to be trained on the National Curriculum Statement for Mathematics

The NCS will be implemented in the Senior Phase from 2006 to 2008. All Senior Phase teachers will receive training from 2005 and 2007.

In addition, special projects, e.g. Thintana MST Project, will address the needs of teachers in disadvantaged, rural and remote schools.

Resources and Learning Support Material

Learning Support Materials to support the NCS will be delivered in 2005/6.
Scientific apparatus and chemicals will be distributed, depending on schools' needs.

Technology equipment for Grades 8 & 9 will be developed and piloted in 2 clusters of WCED schools in 2003. The equipment will meet the requirements of the NCS. Part of the cost of making the above equipment available to all schools will be borne by the school concerned according to a sliding scale based on relative poverty indicators.

Diagnostic testing

Reading and mathematics tests will be administered to Grade 9 learners in all WCED schools. These tests should be administered in the languages of instruction. Testing should be undertaken in late October of 2004, 2006 and 2008. The results of these tests, taken together with the outcomes of the Common Tasks for Assessment will be used to develop programmes and support for schools.

FURTHER EDUCATION AND TRAINING BAND

Learner goals

1. To increase the number of learners taking Mathematics and Science, especially on Higher Grade.
2. To increase the pass rate and performance of learners taking Mathematics and Science, especially on the Higher Grade and particularly for previously disadvantaged learners.
3. To encourage learners to choose the mathematical and scientific fields of study at the tertiary level.

Schools will be encouraged to start or develop various clubs related to mathematics and science e.g. chess clubs, science clubs etc.

Strategies to attain the goals

Teacher Development

The NCS will be implemented in the FET Band (Grades 10 - 12) from 2004 to 2008. In terms of the new FET certificate all learners will study either Mathematics or Mathematical Literacy. In preparation for the introduction of Mathematical Literacy in all schools at Grade 10 in 2004, 175 teachers will be trained during 2003 to take on this responsibility. Universities will be encouraged to develop an Advanced Certificate of Education (ACE) in Mathematical Literacy to encourage teachers to retrain in this field.

In addition, ACE courses for teachers in Mathematics and in Physical Science will be run by the Higher Education Institutions in the province. The WCED will seek bursaries for teachers taking these ACE courses. A similar ACE course will be run for Computer Studies teachers from 2004.

There are currently 40 prospective B.Sc. graduate teachers on WCED bursaries. This programme will be expanded in the period 2003 - 2008.

In addition, teachers will receive training as part of large interventions by NGEOs and universities.

Resources and Learning Support Material

All learners will be provided with textbooks for Science and Mathematics or Mathematical Literacy in the period 2004 - 2006.

Creating MST-focused schools

The WCED will develop and support a number of MST-focused schools in the period 2002 – 2008.

The **Dinaledi Project** is a Mathematics and Physical Science initiative of the national Department of Education. There are six Dinaledi schools in the Western Cape. In 2002 the WCED funded two further schools, so that there is one MST-focused school in each EMDC. As part of the MST Strategy of the Western Cape two more schools in disadvantaged areas will be resourced this year (2002).

The aim of the Dinaledi Project is:

- To increase the number of learners, especially girls, studying Mathematics and Physical Science in Grades 10-12.
- To increase the number of learners taking these subjects on Higher Grade.
- To increase the pass rate in Mathematics and Physical Science, especially on Higher Grade.
- To increase the capacity of the teachers to deliver quality Mathematics and Physical Science education.
- To encourage learners to choose the science field of study at the tertiary level.
- To have well-resourced schools with access to computer-aided learning.

The **Centre of Science and Technology** (COSAT) was started in 1999 in response to the need in disadvantaged areas for learners to take and do well in Mathematics and Science, especially on the Higher Grade. COSAT is an initiative of the Western Cape Education Department and is based at the Good Hope College in Khayelitsha. In addition to offering specialised tuition in Science, Mathematics and Information Technology for a selected group of full-time Grade 10-12 learners, COSAT is reaching out to surrounding township schools. The "Mathematics and Physical Science Higher Grade Jumpstart Programme" seeks to reverse the dramatic decline in Senior Certificate Higher Grade enrolments and performance in these two subjects in local schools. When the Dinaledi project started, COSAT was included in the project.

There are several general projects in the WCED, e.g. the Learning Schools project, which do not focus on any one subject or aspect of academic delivery. Their interventions have nonetheless had an impact on overall performance, and thus also on numeracy and the sciences.

The Mathematics and Science Academy aims to identify and recruit learners with high potential, especially from disadvantaged communities, to place them in a special school (academy), and to recruit competent staff. The Academy will be equipped with effective teaching and learning materials. The Academy will provide for learners from various racial and cultural groups. It will provide hostel accommodation and transport and will recruit sponsors (bursaries).

CONCLUSION

The MST STRATEGY intends to develop teachers' potential to deliver learner-centred, innovative teaching founded on outcomes-based principles. Through this strategy schools will be better resourced and a learner population will be developed which is mathematically, technologically and scientifically literate and capable of meeting the challenges of the 21st century.

Challenges to be addressed.

Educators:
Generate an adequate supply of trained teachers.
Offer support for dealing with large classes.
Develop teaching materials to deal with HG & SG learners in the same class.
Encourage alternatives to teacher-centred teaching.
Mentor teachers in sound, multi-level questioning and formal assessment.

Learners:
Advocate appropriate stimulation at an early age of children from low socio-economic areas.
Develop understanding of perceptual and spatial concepts.
Build comprehension of basic principles.
Enhance a culture of study and reflection.
Counter the perception that Mathematics is difficult and only for clever learners.

Curriculum:
Develop quality assessment strategies.
Set assessment in appropriate languages for various levels.
Streamline curriculum planning in order to reduce load.
Develop the ability to express understanding of Mathematics and Science concepts.

General:
Secure adequate physical resources and storage facilities.
Increase opportunities for practical work highlighting applications of MST.
Build supplies of varied Learning Support Material.
Promote community support for participation in Mathematics and Science.

Special Projects

The WCED has planned a number of projects to support the MST Strategy in disadvantaged schools and multi-grade classes. These projects are discussed below. Additional projects will be added when resources become available or when research shows the necessity.

The Cape Teaching Institute will offer a six-week full-time training course in Mathematics, Mathematical methodology and continuous assessment for the Foundation Phase to 300 teachers in 2003. In 2002, 50 teachers were selected to undergo this six- week training course.

The **Multigrade Rural Schools Intervention** will offer training to Foundation Phase teachers in small and remote schools. In this Project

- Teachers are trained to efficiently manage and organise their multigrade classrooms
- Teachers are trained to use, develop and apply learning programmes optimally with the support of Information and Communication Technologies.

Advanced Certificate of Education (ACE) courses are offered in Mathematics, Science or Technology. One hundred and fifty teachers are training in these three areas through the University of Cape Town, the University of the Western Cape and the University of Stellenbosch. Bursaries have been awarded to teachers taking the ACE.

Short courses of accredited **Assessor training in Mathematics, Science and Technology Education** are planned for selected Grade 4 and 5 teachers in 2003 and for Grade 6 and 7 teachers in 2004. These courses will enhance the knowledge and skills of teachers, especially in the areas of learner-centred activities and continuous assessment. The teachers will thus be well equipped to implement the NCS.

The **Thintana MST Project** is one of the largest and most comprehensive single interventions in the teaching and learning of Mathematics, Science and Technology (MST) at historically disadvantaged secondary schools in the post-apartheid era in South Africa. Two hundred such schools, of which 20 are in the Western Cape, have received equipment and training to advance the teaching and learning of MST. In addition to this, two centres of excellence are being established in each province. These hubs are to function in support of the chosen schools and will offer training to teachers, learners and the community surrounding the centres. Each centre is furnished with a server, PCs, printers, internet access, a range of technology and science equipment and software for computer based training in MST. In the Western Cape the centres are at the Peninsula Technikon (Bellville) and COSAT (Khayelitsha).

The **Khanya Project** aims to provide computers and related technology to all Western Cape schools by 2012 and to provide learners in these schools with ICT skills that can be used as tools in schools, tertiary education and the workplace. In particular, a support programme for Mathematics Higher Grade is offered on the Khanya computers for Grade 10 to12 learners.

The **e-Curriculum Project** is aimed at exploring whether it is feasible for digital technology to become a primary medium through which curriculum planners can develop, deliver and support curricula. It plans to make available further links to databases of resources which teachers can access. This will include MST resource material.