HUMAN SCIENCES RESEARCH COUNCIL

ASSESSMENT TECHNOLOGY AND EDUCATION EVALUATION

SUPPLEMENTARY TUITION IN MATHEMATICS AND SCIENCE

An Evaluation Of The Usefulness Of Different Types Of Supplementary Tuition Programmes

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EXECUTIVE SUMMARY

The Department of Science and Technology (DST) is committed to supporting the Supplementary Tuition sector as a way of improving the learner performance in mathematics and science at the senior secondary level. To assist with the policy formulation process, the DST commissioned the HSRC to firstly, develop a database of service providers in order to develop a typology of supplementary tuition providers and secondly, to evaluate the usefulness of supplementary tuition programmes and present the DST with a strategy document to expand the programme to allow access to a larger number of learners.

The key research questions in this second part of the study are:

1. To evaluate the usefulness of supplementary tuition programmes in terms of quality, impact and cost of the different types of interventions.

2. To develop models of supplementary tuition interventions that can serve different types of learners and which can be replicated in different parts of the country.

3. To present a strategy document (including resources) to expand the programme to allow access to a greater number of learners.

In order to answer these questions we looked at programmes in the 5 typologies we has identified in the first part of the study

1. Programmes linked to tertiary institutions
2. NGO programmes (established NGOs) and newer community based programmes
3. Science centre programmes
4. Franchises providing instruction to individuals
5. Media based programmes (e.g. TV, newspaper supplements).

We developed case studies for each of these typologies. The case studies were constructed around the following structure: programme description, quality, impact and cost. To develop the case studies we observed programmes, analysed programme documents, interviewed co-ordinators, tutors and learners. This information was analysed and case studies for each of the typologies were written.

On re-examining our typology we could categorise the provision of supplementary tuition as three types:

- Face to face instruction to small groups
- Individualised instruction
- Mass based instruction.

Our key findings for each of these sectors are:

Face to face instruction to small groups

1. There are different types of organizations offering programmes –tertiary institutions, non-governmental organizations, community based organizations, science centres. Some of these organizations have infrastructural resources for the teaching of mathematics and science and others not.

2. Generally these programmes offer mathematics, physical science and a small amount of career guidance. The science and mathematics offered in supplementary tuition, at the FET phase are closely linked to the school curriculum.

3. Most programmes are designed as structured inputs, offered on Saturdays and, maybe a block period during the July vacation, in the grade 10, 11 or 12 years or grade 11 and 12 year of schooling.

4. Most programmes operate in urban areas and transport is offered to learners as part of the programmes.

5. Most programme target higher grade learners, because they recognize this as the leverage point.

6. The tutors on the programme may be school teachers from the area, or a teacher from the ex Model C or private schools or postgraduate students at the tertiary institutions.

7. The instructional programme is generally offered on a 'chalk and talk basis'. That is, the tutor stands in front and introduces or revises key concepts. There is very little experimental work or demonstrations and most of the instruction in the Saturday classes mirrors what happens in schools and this is especially so where the Saturday tutors are school teachers.

8. The effective programmes are those offered in small groups where the optimum learners to tutor ratio is 25:1.

9. There is a cost incurred for learners and in the case of the small group instruction this cost is provided by social responsibility funds of private sector.

10. The length of the programme and the cost per learner in the different programmes varies. Programmes which have a residential component are more costly.

11. An evaluation of the impact of the programme indicates that the learners who attend do pass with math and science on the higher grade and many proceed to tertiary studies. Many of the university offered programmes include the incentive of scholarships to students who had participated in these programmes.

12. Learners could proceed with science based studies or studies in either scarce areas (e.g. actuarial science). The Supplementary Tuition programme has also offered learners insights into the 'non-conventional' career choices.

13. The cost of the programme varies from R800 per learner (in institutions where a number of costs are absorbed by the institution) to around R3215 (for a residential course) in the tertiary sector programmes; from around R1700 to around R7000 (for 52 contact sessions and where every part has to be paid for the NGO) in the NGO sector and for around R3700 for the science centre offered programmes.

In individualized own pace settings

1. There are computer based programmes, like MasterMath and Plato, which are based, offered on a modular basis and learners work at their own pace.

2. MasterMath modules are based on the South African curriculum and Plato has a number of generic modules that can be put together as a set for the learner.

3. In these computer based programmes, learners may enroll for a particular section of work that they feel they need extra attention in or enroll for a longer period (payment is on a monthly basis).

4. Instruction is offered for the material that the learner wants, and the learner works at her pace on the material. The programme involves diagnosis of the student understanding of the section, revision of prior concepts (if necessary), building up of the concept, practice exercises and immediate feedback from tutors.

5. The MasterMath programmes operate mostly in urban centres and in suburbs where parents could afford to pay for the extra tuition and the Plato programmes have been installed at FET institutions.

6. In the MasterMath programme there are facilitators who have competence in the FET math curriculum, the Plato system is 'free of human element' and may have an administrator for the programme.

Mass based instruction

1. There are different forms of mass based instruction for supplementary tuition– e.g. television broadcast, newspaper supplements, textbooks, study guides.

2. In the broadcast sector there are 2 different types of broadcast: one involves tutors setting up the topic for a section of work, e.g. electric circuits and linking up to a school where learners send in their questions and the tutor works through the example with linking up to concepts – the presenter does all the talking. In the other type of broadcast, the lesson is pre-recorded and there is a building up of the concepts.

3. The broadcast times in both programmes are, on weekdays, during school time and on Saturday morning. The viewer ship for these programmes is not only school learners but parents, people in old age homes etc. Access for school learners will be for those that are at home or by taping the programme and watching at a different time.

4. The television programme involves learners watching the programme and may be non-interactive. In one programme the tutor talks all the time and the medium is not used to demonstrate or illustrate concepts. It is difficult to assess what and how cognitive or higher order learning skills and knowledge are gained by learners.

5. Newspaper supplements are useful resource for learners to work past year examination papers.

6. Good textbooks, which both develop the concept as well as provide learners with practice examples are a good resource of structured learning materials.

Recommendations

One indicator of the poor state of mathematics and science education is the number of mathematics higher grade passes in the country. In 2002, of those who wrote the national department of education examinations, there were 19 798 HG passes and of these 4637 were Africans learners (2889 learners came from DET schools and 1557 learners came from ex HoA schools). This number must be increased and the biggest concern is with the number of African learners passing with higher-grade mathematics. In the same examination there were 7184

female African learners and 9634 male African learners taking HG mathematics. Of these 1638 females and 2999 males passed. The supplementary tuition strategy must be explicit about the participation of males and females in the programme.

Supplementary tuition has generally been for learners who could afford to pay for the tuition – therefore it is inaccessible to poor learners. Our recommendation is that the DST strategy targets learners who most need the assistance – that is to target African learners in African and ex House of Representative schools. Further, learners who are enrolled for mathematics at the higher grade in these schools must be targeted. This is to ensure that the number and quality of higher grade passes in these schools is increased and thus giving access to the more disadvantaged learners to enter scientific and technical careers through tertiary level training.

There are different types of programmes that the DST can support.

For the face to face instruction in small groups:

They should encourage organizations who are already offering such programmes to apply for funding from the DST to offer such a programme to rural learners. The organizations which have the infrastructure and experience to offer these courses should be utilized. These organizations must continue with the supplementary tuition programmes that they currently offer and be encouraged to offer these programmes to other cohorts of learners.

The primary initial target group should be rural learners, as there are no programmes for them.

The DST should make available money for these institutions to access. It is recommended that the institutions should then apply (according to requirements set down by DST) for this money so that they can offer the programmes.

For the individualised instruction at the learners pace:

DST should offer bursaries for higher-grade learners from the townships to attend. In addition the DST and private sector should start negotiations about how such a programme could be made accessible to rural learners.

The programmes have an audio and video element. The DST should consider funding the cost of translating the audio component into African languages so that African learners would find the programme more accessible.

For mass based instruction

DST should engage with funders and programme designers about offering a pedagogically sound programme that will build the learners concepts and demonstrate concepts that they would otherwise not interact with in the regular classroom situation.

In addition DST should negotiate for such programmes to be offered in accessible times.

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ACRONYMS

CAL	Computer-assisted learning
CASME	Centre for the Advancement of Science and Mathematics Education
CBO	Community Based Organisations
CBT	Computer-based Teaching
CEO	Chief Executive Officer
CTP	Committee of Technikon Principals
DET	Department of Education and Training
DoE	Department of Education
DST	Department of Science and Technology
DSTV	Digital Satellite Television
FET	Further Education and Training
FETC	Further Education and Training Certificate
HET	Higher Education and Training
HESA	Higher Education South Africa
HG	Higher Grade
HSRC	Human Sciences Research Council
ICT	Information and Communication Technology
MST	Maths, Science and Technology
MM	MasterMaths
NCS	National Curriculum Statement
NGO	Non-Governmental Organisation
OBE	Outcomes-based Education
SAASTA	Southern African Agency for Science and Technology Advancement
SAASTEC	Southern African Association for Science and Technology Centres
SAILI	Scientific and Industrial Leadership Initiative
SAUVCA	South African Universities' Vice-Chancellor's Association
SCE	Senior Certificate Exam
SEASA	Science and Engineering Academy of South Africa
TIMSS	Trends in International Mathematics and Science Study

UCT	University of Cape Town
UDW	University of Durban-Westville
UKZN	University of Kwazulu-Natal
UniZul	University of Zululand
UP	University of Pretoria
UWC	University of the Western Cape

CHAPTER 1

SUPPLEMENTARY TUITION IN MATHEMATICS AND SCIENCE: AN EVALUATION OF THE USEFULNESS OF DIFFERENT TYPES OF SUPPLEMENTARY TUITION PROGRAMMES

1. Context and Background

The Department of Science and Technology (DST) and other government departments, agencies and business have repeatedly expressed discontent and concern at the unsatisfactory performance of learners in Mathematics, Science and Technology (MST) in the Further Education and Training (FET) phase. The poor performance is confirmed in a number of studies of matric performance including the Trends in International Mathematics and Science Study (TIMSS). The low level of performance has a knock-on effect in the Higher Education and Training (HET) phase, evidenced in the low levels of participation in Maths, Science and Technology related professions at tertiary education institutions, and consequently impacts on the national economy. The Department of Science and Technology has expressed the need to support the supplementary tuition sector as one of the initiatives, which attempts to break the cycle of the poor state of science and mathematics education in the country.

The HSRC conducted research for the DST to assess the extent, nature and cost of out-of–school mathematics, science and computer studies programmes, which cater for secondary school learners (Reddy, Lebani, Davidson; 2003). In this study we developed a database of programmes, projects, organizations, individuals and institutions that offered mathematics, science and computer studies out of school programmes to learners at the Further Education and Training level. From the database we developed a typology of different types of out of school programmes.

The next phase of the study involved evaluating the usefulness of the different types of interventions. Findings of such an evaluation were to be used to develop a model of out of school programmes, which can be replicated in different parts of the countries.

2. Key findings from Phase One which impact on Phase Two

i. There are a range of individuals, organizations and institutions that provide supplementary tuition.

ii. The type of organisations who offer supplementary tuition include private sector organisations who offer their services for profit, franchises who offer tuition to a large client base; online instruction for learners with access to computer facilities; instruction on television learning channels; non-governmental and community based organisations; supplementary tuition initiated by the provincial departments of education in partnership with service providers and outreach programmes attached to universities and technikons.

iii. Most initiatives generally operate in urban metropolitan areas.

iv. There are more mathematics and science than computer studies supplementary tuition programmes.

v. Instruction in the programmes is mostly linked to the school curricula and the purpose of the intervention is enhancing the quality of the passes in the matriculation examination.

vi. There is a cost associated with access to out of school programmes.

vii. Some initiatives target high performing learners to give them a better chance for access and success at tertiary institutions but most initiatives are open to any student who can pay to attend.

viii. Access to supplementary tuition programmes is dependent on geographical location and having funds to pay.

3. The DST Strategy to change the status of MST

DST has instituted a three-pronged strategy to address the problem. These are synthesised as:

i. There is a need to excite learners about Science and Technology at an early age so that they are inspired to sustain this interest at secondary and tertiary levels.

ii. There is a need to provide adequate academic support (in out of school situations) to learners to enable them to achieve the necessary grade levels for participation in Maths, Science and technology at higher education levels.

iii. There is a need to expose learners to career opportunities in the fields of Maths, science and Technology to encourage them to follow science related careers.

While each of the above goals is singularly and collectively essential in addressing the problem of low performance and participation, this proposal concerns itself with the second identified strategy: *to provide appropriate support, in out of school situations (and this project looks specifically at supplementary tuition as one of the out of school situations) to FET learners.*

Based on the typology provided by Reddy et al (2003), the challenge for DST is to identify and isolate preferred models of best practice with the view to providing support to these programmes, so that they could be expanded. Once the key features of successful intervention models have been identified the next challenge would be to cost the various models so that the DST may find appropriate strategies to ensure that these programmes are available to learners that cannot access this sector at the moment.

4. Research Objectives of Phase Two of this study

Phase Two of this study seeks to achieve the following objectives:

i. To evaluate the usefulness, in terms of quality, impact and cost of the different types of interventions.

ii. To develop models of supplementary tuition interventions that can serve different types of learners and which can be replicated in different parts of the country.

iii. To present a strategy document, including resources needed, to the DST to expand the programmes to allow access to a greater number of learners.

5. Research Approach

We employed a case study methodology in an attempt to gain insights into various models of supplementary tuition support for Mathematics, Science and computer studies. The case study's advantage is that it helps provide an analytical description of the pedagogical merit (quality) and impact of the programme. The case study included interviews with service providers, observation of the programme in action, analysis of curriculum documents, interviews with learners and parents.

The case study examined **two examples** of each of the following types of initiatives:

- Tertiary sector
- NGO sector (established non-governmental organisations and newer community based organization)
- Science Centres
- Franchises
- Media sector (Online instruction to learners and instruction on TV learning channels)

6. Research Activity Matrix

Component	Activities	Deliverables
Establishing the Terms of Reference	Interviews with the Department of Science and Technology about their strategic mission and the groups of learners they would want to target.	A research proposal outlining specifications, scope, budget and time frames
Sampling	Identify one institution/ organisation representing each of the above categories. Negotiate their participation in the research	Send letters of invitation to institutions to participate in research.
Instrument Design	Instrumentation workshop • Design instruments • Briefing and training on data collection	• Curriculum analysis schedules • Interview schedules • Observation schedules
Desktop Analysis/ Meta analysis	Request documents from participating institutions (including) • Policy documents; mission/vision statement • Most recent curriculum documents. • Teacher guides (general and specific relating to Science Maths and Technology). • Assessment strategies • Textbooks used by teachers and learners Other relevant curriculum materials used by teachers and learners	Analytical piece on the state of the programme and refinement of instruments.

Site visits	In-depth interviews with • Key managers and participants in each of the organisational entities identified above. • Teachers, tutors, lecturers • Learners • Parents **Instructional Observation** Observation of at least two lessons in each organisation	The interview schedules will focus on • The institutions' approach is to teaching MST • In what way is support having an impact upon quality teaching and learning of the subject curriculum? • Assessment strategies • The level of educator competence in MST • Issues of infrastructure, capital expenditure and recurrent expenditure • Issues of sustainability • Cost of programmes • Issues for expansion
Cost analysis	Contract consultant to provide cost analysis	Provide a cost and costing model for expansion of the different types of programmes. The cost will be in done through an analysis of the expansion in three provinces (Gauteng, Limpopo and KwaZulu Natal).
Data analysis	Analysis of data	• Integration of meta analysis and empirical data • Exploring various models and their design and cost features
Policy Dialogue with DST	Discussion with the Department of Science and Technology about the various models and kinds of programmes they want to support	• Modelling cost and conditions for best practice • Presentation of preliminary findings to DST and discussion of preliminary options

Draft report	Compilation of draft report	Present a strategy document to the DST to expand the programme to allow access to a greater number of learners.
Final report	Compilation of final report Review of final report	Present a strategy document to the DST to expand the programme to allow access to a greater number of learners.

CHAPTER 2

SETTING THE SCENE FOR THIS STUDY

1. Context and Background

Over the last few decades, two trends fuelling growth in the global economy have emerged: the increasing importance of scientific and technical knowledge and the associated rise of the "knowledge economy" and; the growing importance of the services sectors. These trends point to the progressively greater role that human capital – the stock of knowledge-intensive human resources – play in the economies of countries.

For a country to develop a competitive advantage in the global economy, it is critical that its citizens be able to compete internationally. This requires citizens to receive a high standard of scientific and technical education. The ability of all learners to succeed in today's technologically oriented society is increasingly dependent on their understanding of, and ability to solve Mathematics, Science and Technology (MST) and computer studies problems. International surveys like TIMMS 1999 and TIMSS 2003 have shown clearly that South Africa's learners are seriously underachieving in numeracy, mathematics and science. A legacy of inequality persists in these key fields of study, limiting both the participation of learners as well as realization of their potential. Improving the quality of learning and achievement in MST and computer studies has now become a national priority. This point is underscored by the goals of the South African government.

The Department of Science and Technology's (DST) National Research and Development Strategy (2002) documents that human resources in science and technology are not being adequately developed and renewed, and that the key research infrastructure is composed of people who will soon retire. In South Africa, there is less than one researcher for every thousand members of the workforce, as compared with five in Australia and ten in Japan. Furthermore, black and women scientists, technologists and engineers are not entering the academic ranks in numbers that would help address this problem.

In developing the National Strategy for Mathematics, Science and Technology Education in June 2001, the Minister of Education had reached the same conclusions. In reflecting on the fact (based on Kahn's language proxy methodology) that in 2001, about 3000 African matriculants obtained passes in higher grade mathematics, both the DST and Department of Education (DoE) policy documents highlight a pressing need for "Increasing the number of matriculants, particularly the number of black matriculants and young women, with appropriate passes in Mathematics and Science." The increases are in order to provide the necessary numbers required for entry, and ultimately graduation from, degree courses in the sciences and engineering disciplines. The actual number of African mathematics HG passes in 2002 was 4688 (Kahn, HSRC 2004), which is still far too low for South Africa to meet its MST goals.

2. The Role of the DST in Secondary Education

Education within the schools is the responsibility of the DoE. As documented in the 2004 Inter-ministerial co-operation agreement, the DoE perceives strengthening cooperation with the DST to be crucial to effectively remedy this shared MST "crisis". It is clear that the DST has a mandate to get involved in the improvement of MST education. However all such efforts initiated by the DST need to supplement the primary role played by the DoE in South African education. In other words, given their clearly differentiated mandates, this requires the DST to target initiatives that will both support and complement the DoE's existing role.

One set of initiatives clearly presents itself – that of supplementary tuition. Unlike other countries where mainstream and supplementary tuition operate separately, the South African government is considering supporting the supplementary tuition sector. What is particularly encouraging to see is harmonisation in the outlook of the DoE and DST towards the supplementary education sector. In its 2002 National Research and Development Strategy document the DST recognized the need to increase "out-of-school" programs to support mathematics, science and computer education to meet this need. Since these programs necessarily complement the existing work of the DoE, supporting out-of-school programs like supplementary tuition, is a clear way in which the DST can proceed cooperatively with the DoE to meet their shared goals. In July 2004 there was a Cabinet level memo that DST and DoE work together to improve school math and science.

3. Supplementary Tuition Programs

All forms out-of-school programmes, including supplementary tuition, may be viewed as a "mechanism through which pupils extend their learning and gain additional human capital, which benefits not only themselves but also wider societies of which they are part" (Bray, 1999:18).

International research on supplementary tuition programmes argues that this operates alongside formal public schooling. These programs have largely been set up in response to the concerns about quality and service of traditional classroom teaching. In most cases parents seek to equip their children with a relative advantage over others for success in later life. Providers of supplementary tuition programmes offer prospects for enhancing the understanding of subjects; in this endeavour they may be increasing inequality within the education system by forcing a wedge between the learners with access to supplementary tuition and those learners without access.

Internationally, the emergence and continued existence of supplementary tuition is explained by the increasing need of countries to develop a globally competitive labour force. The quality of the labour force relates to productivity, which among other things is linked to the level of education of respective employees. As a result countries compete on the basis of the quality of their workforce. From the perspective of individuals higher levels of education are associated with better chances of securing a job.

4. Supplementary tuition in South Africa

Supplementary education in South Africa can be traced back to the large-scale educational efforts of Christian missionaries in the nineteenth century. These outreach programs formed the basis of formal education prior to the emergence of national and provincial educational authorities. Church authorities were also responsible for the training of teachers. After the establishment of government educational authorities, religious bodies participated in both formal and supplementary educational activities. Up until the last two decades supplementary education has continued to be driven by church and other civic groups, and primarily focused on religious instruction. From the 1980s the inequalities in education motivated the private sector and non-

governmental organisations (NGOs) to launch training programs for black teachers, in areas including mathematics and science education.

Supplementary programs targeting learners have historically been offered in the form of after-school lessons by schools (as enrichment to in-school tuition, usually for struggling learners) and other community institutions. In addition privately paid tuition has been the exclusive preserve of a wealthy few. Instruction has mostly been face-to-face.

However the provision of supplementary tuition to learners is increasing. Reasons explaining the emergence and re-emergence of supplementary tuition in various parts of the country include a growing middle class, changing aspirations across social strata, a perceived poor mainstream education system, increased marketers and enhanced marketing strategies of the providers. It is against this backdrop that the demand for supplementary tuition, as a complement to mainstream education, has continued to grow over time.

South Africa's economy is characterised by a massive unemployment rate, and very large informal economy. The best employment prospects are found in the formal economy. These employment prospects are closely tied to exam results, particularly matriculation results, which explain the prioritisation of most parents and learners on matriculation examination performance. Since employers in the formal economy demand a particular skills profile, they require employees that meet certain education requirements. An endemically high rate of unemployment means that the majority of those who fail their school exams will not be absorbed into the formal economy. This explains why in South Africa, the demand for supplementary tuition is greatest amongst secondary school learners.

The popular subjects for supplementary education are mathematics and science. This is market recognition (by providers of supplementary education and the learners who demand it) that technology and engineering fields are crucial to establishing a competitive skills edge. Mathematics and science are also seen as the gateway subjects for access into various sectors.

In light of the above, what then is supplementary tuition in South Africa? Basically, supplementary tuition should be viewed as all those mechanisms outside formal schooling that enhance learning and occur in both the private and public domains.

In the first part of the study we found that the forms of supplementary tuition included small groups with a tutor in classrooms. In addition to this are television programmes that cater for large groups. Supplementary tuition may also be provided through computer-based instruction. E-learning is gradually gaining importance. There are also examples of individualized instruction between learner and tutor. Other forms of tuition, which could enhance learning and/or passing examinations, include study guides, which focus on study skills and working of past examination questions. All these types of tuition inevitable augment the learning process and form part of supplementary tuition.

In the first part of this study, which mapped out the terrain of supplementary tuition providers, Reddy et al (2003) found that in South Africa,

1. There are a range of individuals, organizations and institutions that provide supplementary tuition.

2. The type of organisations who offer supplementary tuition include private sector organisations who offer their services for profit, franchises who offer tuition to a large client base; online instruction for learners with access to computer facilities; instruction on learning channels of the television; non-governmental and community based organisations; supplementary tuition initiated by the provincial department of education in partnership with service providers and outreach programmes attached to universities and technikons.

3. Most initiatives generally operate in urban metropolitan areas.

4. There are more mathematics and science than computer studies supplementary tuition programmes.

5. Instruction in the programmes is mostly linked to the school curricula and the purpose of the intervention is seen as enhancing the quality of the passes in the matriculation examination.

6. There is a cost associated with access to out of school programmes.

7. Some initiatives target high performing learners to give them a better chance for access and success at tertiary institutions but most initiatives are open to any student who can pay to attend.

8. Access to supplementary tuition programmes is dependent on geographical location and having funds to pay.

5. The Impact of Supplementary Tuition

One cannot establish with certainty that supplementary tuition will causally result in an improvement in academic performance or not. The performance of learners is a function of many factors, some of which fall outside the immediate learning environment. Research carried out in Egypt (a survey of 7309 individuals from 4 729 households at the primary level of education) found no statistically significant correlation between private tutoring and achievement (Fergany 1994 cited in Bray 1999:50). Conversely a study of the Japanese *Juku* revealed that private tutoring actually gave learners increased opportunities to learn and resulted in higher scores for arithmetic and algebra (Sawada and Kobayashi 1986 cited in Bray 1999: 49-50). The impact of private tutoring appears to be largely context specific.

The success of private tutoring largely depends on "the content and mode of delivery of the tutoring, the motivation of the tutors and tutees, the intensity, duration and timing of tutoring and the types of pupils who receive tutoring" (Bray, 1999).

In thinking about the impact of supplementary tuition it is important to consider the feedback of these initiatives into the formal schooling system. In countries with high-income inequality, such as Brazil and South Africa, remuneration is closely linked to additional schooling. Wealthy individuals realise this and try and guarantee the best prospects for their children by providing

them with superior educational opportunities. This means that wealthy parents will be prepared to pay a premium for the services of private educators who provide tuition to their children.

In South Africa, like many other countries, the monetary rewards associated with providing extra tuition are higher than in formal teaching. Movement of teachers into the supplementary tuition sectors may deny the mainstream system of talented educators. There is also a possibility that teachers in the mainstream system may deliberately fail to complete syllabi in an effort to induce learners to attend their private sessions.

6. The constraints and costs of supplementary tuition

Learners attend supplementary tuition programmes outside of regular schooling hours. The ability of learners to access such programs is constrained by considerations of cost and geographic proximity.

Supplementary tuition providers use different forms to reach their target audience. Some national and regional programs, such as those broadcast through television and radio rely on learners having access to these media. However, most programs are restricted to a particular geographic radius due to their emphasis on physical interaction between learners and tutors. Whether an operation is situated in an urban or rural setting influences access to supplementary tuition services. Generally, service provision in urban areas is more readily available than in rural areas.

All programs have an associated financial cost, which is either paid by the learner and her family or by the organisations that sponsor the supplementary tuition program. These costs include fees payment, the purchase of stationery and travel-related expenses. In addition we need to remember that the time invested in a program by learners is a cost in the sense that they could instead have committed themselves to some other activity.

In countries like South Africa, where standards of living are closely linked to the level of education, rewards associated with additional schooling like supplementary tuition, are significant. Socially privileged groups have a strong incentive to use their material and cultural power to ensure their children gain access to supplementary tuition outside normal school hours.

The largely private provision of supplementary tuition may widen the chasm between rich and poor by placing a barrier of access to elite universities and occupations, compounding income inequalities through the impact of education and skills.

Thus, in addition to urban bias, the cost of supplementary tuition places a severe limitation on the number of learners and particular profile of learner that can be reached.

CHAPTER 3
RESEARCH METHODOLOGY

1. Introduction

We have been contracted by the DST to research the supplementary tuition sector and come up with a set of policy options available to the DST to improve the state of mathematics and science education in the country. Our approach to this problem was to:

i. Develop general best-practice models of the different types of supplementary programmes that currently operate,

ii. Evaluate the usefulness of each of these models in terms of quality and impact of the different types of interventions,

iii. Establish the cost of each type of intervention model and provide a cost per learner for each type of intervention,

iv. Present a set of recommendations to the DST on how they can fund supplementary tuition programs so as to increase the number of black matriculants that obtain passes in mathematics and physical science on the higher grade.

2. Research Approach

We employed a case study methodology in an attempt to gain insights into various models of supplementary tuition support for Mathematics, Science and computer studies. The case study provided an analytical description of the pedagogical merit (quality) and impact of the programme. The case study was developed through interviews with service providers, observation of the programme in action, analysis of curriculum documents, interviews with learners and parents.

We showcased **at least two examples** of each of the following types of initiatives:

- Tertiary sector
- NGO sector (established non-governmental organisations and newer community based organization
- Science Centres

- Franchises
- Media sector (Online instruction to learners and instruction on TV learning channels).

We acquired further information to provide answers to the following:

- Which grades should the supplementary tuition programmes start at and target.
- Who should participate in these programmes? Should it be all learners or "high-fliers" or "under achievers".
- How should the programme address the problem of access to supplementary tuition programmes, particularly the urban-rural divide?
- Should the DST support and strengthen one or more of the existing models, or should new, alternative models be conceived.
- How can opportunities be created for the parent community to participate in design, implementation and support of out of school programmes?
- How can the supplementary tuition programmes be extended to promote Science and Technology for entrepreneurship?
- Should the supplementary tuition programme focus on tuition in individual subjects or should it be a holistic approach to MST?
- How can higher-grade participation and performance be increased?
- What should be the link between supplementary tuition programme and the school curriculum?

For each type of intervention we investigated at least two programs of that particular type. The case study is descriptive-analytical.

3. Data Collection

The following table gives an indication of the framework for the data collection.

	INDICATORS	DATA SOURCES
PROGRAMME DESCRIPTION	Detailed description in terms of Structure of programme, Contact time, Curriculum, Situation of programme in the institution Admission criteria Evaluation of the programme	Int. co-ordinator/ prog doc Int. co-ordinator/ prog doc Curriculum documents of prog Int. co-ordinator/ prog doc Int. co-ordinator/ prog doc Collection of evaluation documents
EVALUATION OF QUALITY	Philosophy of the programme (e.g focus on exams or broad vision of ed). Mode of interaction with learners plus assessment Who are tutors? Class size Infrastructure for the programme	Int with learners, tutors and co-ordinators Int with learners, tutors and co-ordinators PLUS observation of the programme in action (incl photos). Interviews and observation Interviews and observation Interviews and observation
PROGRAMME IMPACT	No. of learners per year (enrolments) Who are the learners: Geographical pace Race Gender Age Academic proficiency of learners Throughputs to subsequent years of prog (staying power of learners). Matric pass rates (incl. HG) Tertiary level choices Tertiary level pass rates Knowledge and attitude shift of learner as a result of programme.	Analysis of Statistical info Tracer studies of students who have been on the prog. Interviews with learners who have dropped out from the programme Analysis of Statistical info Learner questionnaire

	INDICATORS	DATA SOURCES
COST	Cost paid by individuals Incentives for learners on prog Cost of programme	Co-ordinator int Co-ordinator int Co-ordinator int + financial statements
PROGRAMME EXPANSION AND REPLICATION	Capability of present prog to take more students. Capability of other institutions to offer the programme GIS plot of present infrastructure to look at access for learners.	Institutional interview Other institutional inter + SAUVCA, CTP

The instruments, which were used to collect information, are provided in the Appendix.

The case study data for each of the typologies was sought from the following organizations.

Typology of programme	**Data sources**
Tertiary sector	University of Pretoria (UP with Science) University of North West (Ikateleng) Nelspruit Technikon University of Durban Westville (Upward Bound) University of Western Cape Outreach programme SAUVCA
NGO sector	SEASA SAILI Programme Imfundo Maths Champ
Science Centre	University of Zululand Science Centre MTN Science Centre in CT MTN Science Centre in Dbn
Franchises	Kumon Math Master Math PLATO
Media Sector	Liberty Life Learning Channel on SATV Mindset on DST

5. Case Study structure

Case studies are constructed along the following lines:

Program description: This gives basic background information on the program including the medium of instruction, the physical setting and learner: tutor ratios.

Structure of program: This describes the total length of time that a learner is enrolled in the program, the program curriculum, the contact time of a program session and the activity structure of a typical program session.

Evaluation of the program: This section analyses the particular features that characterise the educational experience offered by the program to learners. This provides us with a means to judge the effectiveness of the program and suitability of such interventions to the DST's stated potential audience. Particular facets of the program that we pay attention to are the teaching philosophy of the program, tutor-learner interaction, and program infrastructure.

Program costs: This section provides a basic cost per learner for the program and identifies the particular resources that comprise this cost per learner.

Recommendations for program expansion: Finally, for each type of intervention (case study) we propose a number of different ways that the intervention can be established for the purpose of providing supplementary tuition in mathematics and physical science to grade 10-12 black learners, with the aim of expanding on the number of black matriculants that obtain passes in these subjects on the higher grade.

CHAPTER 4

TERTIARY SECTOR CASE STUDY REPORT

This chapter reports on the case study of the tertiary sector. We collected data from four institutions: UP with Science programme (University of Pretoria), Ikateleng programme (University of North West), University of Western Cape's Outreach Project and Upward Bound programme (University of Durban-Westville).

1. UP with Science

The UP with Science Supplementary Programme operates from the University of Pretoria. Data was collected from meetings with the co-ordinator, engaging with the documents, visiting the programme, administering a learner questionnaire, interviews with learners of the programme.

1.1. Philosophy and description of the UP with Science programme

The UP with Science programme is recognized by University of Pretoria authorities as one of the prestigious and successful community outreach projects that the university is involved in. The coordinator of the programme is also a lecturer in Science Education at the university. The philosophy behind this tertiary sector's programme is to expose learners to different scientific areas. This, they do by showcasing the activities that different science departments within the university engage in. A unique feature of this showcasing involves learners observing scientists at work, learners participating in hands on experimental activities, and being exposed to typical role models. In observing scientists at work, learners either visit science departments within the university say, the department of chemistry where experiments are demonstrated or they visit scientific sites like the Sterkfontein caves where they observe archaeologists at work. In hands on experimental activities, learners are allowed to perform experiments under guidance and supervision of experts. In exposing learners to typical role models, scientists from industry are invited to address and encourage learners on the importance of being a scientist in industry, and the advantages this brings to society in general.

An advantage of exercises like these is that they expose learners to different scientific fields and experts who they relate with and ask questions regarding their diverse areas of expertise.

So, the aims of this tertiary sector's supplementary tuition programmes are (a) to encourage learners' interest in science as a field of study and specialisation (b) to provide information on possible career paths and opportunities in science. This hopefully, will open up future career prospects that learners may not have known of.

The UP with Science supplementary tuition programme is motivated by the need to increase the number of students graduating in science at university. Also, to support calls from government to increase the number of learners who take mathematics and science at school. Of importance, is the fact that university authorities support the programme, which renders it more credible and worthwhile.

1.2. Programme modus operandi

The UP with Science supplementary tuition programme runs for a period of 3 years. Learners from a relatively wide radius from the university, apply for entry into the programme towards the end of their Grade 9 studies. Learners have to be taking mathematics and physical science at higher grade. Based on their Grade 9 results, approximately 50 (see Table I) are accepted and the programme commences in June of the Grade 10 year. The programme continues until June of the Grade 12 year. Learners attend the programme for approximately 28 days over the two full years. This includes participation and attending and attending a 1-week's winter school during their June school holidays. This effectively means that a full cycle of the UP with Science supplementary tuition programme covers a minimum of 28 scheduled contact days with learners.

In the programme, learners are divided into groups of five and assigned to different departments within the faculty of science. Typically, learners participate in projects covering diverse areas like Physics, Biochemistry, Town and Regional Planning, Genetics, Mathematics, Plant production and Soil Science, Chemistry, and Plant pathology. In terms of the curriculum covered, it is worth noting that learners do not follow the regular school curriculum. They instead are involved and participate in particular research projects that different departments are involved in. The departments allow learners to engage hands-on with equipment and participate in experiments. In almost all instances, learners' involvement signifies the first time they see, handle, and use different scientific equipment.

A distinct advantage of this tertiary supplementary tuition programme is the fact that tutors are mainly postgraduate students although in some cases, university lecturers are involved.

This is an advantage because most of the time, postgraduate students are generally younger which helps learners identify as opposed to working say with respectable professors, which may have an intimidatory effect.

1.3. Who are the students in supplementary tuition?

Table 1: Number of learners that participate in the programme

Year	Group	Grade 10	Grade 11	Grade 12	Students Registering at UP
1998	A	50	-	-	-
1999	B	50	49	-	-
2000	C	51	45	49	
2001	D	50	48	39	22
2002	E	48	49	47	3 + 29
2003	F	50	48	49	3 + 28
2004	G	50	47	40	
2005	H	New intake -May 2005	49	43	

Table 2: Race and gender distribution of learners[1]

Year	Black/Indian males	Black/Indian females	White Males	White Females	Total
1998	16	14	10	9	49
1999	16+10	14+13	10+8	9+14	94
2000	16+10+10	14+13+19	10+8+10	9+14+12	145
2001	10+10+9	13+19+19	8+10+9	14+12+12	145
2002	10+9+5	19+19+16	10+9+12	12+12+10	143
2003	5+4+9	19+15+13	9+11+10	12+10+11	128
2004	4+9+12	15+13+16	11+10+10	10+11+11	132
2005	9+12	13+16	10+10	11+11	92[2]

[1] **Guide to Table:**

1998 -	Reading across 1998, the table shows that there were 16 Black/Indian males; 14 Black/Indian females; 10 White males and 9White females
1999-	Reading across for 1999, notice that the 1998 numbers are included with the new intake for this year. Hence, we now have:
	16 (1998) Black/Indian males +10 (1999) Black/Indian males
	14 (1998) Black/Indian females + 13 (1999) Black/Indian females
	10 (1998) White males +8 (1999) White males
	9 (1998) White females +14 (1999) White males
2001	In 2001, notice that we lose the 16 Black/Indian males; 14 Black/Indian females; 10 White males and 9White females – This is because this the original lot who joined in 1998. They finish the programme and there is a new intake and so new additions are put in with those already in the programme.

[2] Do not have the statistics for new intake in 2005, so only grade 11 and 12 are counted.

Table 3: Race and gender distribution of learners

Year	Total Black	Total White	Total males	Total females
1998	30	19	26	23
1999	53	41	44	50
2000	82	63	64	81
2001	80	65	56	89
2002	78	65	55	88
2003	65	63	48	80
2004	69	63	56	76
2005	52(Gr.11&12)	42(Gr.11&12)	41(Gr.11&12)	51(Gr.11&12)

1.4. Quality and impact of the programme

An important attribute of the UP with Science supplementary tuition programme is that learners at the end are offered tuition bursaries that may see them through a BSc degree and beyond. A major condition of the bursary is that students must perform well. This has benefited a number of students because not many have dropped out of the programme. That the university has through the programme been able to have a substantial number of learners registering for studies in science bears testimony to the quality of the programme (see Section 1.8). The acceptance of learners from the programme by the different departments with in the faculty of science, in a sense is a measure of the confidence these departments have on the learners and the programme.

The impact of this programme may also be seen in terms of its ability not only to provide expert guidance in different scientific areas but also in exposing learners to science careers they may never have known of (as will be illustrated by a student interview). Also, it helps familiarise learners with the university environment, for example, to understand the requirements for one to register as a student. It also helps with a number of other non-formal educational aspects that learners get to understand because of their participation, like the importance of using the university library.

1.5. Cost of the supplementary tuition programme

The UP with Science programme garners funds and support from private enterprises. To participate in the programme learners do not pay. The programme however incurs costs per learner. The only major cost for learners pertains to travelling and those who genuinely show they cannot afford are subsidised. Interviews with the programme co-ordiantor indicates that they fundraise about R120 000 per year for the three groups. This cost covers cost of tutors,

printing and photocopying, excursions, subsidising cost of learners who cannot afford the transport. The university and the departments offering the tuition do so at their own cost. So costs are borne by both the university and by fundraising (hence the cost is low).

In the present programme the students come to the university once a month and for 5 days during the July holiday. Therefore there area total number of 14 contact days per year. The cost is R800 per learner.

With respect to programme expansion, the concern was mainly in the logistics of handling big numbers. As the programme relies on heads of department selecting tutors, it was felt that those chosen might take involvement as an extra burden and therefore resent their participation. This, the coordinator felt would affect the high levels of enthusiasm tutors currently display.

We discussed the model of brining rurally based learners to the university for a residentially course. There are reservations about this module because of the responsibilities of chaperoning these learners.

1.6. Learner views of the UP with Science programme

1.6.1. Participants

There were 63 participants (45 Grade 11 and 18 Grade 12 students) who completed the questionnaire. Of the total, there were 33 (52%) girls and 30 (48%) boys with ages ranging from 15 to 19 years (M = 16.3, SD = .76). With respect to the grade level at which they took mathematics and physical science, only one student took mathematics at standard grade.

1.6.2. Descriptions of the program

UP with Science is a supplementary tuition program in science-related subjects. Students travel to the University of Pretoria where classes are generally held on Saturdays. The majority of the learners reported the program to run approximately 7 ½ hours a day. They were happy with the length of time as it allowed for enough time to completed program activities. All the learners indicated that fees are charged to attend the program.

About half the respondents indicated that the purpose of the program is to encourage, improve or enhance their understanding and knowledge of science-related subjects. Others, about a

third of whom, felt the program provided an opportunity of gaining entry into university as well as allowed them to make career decisions. On the other hand, about 19% felt that the program would aid them in acquiring bursaries for further study at the university.

1.6.3. Joining the program and encouraging other to do the same

Most learners (95%) received information about the program from their schools. Few (3%) were told by their friends and one learner was encouraged by a sibling already in the program. Most learners (94%) indicated that they had to write an entry test of some sort and hand in school examination results. About 2% felt they had to get good marks in Mathematics and Science to gain entry while a further 2% thought their teacher booked them into the program.

On how they would advise other learners about the program, about half (43%) indicated they would tell them about how extremely helpful it is; 15% would tell the learner to be highly motivated while 14% would refer the learner to someone in authority who could possibly get him/her into the program.

1.6.4. Impact of the program

About half of the learners (57%) indicated that the program had a positive impact on their understanding of Physical Science concepts/ideas. They felt they were much better in this subject than before joining it; 40% indicated they were a little better and only 3 felt nothing had changed. With mathematics however, 20 (38%) felt nothing had changed; 29 (46%) felt they understood mathematics a little better while 22% thought they understood it better.

More (68%) students were confident in writing Science tests while only 32% were in taking mathematics tests.

A further 32% reported that the program had no impact on their confidence or ability to write mathematics tests while 22 students reported feeling a little more confidant in their mathematics ability.

More than half of the learners developed interest in science as a career and 48% had interest in studying mathematics further.

With respect to methods of teaching compared with their schools, 40% felt the program was different in teaching and in practical applications, which improved their results. Also, while

about 37% were exposed to practical experiments in school (either demonstrated or performed by them) all the learners in the program had a chance to perform experiments on their own.

Only 8% reported that they received notes while participating in the program. This contrasts their schools' way of teaching, where almost all the time notes were prepared by teachers.

In both the program and at school, most students indicated that they were allowed to share their ideas even if they might be wrong.

Only 2 respondents indicated that they were absent for more than three times, while 29 reported they had been absent once or twice.

1.6.5. Challenges with the program

About 48 (76%) respondents did not experience difficulties in attending the program. However, 24% indicated that they did experience difficulties. Typically these included clashes with other activities that also occur on a Saturday, like family related activities.

1.6.6. Suggestions to improve the program

Most did not see a need for improvement but about 14% felt more activities in the form of field trips, group functions, more experiments, and class tests could be added.

1.7. An exemplar: narrative from a student interview

The interview was carried out with Mapula[3] a UP with Science graduate, who is currently in her final year of the BSc Actuarial Science degree. She went to school in what she described as an ordinary township school in Mamelodi, with ordinary teachers who were not well qualified. She joined UP with Science in 1998. Mapula got to know about the UP with Science tuition programme when people from the university visited her school to explained the programme offerings. Learners were informed of the selection criteria and procedures to follow to apply. Because she was one of the best learners in both mathematics and physical science, her teacher told her to apply to attend UP with Science. She applied and was invited to the tuition programme.

When she joined UP with Science she was surprised because the programme did not operate in the manner she expected. She assumed they would receive remedial help in school

mathematics and physical science but this was not what the programme was about. In the programme learners were introduced to research and experiments, which meant a different and new world of science to her. After a while, she realized that UP with Science was in actual fact broadening her view of science. Her school knowledge had meant that taking mathematics and physical science was about becoming a doctor or engineer. This was so because role models outside school were generally in these two professions.

When she participated in the programme, she often wondered about how much she assumed she knew about science from school and how UP with Science changed her perceptions and understanding. Mapula then realized that "at school it was study now you will find out later what you will be". She felt that teachers never talked about what they could study perhaps because they themselves did not know. Her participation in UP with Science meant that she interacted and was exposed to people specializing in different areas of science. This resulted in her understanding the work they were doing.

Since UP with Science brought together students from different cultures this helped enhance and improve her usage of English, a language she would hardly speak among friends at school. Participation in UP with Science also brought home the realisation that studying science at university would need taking mathematics and physical science at higher grade level at school. Teachers too did not stress this at school. She conceded that UP with Science brought to light a number of things she did not know, considering her initial mixed feelings about it. She therefore felt that the programme should reach more and more learners, even if it meant, "just to see what is going on and gain information".

Mapula indicated that she would unreservedly encourage learners to join UP with Science. About her personal empowerment, she gave account of her visit to Paris (her first visit overseas and being in an aeroplane) where she interacted with learners from other countries. Also, she recounted her surprise in discovering younger learners from other countries who already knew what she did not, despite her more mature age. Mapula felt that the winter school could be changed to a spring school where it did not clash with her school's programme. She indicated that learners who dropped out of the supplementary tuition programme we generally those from advantaged schools who felt they already knew what the programme was about.

[3] Not the student's real name.

In her concluding remarks, Mapula commented on how she always thinks about where she could have been had she not joined UP with Science. She speculates that she may have been working in a restaurant somewhere. She felt proud that she was in her fourth year of Actuarial science. She meantime reminded me that before the programme she did not know anything and may never have heard of actuarial science. She also praised the tuition bursary she received because it covered her fees while she knew her parents would never have paid the money paid so far. Even more, she was happy that insurance companies have recruited her and other students, which suggests good employment prospects. All this she felt, " ... would never have happened if I did not participate in UP with Science".

1.8. Where do students who participated in UP with science go to when they enrol at University of Pretoria?

Students who had been on the UP with Science programme are offered bursaries for continued study at the university. Many students stay at University of Pretoria and they go to a range of faculties at the university.

Field of Study	Group A[4]	Group B[5]	Group C[6]
BChB		1	1
Bcomm	5	2	6
BCons Sc: Interior Managem		1	1
BEd: FET:(Econ & Mngmnt Sciences)			1
BEd: FET (Natural Sciences)	1	1	
B Eng	1	3	3
BInstAgrar: Food Production & Process		1	
BMus			1
BOcc Ther	1	1	
B. Physics	1		
BSc: Applied Mathematics		1	
BSc: Biochemistry	1	1	
BSc: Biological Sciences			4
BSc: Exploration Geophysics		1	
BSc: Financial Mathematics	5	2	2
BSc: Genetics		1	
BSc: Geoinformatics		1	
BSc: Geology		3	
BSc: Human Phys, Genet. & Psychology			1
BSc: Information Technology	6	2	
BSc: Microbiology		2	
BSc: Physics			1
BSec.Ed(Sci)	1	1	
BSocSci: Sport Psychology		1	
BTh			1
B Town-& Regional Planning			1
Ext. Prog.: Math/Computer Sci		2	4
MBChB	2	2	1
Science: Foundation Year Programme			1
Not registered 2003	1	1*	6**
Enrolled at UP (Oct. 2003)	**25**	**32**	**34**
Total in group at the end of the 3 years	46	39	47

* 2002 (Extended Program: Biol. & Nat. Sciences)

** These learners either decided to study elsewhere or were not admitted to the courses they applied for.

[4] Started gr 10 in 1998 and university in 2001.
[5] Started gr 10 in 1999 and university in 2002
[6] Started gr 10 in 2000 and university in 2003.

2. Ikateleng programme

2.1. Introduction

This programme is co-ordinated by the University of the North West. The programme begins in April each year and therefore we were unable to observe the programme. Data was collected by interviews with the co-ordinator and engagement with the programme documents.

2.2. Philosophy and description of the Ikateleng programme

The Ikateleng programme is a recognized community outreach supplementary tuition programme that is supported and endorsed by the University of North West. The coordinator of the programme is a fulltime employee of the university. Ikateleng's philosophy is to improve the overall examination results and symbols of matric learners, to enable them to meet admission requirements of tertiary institutions. Over a year, the programme registers approximately 1 000 learners in three sites in. Learners apply to participate in the programme when in Grade 11 and are admitted on the basis that they take Mathematics, Physical Science and Biology.

2.3. Programme modus operandi

In this programme, the curriculum followed is exactly that of Grade 12 school curriculum including life skills. Tutors used in the programme are good teachers of mathematics and science selected from each of the three (Vanderbijlpark, Potchefstroom & Taung) regions. In each site, learners attend for approximately 20 Saturdays over a year. The programme is run in two streams one being the Science and the other an Economics stream. Grade 12 learners, depending on their subject choice are expected to take a combination of subjects as shown below:

Science	Economics
Mathematics	Mathematics
Physical Science	Accounting
Biology	Economics

In each stream, learners may select a minimum of two subjects, at a cost of R50.00 per subject. The cost per subject is included to ensure learners' commitment to participate in the supplementary programme rather than cover cost. Besides normal teaching, learners receive booklets of notes that are specially prepared for each subject they register for.

2.4. Quality and impact of the programme

In terms of quality, the Ikateleng programme reveals that they produce better results compared to for example, the different provinces (see tables below). With respect to impact, an estimate of learners who qualify for tertiary education is reportedly, ± 56% of intake. Also, they indicated that in 2003, ± 26% of learners enrolled at the University of North West.

Ikateleng District Pass Percentages

District	2002	2003	2004
Brits-Mooinooi	76.2		
Pot-Kosh	80.1	91.3	85.3
Rustenburg	84.6		
Upington	82.5		
Vaal	83.3	86.2	74.2
Taung			82.3
North West	**67.8**	**70.5**	**64.9**

Provincial Pass Percentages

Province	2002	2003	2004
Western Cape	86.5	87.1	85.0
Northern Cape	89.9	90.7	83.0
Gauteng	78.1	81.5	76.8
KwaZulu-Natal	70.8	77.2	74.0
Mpumalanga	55.8	58.2	61.8
Free State	70.7	80.0	78.7
Limpopo	69.6	70.0	70.6
Eastern Cape	51.8	60.0	53.5

2.5. Cost of the supplementary tuition programme

Funds for running this supplementary tuition programme are raised by the university's fundraiser. Most of these are obtained from various donors, especially the corporate sector.

Apart from the registration costs per subject, learners do not pay for any other cost. The estimated cost per learner for the programme per year is about R1000.00.

On expanding the programme, the major concern was cost. For example on this issue the coordinator indicated,

> Any programme can be doubled provided that there are sufficient funds, e.g. we have already made a survey in the Mafikeng area where the tutors and learners are very, very excited. The problem is that to cater for 200 learners we need ±R200 000. It is quite "scary" to start Ikateleng each year with a zero balance.

2.6. Comments from participating learners

Students' views of the Supplementary tuition program revealed that the learners are extremely pleased with the Life Skills classes and the attitudes, approach and enthusiasm of the teachers who are in the program. With regards to the Life Skills classes, learners expressed their enjoyment of this particular class as it taught them how to cope with stress, improved their self-esteem and self-confidence and improved their study skills. It was felt that the Life Skills classes were well presented and engaged their interest and attention.

Learners commented that the teachers in the program present the work very well, which helps in their understanding of the subject matter and in has improved their knowledge. As a result of the friendliness and enthusiasm of the teachers, the learners report that they feel more comfortable in asking questions and sharing their ideas in the classes.

3. UWC OUTREACH PROGRAMME

3.1. Introduction

We tried to set up interviews and visit the programme at UWC. The co-ordinator only wanted to engage by e-mail. In his correspondence he indicated that the programme had funding difficulties and was unable to offer any activities. He was very angry and bitter at what he saw as the lack of support. He posted us the Annual Report and asked us to use that document as the basis for the data. Thus the Annual Report forms the source for the write up below.

3.2. Philosophy and description of the UWC Outreach Project

The Outreach Project is a supplementary tuition programme that is supported by the School of Science and Mathematics Education of the University of the Western Cape. The project was started in 1982 with the aim of providing computer-assisted learning environments in mathematics, science and technology to high school learners and educators among townships and rural areas within the Western Cape. Its aims are to design and implement a large scale technological and intervention strategy to improve Grade 12 mathematics and physical science results of poorly performing schools. In the 2003 report of the project, it is stated that "The off-campus activities were planned to engender the philosophy of self-sustaining community involvement with the ultimate goal of community upliftment" (p.14).

3.3. Programme modus operandi

The modus operandi of the Outreach Project is to address and rectify identified disparities and deficiencies of particularly Grade 12 mathematics, science, and technology (Outreach Project Report, 2003). All learning in this programme takes place in a computer-enabled environment. To provide the needed help, the project established on site computer assisted learning facilities in different township and rural schools. Grade 10 to Grade 12 mathematics and science software developed at the university was used and this was reported to benefit both learners and their teachers. An apparent issue from the report is that since its conceptualization, its operations have changed from year to year. For example, in 1999/2000 the programme took approximately 450 hours to implement. In this period the programme started in March and continued almost every Saturday. This included 20 hours of intense revision before examinations. Who the tutors of the project are, is not explicitly indicated in the provided report.

3.4. Quality and impact of the Outreach Project

A doctoral study that was *inter alia* used to evaluate the programme, reported that school results of Grade 12 physical science and mathematics learners from participating schools increased by 20% and 10% respectively. This increase was attributed directly to the programmes' intervention strategy. A longitudinal study conducted by the project coordinator also indicated that from 1999 to 2002, 70% more learners were successful in matric mathematics standard grade. For the period 2000 to 2002, 90% more learners were successful. The table* below also gives an indication of the success rate of Outreach Project in helping students register at the University of the Western Cape and finish their studies in different degree programmes.

Table indicating success rates of students who registered at UWC

Faculty	Degree/Diploma	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			
	Hons 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
	Hons 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	18	43	3
		2000	16	7	
	Hons BComm	1999	7		
		2000	2	2	1
Law	LLB	1999	14	13	8
		2000			
Edu	ACE (Math)	1999	15		
		2000			
	HDE	1999		9	
		2000			
	BEd (Math)	1999	4		
		2000	2		
	Dentistry	1999/2000		3	1
	Dip O H	1999/2000	5		

* Source – Outreach Project Report 2004

3.5. Cost of the supplementary tuition programme

A common thread in both the 2003 and 2004 project reports, suggests that funding is one of the obstacles to the implementation of project goals. An example of this may be inferred from the statement "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 a UWC website" (p. 24 – 25). We are unable to get a sense of the cost per learner per year.

4. Upward Bound Programme offered at UDW

4.1. Introduction

The Upward Bound Programme operated at the former University of Durban-Westville. The program ran from 1999 to 2004. It was affected by various difficulties and control of the program changed hands a number of times. The program has formally ended but prospects for its continuation are being reassessed. Data was collected from meetings with the current program co-ordinator as well as the very first program coordinator.

4.2. Philosophy and description of the Upward Bound programme

Upward Bound, a 5-year program started in 1999 at the then University of Durban-Westville (UDW) is based on an American model of the same name. The program was envisaged to be a primary feeder scheme of learners from disadvantaged backgrounds into higher educational institutions. It was designed to address access to higher institutions, particularly in scarce skills fields such as mathematics and science. Its aim was to develop suitable learners for entry into the engineering, mathematics, and commerce disciplines at UDW. This development would be achieved through academic enrichment aimed at assisting learners to pass matric and preparing them for university life through a "social life skills" program component.

4.3. Programme modus operandi

The program was established in such a way that it deliberately had a 60% bias towards girls (and a bias towards female staff) as well as a 100% bias towards black learners from townships and rural areas.

Initially the program was designed to accommodate 2000 learners. This number would be made up of 500 learners each from grade 10, 11 and 12, as well as a further 500 learners placed in either university bridging programs or a full (maths, science, engineering or commerce) undergraduate degree at UDW or other higher education institution. The schools selected all participating learners.

The program took place twice a year (summer and winter) and lasted for 2 to 3 weeks, depending on the length of school and university holidays. Learners and tutors were provided with food and accommodation in the university's residences. A large number of tutors were used (over 200 at a time) and were mostly undergraduates at UDW.

Before the program commenced, tutors received 5 days of training covering all the material that they would teach during the program.

At the end the program was taking in 120 learners (40 from each grade) and 60 teachers. They were accommodated on university campus twice a year, for 10 days at a time.

4.4. Evaluation of Upward Bound

In December 2004, the last time that the program ran, there were 1500 learners and at that stage the programme proved to be unmanageable. Intake was then scaled down 120 learners and 60 teachers from 20 schools in July 2004. Thereafter, intake was 80 grade 10 and 11 learners and 60 teachers in December 2004. The plan at this stage was to take the cohorts of learners from grade 10 through university. However, schools took it upon themselves to switch learners in the interests of equity. In the end a geographic coverage with a 50-50% mix of township and rural learners and gender mix was selected. It was found however, that targeting township learners was easy but rural learners posed a significant challenge, with serious costs and logistical implications. Also, as initially envisaged, there would at any one time be 2000 learners in the program, but the intended 500 First year undergraduate university students (who were supposed to receive academic support, remedial programs, allowances etc.) were not catered for because of problems relating to program space at UDW, as well as insufficient bursary funding.

4.5. Cost of Upward Bound

The Upward Bound programme was costly as the breakdown that follows indicate. For example, when it was launched in December 1999 as a pilot with 500 grade 11 learners, this

was at a cost of R1/2 million. In 2000, there was a full rollout of 2000 learners and 200-300 tutors at a cost of R6-7mil per annum. In 2001, 1500 (Gr. 10-12) learners and 200-300 tutors participated in the program at a cost R6-7mil. In July 2004, 120 learners and 60 teachers attended a 12-day program at a total cost of R313 387. In December 2004, 80 learners and 60 teachers attended a 12-day program at a total cost of R205 106. These cost per participant is then R1750 per participant (both learners and teachers participated) for the July course and R1465 per participant for the December course. This means a cost of R3215 per participant for a 24-day residence course.

5. Technikons

We tried to access information about technikon programmes. While we have an indication that they do exist, they do not seem to be well organised and we were unable to get information about them. One technikon indicated that they offer second chance programmes to learners who did not have the appropriate pass to access techikons. In this case they could better their symbols, but learners were encouraged to take mathematics on the standard grade, because with that pass a learner could gain access to the technikon. The charge on this second chance programme was R6000.

6. SAUVCA/ HESA

In a discussion with SAUVCA about their involvement in this sector they indicated that they were willing to work with DST in supporting the sector. SAUVCA and the CTP (Committee of Technikon Principals) have formed a single organisation HESA (Higher Education South Africa) in which the 23 public higher education institutions are represented.

7. Key findings and issues from the tertiary sector case study

This case study examined programmes that were organized and co-ordinated by the tertiary sector. The nature of these programmes has both similarities and differences.

The tertiary sector has been involved in providing supplementary tuition to senior secondary learners for a number of years. Many of these programmes operate on sponsorship (and thus learners do not pay) and the reason that the tertiary sector offers these programmes is both, because they want to contribute to increasing the quality of passes and because they want learners with high quality passes who would register for math and science related courses at their tertiary institutions. Tertiary institutions are well placed to provide these programmes

because they already have the infrastructure (classrooms, laboratories etc), organizational structure (providing administration etc) and a pool from which to draw its human resources (teaching staff and postgraduate students).

The types of programmes offered range from structured small group programmes offered over two years and which can be used to build concepts and knowledge, to year long courses which may be offered in the final year of instruction and which are offered in big groups. One of the programmes we looked at was non-curriculum based programme in which learners are exposed to science and science related activities. In this programme learners are encouraged to participate in activities that enhance their knowledge of science, and learn more about careers in different fields of science. An advantage of this programme is the fact that learners are engaged in activities for a sustained period, spanning from Grade 10 to Grade 12. The other programmes are curriculum based and include elements of life skills.

Although the *modus operandi* are slightly different, most programmes targeted mathematics and science higher grade learners with the aim of helping them obtain better school marks that would ensure that they qualified for university entry. Most programmes target Black learners.

The different programmes use different types of tutors. In the Ikateleng programme, high school teachers are the Saturday tutors, in the UWC Outreach Project teaching is computer based, while in Upward Bound programme tutors may be students who were specifically trained for the supplementary teaching task, in the UP with Science programme tutors are mostly post-graduate students.

In terms of quality and impact, all programmes indicated that their main objective was having learners pass with high quality mathematics and science and qualifying for university studies. Some of the programmes provided statistics to indicate that the number of learners who passed and then enrolled at the university. While the aim of the programme is for learners who have been targeted to continue with math and science at the tertiary level, many students may progress to fields that are not science related. This should not be considered as a lost investment as students entering the fields of commerce or arts are still contributing to the human resource capacity of the country.

Attending a supplementary tuition programme at a university has the added advantage of exposing learners (who would not otherwise have the opportunity) to tertiary institutions, making them aware of the range of career options that could be available to them. For

example, most black students would be aware of the traditional careers of medicine, teaching and law but exposure to a university in their grade 11 and 12 years would expose them to other possibilities. (See the exemplar of an interview with a final year Bachelor of Actuarial Science student).

Some programmes offer a package where students who complete the school supplementary tuition programme are offered bursaries to continue to tertiary education. Thus there is a long term investment in the learner.

With respect to cost, all the programmes reported that this was the prohibitive factor because they rely on donor funding. Given that these programmes are targeting the poorer learners then these programmes would need external funds for it to operate. The range of student cost is from R800 per learner per year (14 contact days a year, non-residential) to R3215 per learner per year (24 contact days, residential course).

All programmes, except the Upward Bound programme, targeted urban-based learners. If one wants to target rurally based learners then the programme needs to be offered as a residential course. This has further organizational and cost implications.

The model of tertiary institutions offering supplementary programmes to secondary learners is attractive because they have the infrastructure to offer the classes (lecture rooms and laboratories); they have an organizational structure which can administer this course; with the number of post-graduate students they have easy access to young, knowledgeable tutors; these programmes can offer the stock from which they can draw learners for their own tertiary based programmes; they can offer bursaries to learners who succeed in the programme. SAUVCA/ HESA (Higher Education South Africa which brings together the 23 public higher education institutions), should be encouraged to make the programme of offering supplementary tuition to grade 10 to 12 learners a part of their set of programmes.

CHAPTER 5

NON GOVERNMENTAL AND COMMUNITY BASED ORGANISATIONS

1. Introduction

In the initial report (Reddy et al 2003) we found that the NGO and CBO sector was also involved in the provision of supplementary tuition. For the case studies we investigated the following organisations: SEASA, SAILI, MathChamp and Imfundo further. When we developed the database of supplementary tuition service providers, we categorised the NGOs as those with a national presence that had been in existence for a long time (e.g. Protec), local NGOs that had been in existence for a long time (SEASA), smaller and newer NGOs (e.g. SAILI, Math Champ, Imfundo).

2. Scientific and Industrial Leadership Initiative (SAILI)

2.1. Programme Description

SAILI is a broad initiative aimed at providing learners from historically disadvantaged communities with opportunities in science and engineering. The SAILI initiative places learners with the potential to succeed in selected schools (well performing) and provides supplementary enrichment and tuition on alternate Saturdays (called Academic Enrichment Programme). Both the in-school and out-of-school components of the program span the entire length of a learner's secondary education, i.e. from grade 8-12. Learners are identified in grade 7 and selected on academic merit in maths and science testing. The learners are then placed in the selected schools. During this time, all costs (fees, books, lunch money, transport, sport kits) for the learners are covered by SAILI. After grade 12, SAILI assists learners in securing placement at university in their chosen fields of study and in securing bursaries to finance these studies.

Supplementary tuition in the SAILI program is split into junior and senior-level programs. At the junior-level, about 75 grade 8 and 9 learners (In 2005: 38 grade 8 and 35 Gr. 9) are hosted at the MTN Science centre in Century City for 18 sessions (roughly) each year (see for more detail in the section on Science Centres).

In this case study we will focus on the senior-level supplementary tuition program. This program serves learners from Gr. 10-12. The program is conducted every fortnight, from February to October, using venues in Stellenbosch University's School of Engineering. There is also a July holiday session hosted at the Cape Technikon. Learners are transported to the venue by minibuses. This transport is financed and provided by SAILI.

Learners enrolled in both mathematics and physical science on the Higher Grade qualify for the senior-level program. Initial cohorts of learners in the SAILI program were racially classified as coloured. Some of these learners have been obliged to drop out due to the failure to meet the higher-grade criterion. In the last 2 years African learners from township schools have been included in the programme.

Information for this case study was collected from observation of the program, analysis of learning material and programme documents; interviews with the SAILI program director, the three tutors on the SAILI senior supplementary program including learner responses to questionnaires and interviews.

2.2. Philosophy and programme description

SAILI started the programme in an effort to bring learners together to encourage them into engineering careers. Their focus now is on providing supplementary tuition to math and science higher grade learners – this is essential. If a learner's grade drops to standard grade, the learner has to drop out from the programme. Supplementary tuition in this programme is linked to the school curriculum.

The SAILI program operates from 9am to 1:30pm for 18 Saturdays of the year. 120 learners (40 per grade) take part in this program. This program consists of a two-hour mathematics session and a two-hour physical science session interspersed by a half-hour break. The grade 10 tutor (with a professional background in actuarial services) provides both the mathematics and physical science tuition for that grade. The grade 10 tutor (who does not have a teaching background) emphasised that she is not prepared for the teaching of OBE. She uses material that was prepared in 2001 by another tutor.

A dedicated mathematics tutor provides tuition for the grade 11 and 12 mathematics classes, whilst a dedicated physical science tutor provides tuition to the same classes. The grade 11 and 12 tutors both come from teaching backgrounds. Each tutor teaches 40 learners at a time.

2.3. Modus operandi of the programme

Most of the two-hour session features the tutor teaching a section of the grade syllabus to the learners. Tutors select sections offered in the school syllabus, that they deem both demanding and important. To help enhance understanding, selected sections are taught around the same time as at school. For practical reasons topics may however not fit exactly with work covered at school.

This decision to teach a few sections in detail is in response to the limited number of contact hours. Each session ends with learners writing a test that is based on the material that was covered in that very session. At the beginning of the following session learners receive the marked test that they wrote in the previous session. They are also shown a memo of the correct answers to this test, as well as a memo of the answers to problems from the previous week that were assigned as homework.

There seems to be very little practical/ experiential work done – almost all the teaching is chalk-and-talk based.

In addition to the learners being part of the Saturday classes, the original intention was to take the better performing learners from disadvantaged schools and place them in well performing schools. The Coloured learners are mostly in the placement programme, and the African learners come from township schools.

2.3.1 Characteristics of placement schools

- Must be in close proximity to where learners reside; not always possible...SAILI then covers their transport.
- The placement into schools is done in consultation with the parent/guardian.
- The school must be functional, good stable environment, conducive to learning and teaching.

- Qualified educators, particularly in Math and science.
- The school must offer Math and science on Higher Grade in classes separate from Standard grade
- The school must be prepared to identify a liaison person who is the key link person with SAILI, and thus concerns and problems are addressed immediately.
- The school agrees to forward the progress results of learners to SAILI asap.
- The school's Guidance Counsellor liaises with SAILI Counsellor if any interviews need to be done at the school at a particular time.

2.4 Who are the learners?

The learners are from grade 10 to 12 and are mostly Coloured students. There are now a few African learners in the programme.

Table 1: An indication of the schools in the Western Cape Peninsula that the grade 10 learners come from is given in the following table:

NAME OF SCHOOL	NUMBER OF STUDENTS
Athlone	1
Blackheath	1
COSAT	4
Hottentots Holland	6
HTS Bellville	8
Pinelands	7
Rhodes	2
Rylands	1
Simonstown	1
Thandokhulu	1

2.5 Quality and impact

The grade 10 tutor felt that the cohort of learners has recently become weaker. In 2004 half her class was struggling and the marks were very widely distributed. The 2005 grade 10s were given a test on grade 9-baseline material and the top mark was 55%. This tutor reports that her role in the last two years has shifted from working through examples to teaching material from basics. The grade 10 learners would have participated in the SAILI Comets programme. As a result of

the poor performance on the grade 10 test, content based mathematics was introduced into the SAILI Comets programme from 2005.

The Program aims for learners to pass with As in Maths and Science on HG with an overall A aggregate as well. In 2003 the mathematics average for the Grade 12 group (27 learners wrote on the HG) on their final matriculation mark was 62%. Five learners obtained As in mathematics. The average for the Science HG (group of 26 HG learners) was 64%. There were two A symbols in science. One learner failed mathematics and one learner failed science.

In 2004 the mathematics average for the Grade 12 group (26 learners) on their final matriculation mark was 64% - all on HG. Nine learners obtained As in mathematics. The average for the Science HG (25 learners) was 68% with nine As in science (SAILI Matric 2004 Report).

2.6 Learner perspective about the programme

80 grade 11 and 12 learners completed a questionnaire about their perceptions of the programme.

2.6.1 Who are the learners in the program

A majority of the learners (46 versus 34) were male. Their ages ranged from 15 to 20, with the most participants either 16 or 17 years old. There were slightly more grade 11 than grade 12 (43 versus 37) participants in the program.

Although SAILI is ostensibly a higher grade-only program, it is interesting to note that 5 participants take maths on standard grade (the other 75 are all HG) and 1 takes science on SG (78 on HG). Of the sample of 80 learners, 37 learners take Biology on HG, 17 on SG and 26 don't take Biology.

2.6.2. How did learners find out about program?

Three quarters of the learners identified their school or a teacher as their *introduction* to the program. A further 9 learners (of the 80) were introduced to the program by their friends. Half the learners indicated that they were ultimately responsible for deciding to join the program.

Teachers also played the primary role for a large number of learners. Parents were less important, identified by only 9 learners as the chief decision-maker in their joining the program.

Most learners mentioned taking an entrance test and filling in an application form as part of the formal procedure for joining the program. Learners also mentioned that good performance in mathematics and science and enrolment in both subjects on HG were requirements for joining the SAILI program - so there is common understanding of the goals of the project.

2.6.3 Description of program

In the SAILI program, learners are bussed into Stellenbosch every second Saturday during the school term, where they receive supplementary tuition in both mathematics and physical science on HG. Learners do not pay any fees to participate in the program. SAILI also covers the cost of bussing learners from set "pick-up" points.

All 80 participants indicated an interest in improving their understanding of, and school marks in, mathematics and physical science as the purpose of the program. In addition learners mentioned that the program focuses on more difficult subject content (22), maths and science on HG (25), and encouraging learners to pursue further careers in science (16).

Learners suggested that the program would function better if SAILI was to increase the number of days that lessons are held (8), settle on a fixed starting time (6), provide more food (4), arrange field trips (7), include more breaks in the day (3) and conduct laboratory experiments (3).

Most participants had a high rate of attendance in the program and only 6 learners (of the 80) reported having been absent more than 3 times. About half the learners "sometimes" had difficulties attending. For others attendance is sometimes a problem. Reasons for attendance difficulties that there were given by learners include problems with transport (13), illness (7) and involvement in other activities (7).

When asked how many learners they knew, that had dropped out the program most only knew of 1 or 2 learners, if any, who had dropped out the program.

When asked about their feelings on the length of program sessions, learners were divided – 33 (40%) would like each Saturday session to run longer, 27 (33%) would like sessions to be shorter and 16 (20%) were happy with the status quo. 26 of the learners who preferred longer sessions wanted these to cover more work. Another 6 felt that the time was too short to accommodate both teaching and testing. Of the 27 learners requesting shorter sessions, 20 felt that the Saturday program detracts from other activities such as school homework.

When asked how they would advise potential candidates about the program, most learners suggested that they contacted the SAILI office. Some learners also mentioned that candidates were required to take both maths and science on HG.

2.6.4 Impact of program

According to most participants, the chief characteristics shared by the SAILI program and school were the curriculum material and teaching approaches (12). Specific elements identified by learners as common to both programs include "sharing ideas, being given problems to solve and having answers corrected" (11), and taking down of notes (7).

55 (i.e. 2/3) of the 80 participants felt that they had gained further exposure to, knowledge and understanding of, and better problem-solving technique in maths and science from the program. 12 learners felt that through their participation in the SAILI program, they had more confidence in solving maths and science problems. 3 learners mentioned that their marks had improved.

Over half (44) of the participants felt that they applied knowledge learnt in the program in their schoolwork "all the time", whilst 31 felt that they did this "sometimes".
Key differences identified by learners between the SAILI program and their school include:

- Teaching at school includes Xhosa, whilst in the program it is 100% English (11)
- Different teaching methods (8)
- Testing work at the end of every SAILI lesson (7)
- Focus of the program on more difficult material (5)
- Specialist HG focus of the SAILI program (3) (in contrast to mixed-grade school classes)

- Faster pace of working in the SAILI program (3)
- Working in groups at school, individual working in the SAILI program (3)

32 of the 80 learners mentioned that the program was more beneficial than their school experiences. Learners felt that the program's quality of explanations (10) was better and that the SAILI program was both more practical and enjoyable than school (13).

The issue of language featured in this evaluation. The grade 11 and 12 Xhosa speaking learners indicated that they would like to see an intermix of Xhosa and English (some form of code-switching). A few of the Xhosa learners preferred their school teaching because it included their home language. Learners interviewed in the Grade 10 class thought that the program was not much different to school. One learner preferred his teacher at school who combines English and Xhosa when teaching.

Table 2: Learner perceptions of learning

	In School			In Supplementary Program		
	All time	Sometimes	Never	All time	Sometimes	Never
Experiments demonstrated	11	58	10	11	54	9
Conduct own experiments	4	45	30	7	35	38
Teacher-written Notes	48	31	1	63	8	5
Own notes from Reading	8	52	17	8	27	38
Learners passive, teacher active	8	45	25	7	35	24
Allowed to share ideas	56	19	5	55	14	8

Learners viewed what happened in their schools and in the supplementary tuition as similar: they generally felt that they were able to share their ideas; learners appeared to have very similar feelings towards the extent to which experiments were demonstrated in school and in the program; more learners felt that they had about the same amount of teacher-written notes in the program as at school.

Table 3: Learners' perceptions of the impact of the program on Knowledge, Skills and Attitudes

	Science			Maths		
	Much Better	**A little better**	**Nothing changed**	**Much Better**	**A little better**	**Nothing changed**
Understanding	52	24	0	47	29	1
Problem Solving	40	36	0	44	31	2
Confidence in writing tests	40	33	4	44	29	4
Interest in studying further	54	18	5	55	16	5
Interest in following scientific field	46	23	8			
Helped knowledge ideas/concepts	37	37	2	43	32	2

Knowledge – About half the learners felt that their conceptual knowledge of maths and science was "much better" as a consequence of the program. A further 35%-40% of learners felt that their conceptual knowledge was a "little better" as a result of the intervention. Approximately 60% of learners felt that their understanding of both maths and science "got much better". In both maths and science only a small minority felt that the program did not have any impact or made a difference in their conceptual knowledge.

Attitudes - 70% of learners felt that their interest in studying both maths and science further, is much higher as a result of their experiences in the program. About half the learners felt that their confidence in writing tests in both subjects was "much better" as a consequence of the program. A further 35%-40% of learners felt that their confidence got "a little better: as a result of the intervention. Only a small minority of learners felt the program made no difference to their confidence in writing maths and science tests, and their interest in further study in these subjects. Although 10% of learners felt that the program made no difference to their interest in following a scientific field, 30% claimed that their interest was a little higher and 55% also claimed that their interest in the field was much higher due to the program.

Skills - About half the learners felt that their problem-solving in both maths and science had got much better as a consequence of the program. A further 35%-40% of learners felt that their problem solving got a little better as a result of the intervention.

2.7. Programme Evaluation

SAILI had commissioned an evaluation (SAILI End of Term Report; ERA 2004) to examine the impact of the programme.

2.8. Costs

Stellenbosch University provides venues for free (and this contributes to lowering costs) and SAILI pays for transport costs.

According to figures supplied by SAILI the 2005:

Program cost is	R185000,
Administrative cost of	R18500,
Total cost for the year	**R203500.**

Budgeted for 120 learners this works out to a cost of R1696 per learner. This programme is for 18 Saturday contact session.

There is a vacation programme, which is held at Cape Technikon in July for 5 days (learners are bussed in) and the cost of that programme is R15 000.

3. MATHCHAMP

MathChamp is an NGO operating in Diepkloof, Soweto. It is run by three math teachers and there are many dimensions to the programme. The Supplementary Tuition part is where learners, supported by their parents come to the center because they have problems with particular sections of work. MathsChamp gives them a diagnostic test in that area of work and then sets them work that matches the score on the diagnostic test. The work set by MathsChamp might not be set to the grade level at which the learner is at.

Learners come to the center at least once a week and they pay a fee of R210. At the center the learners work through structured exercises on particular sections. MathsChamp offers individualized tuition in Math, Physical Science and English.

At the moment there are 20 grade 11 learners and 14 grade 12 learners. Numbers in grade 12 are lower because the department of education also offers classes to matriculants. The model is based on a respond to needs rather than a structured programme. The programme is offered on a Tuesday (from 2.30 onwards) and Saturday (9h00 to 13h00).

The NGO element of Maths Champ falls outside the supplementary tuition sector. This involves in-school interventions. These interventions entail the co-planning of a school syllabus with a teacher using worksheets that have been developed through MathChamp Private supplementary tuition. Furthermore MathChamp goes once a week to class with the teacher, either to co-teach or fully teacher material.

The present model of a respond to need is not viable for future support – for government intervention it must be a structured programme with a set curriculum. However it is advisable for the small NGOs also be eligible to apply for the funding for the programme, as they serve a localized population, but they must demonstrate the ability to offer a structured programme.

4. IMFUNDO CASE STUDY

4.1. Programme Description

Imfundo is a program that operates in Sandton and services learners from townships to the north of Johannesburg (viz. Alexandra). Imfundo was established in 2003 and focuses on providing support to learners in science and mathematics, as well as providing career guidance to learners and introducing them to practical examples of entrepreneurship and technology.

The programme runs for 38 Saturdays of the year (starting early February) and there are 3 contact sessions during the breaks (April, July and September). So the total contact time is 52 days a year.

The learners in the Imfundo programme come from 3 high schools in Alexandra Township. The classes were originally held in a school in Alex, but because of a hijacking, they managed to secure premises at the Nedcor Buildings in Sandton.

The energy and drive for the programme comes from young black professionals who want to plough back to their communities. Ntutuko Shezi (the co-ordinator) is from Ndwedwe (just outside Durban). He got an A in math and physical science in matric - went to UCT and completed an engineering degree. Having received all this education he wanted to give something back to the community, Two years ago he and a few colleagues started working with learners from Alex on Saturday - all of this was totally on a volunteer basis. They set up Imfundo and they have registered the organization as an NPO.

Imfundo provides transport for the learners from Alex to Sandton. The students meet at 08h00 and classes start at 09h00 until 14h00 and the learners are back home at 15h00.

Every Saturday (38 Saturdays a year) the grade 11 and grade 12 learners are bussed from Alex to Nedcor. They have 1-hour math and 1-hour science by a professional teacher (they have employed private school teachers who want to make some contribution). Then they have a 1.5-hour tutorial, this is run by young, black professionals - they have degrees in Engineering, computers, actuarial science etc. They work through tutorials and math and science problems -

they do it on a volunteer basis. The tutors are around 22 or 23 years old and therefore easy for the grade 11 and 12 kids to interact with. When I asked them why they do it, they all said that they want to give back to their communities and having this organisation allowed a vehicle for them to do so.

4.2. Structure of programme and modus operandi

A typical supplementary tuition Saturday runs from 9am to 2pm. This is broken down into one 90-minute mathematics and one 90-minute science class with a 30-minute break. These lessons are offered separately to grade 11 and 12 learners. The lessons are taught by professional educators (one is a teacher at King Edward and the other at Sacred Heart College). These teachers indicated that they teach the topics that they would have taught to their classes that week – this may or may not resonate with the topics that the learners may have been going through in their schools. So the supplementary tuition is seen as either new topics (and when the school teacher presents it, it is the second time the learners see it), or as reinforcement of the learning that already occurred in the school. I observed a lesson on vectors and the modus operandi was for the learners to work a number of problems and for the teacher to work through the problems. The teacher indicated that at times he did do experiments and demonstrations. In the math class it is also a similar approach and the teacher working through examples and introducing new work.

This is followed by 90 minutes of tutorial sessions given by volunteer professionals from various companies. Each tutorial works around a ratio of 1 tutor to 4 learners. Tutors receive weekly emails outlining the plan for each week. The tutorials involve working through the examples set by the teachers.

The tutorials are conducted by young, black professionals and they can have an easy rapport with the students. In addition there is code-switching of languages (English-Zulu) so that learners can have an easy understanding of the work.

Learners are also provided with textbooks for science and math and science, math sets as well as stationary.

4.3. Evaluation of the programme

The programme started with lots of enthusiasm and the co-ordinators are developing a model for the programme. In 2003 Imfundo taught 6 learners taking matric. Of these 2 are rewriting matric, 3 are employed and 1 unemployed

In 2004 Imfundo took 11 grade 11 learners and 10 grade 12 learners. About 18 (90%) of the learners came from 3 schools in Alexandra (teachers in the other three 3 schools are not keen on supporting the programme) and the other 3 learners came from Thembisa, Vooslorus and Kagiso.

The number and the structure of the programme has become more formalised in 2005 – with teachers and tutors.

4.4. What do learners say about the programme?

A sample 13 Grade 12 learners were asked to complete a questionnaire on the purpose, impact and challenges experienced in the Supplementary Tuition program.

4.4.1. Who are the learners in the program?

Of the 13 students in the sample, 69 % were male and 31% were female students. All the students were in Grade 12, with the average age being 18 (range: 17-21). The table below shows the number of students who take Mathematics and Physical Science either on the Higher grade or Standard grade level.

Table 4: Number of students taking Mathematics and Physical Science on the Higher or Standard Grade

Grade Level	Mathematics	Physical Science
Higher grade	8	11
Standard grade	5	2

4.4.2. A description of the program

The Imfundo program involves students being bussed from Alexander to Sandton every Saturday to attend Supplementary Tuition in Mathematics and Physical Science on the higher grade. All the students (n=13) attend the Imfundo program on a Saturday for approximately five hours between 9:00 am and 14:00 pm. None of the students are required to pay a fee to attend the program. There is consensus among the students that the Imfundo program is geared toward helping them improve their Mathematics and Science with the aim of improving their future prospects. For example 54% of pupils indicated that in improving their Mathematics and Science, there would be the possibility of attending university and more career opportunities.

As a group there appears to be consensus among the majority of students that the length of the program should be longer. Fifty –four percent (54%) of the students cited wanting to learn more as the reason for this. Attendance at the program has been very good with over half the learners indicating that they have never been absent from the program and a third of learners indicating that they have been absent once or twice. Of the latter, students difficulties in transport to the program venue appeared to the main reason for attendance problems.

4.4.3. Where do students get their information about the program?

The major source of information that allowed students to learn about the program was through friends with half of the respondents indicating that they had had a friend in the program. There are many steps that students reported taking in joining the program. One third of respondents reported that good results, especially in Science and Mathematics, were a requirement to get into the program. When asked to give advice about how another learner could access the program, half of the respondents felt it would suffice to refer the individual to someone in charge (Program manager) and one third felt that an individual could simply join the program.

4.4.4. Impact of the program on learners

Influence of the Supplementary Tuition program on learners knowledge and interest in Mathematics and Physical Science.

The Supplementary Tuition program appears to have a positive impact on the majority of learners in terms of their knowledge and understanding in Mathematics and Science, ability to solve

problems in these subjects and has also increased students' confidence and their interest in either studying the subject further or pursuing careers in science.

Table5: Impact of the supplementary tuition on learners' knowledge and interests.

	SCIENCE		MATH	
	Much better	**Little better**	**Much better**	**Little better**
Understanding	11	2	12	1
Problem solving	9	4	9	4
Confidence in writing tests	8	5	9	2
Knowledge ideas/concepts	9	4	10	3
Further interest in science field	10	2	10	3

From the learner responses the program appears to have a positive impact on learners understanding of Mathematics and Science. About two thirds of the respondents indicated that that their problem solving abilities were much better and two thirds of the learners indicated that their confidence in writing both Math and Science tests was much better as a result of the program. The majority of the learners (over two thirds) felt that their knowledge in both math and science has become much better and three quarters of respondents felt that they have become much more interested in studying Math further and pursuing science as a career.

4.4.5 Impact of Out of School program on learners' skills

It would appear that in terms of practical skills (Conducting experiments, note-taking) schools appear to undertake more of these activities.

Table 6: Impact of program on learners' skills (N=13)

	School			Program		
	All time	Sometime	Never	All time	Sometimes	Never
Experiments demonstrated	5	6	2	2	1	9
Conduct own Experiments	2	8	2	0	3	10
Teacher-written notes	10	3	0	9	3	1
Own notes from reading	5	5	2	6	2	4
Learners completely passive, teachers fully active	4	7	2	5	7	1
Allowed to share ideas	7	4	2	7	4	2

From the learners responses more experiments are conducted in school than in the program with a little over two third of the respondents claiming that they conduct their own experiments (sometimes) in school and the majority of respondents (over two third) claiming that they never conduct their own experiments in the program. It is possible that their schools are better resourced to conduct experiments.

Over two thirds of the respondents claimed that in both school and the program they received teacher-written notes and most respondents were required to compile their own notes from reading.

About two thirds of the learners felt that they sometimes played a passive role in both the program and at school, but the majority of respondents indicated that they were free to express their ideas, all the time, at the program and at school.

4.4.6. Challenges faced by learners

Learners reported experiencing some difficulties in attending the program and these difficulties appear to center around issues of transport. Twenty-three percent of learners identified lack of transport and the cost of transport as factors that affect their attendance at the programs. (the co-ordinator indicated that for 2005 Imfundo was providing for and paying for transport).

On asking learners about students who dropped out of the program it was revealed that a number of students had dropped out. Sixty-two percent of respondents reported between 5-15 people who had dropped out of the program. When asked to suggest explanations for why these individuals may have dropped out of the program a large number of learners (42%) failed to identify a reason, however, 38% suggested that a possible reason could be that the students performed poorly in the tests conducted by the Supplementary Tuition program and became de-motivated and hence left the program.

When required to provide suggestions as to what the learners felt could be improved in the program about a half of students felt that more activities or choices could be introduced into the

program, in terms of, the need for computers at the program, the need for more Camps/ Fieldtrips and more courses to be introduced into the program.

4.5. Program costs

As an NGO the program relies on corporate organisations to provide classroom facilities and other resources. For example the Saturday program is held at the Nedcor Conference centre in Sandton.

From the business plan offered by Imfundo, the budget for 2005 is R176 658 (R40 000 for transport costs). This is for 15 students and therefore the cost per learner is R7361 – this is for a total of 52 contact days (Saturdays and vacation).

The programme intends expanding to grade 10 learners in 2006 and the budget for 50 learners is projected at R247 546 and the cost per learner is R4951.

4.6. Recommendations for program expansion

At the moment the unit cost per learner is very high – this is because it is a very small class size. To be viable there needs to be more students per unit group. The accommodation at Nedcor will only allow a maximum of 20 learners.

5. Science and Engineering Academy of South Africa (SEASA)

SEASA was one of the oldest NGOs interfacing with learners (established in the 1980s). The co-ordinator Dr Gordon Sibiya was very angry with what he perceived as the non-support from DST and did not want to be interviewed.

6. Summary from the NGO sector

The NGO sector offering supplementary tuition can be categorised into two types: those that respond to the needs of individual learners and those that have set out a structured programme for learners. We would recommend supporting the structured programmes rather than working on the basis of "respond to needs of the individual." Most of the NGOs offer local programmes.

The structured programmes combine elements of knowledge, skills, awareness, industrial exposure and careers in the structuring of programs. The programme seems to mirror school very closely in the way the programme is delivered, but with an experienced and knowledgeable teacher. The programme should try and engage with the university, whose premises they use to use the facilities and resources. This is especially important for the sciences where experiments need to be conducted.

The learners are sponsored to attend the programme and the attendance rates for these Saturday classes are high. Some of the programmes are offered as 'package' with learners sponsored for the school programme and scholarships offered to encourage learners to follow tertiary level math and science studies.

Sometimes the work covered in the supplementary tuition had been dealt with in the schoolroom and this session serves as revision. At other times this would be the first time the learner would see the concepts.

The programme serves small groups of learners and is focussed on a key development need – i.e. increasing the number of higher grade learners. It would seem that a ratio of 1:25 is optimum for the interactive question and answer.

The programme targets learners in the urban areas. In order to give rural learners access it would mean that the programme must run a residential-based model (in urban areas) for a total of 15 days each year (5 days in April, 5 days in July and 5 days in October). The various NGOs interviewed were agreeable to this model.

An important consideration for supplementary tuition programmes is the language of instruction. Some African learners indicated that they would like languages code-switching in the classrooms to ensure greater understanding. One NGO has deliberately structured its tutorial with learners to be with young African professionals who provide role models to the learners as well the language of interaction with the learners is English and an African language.

There are lessons to be drawn from studying the Imfundo project where young African professionals have organized themselves to provide a supplementary programme as part of their 'plough back' to the community. As a self-standing programme this is an expensive model to replicate but there are elements that can be used in designing future programmes.

The cost of the programmes vary – for the SAILI programme it costs around R1700 per learner per year (18 contact sessions and high transport costs). The Imfundo programme costs around R7300 per learner (52 contact days and small number of students).

CHAPTER 6
SCIENCE CENTRES

1. Introduction

In this study we decided to look at science centres because they are well-resourced public spaces whose purpose is to increase science awareness and interest. Science centres focus on education through entertainment and fun. However, given the poor performance in mathematics and science in South Africa, science centres are an ideal resource in providing opportunities for a programme of supplementary tuition for learners. Based on this, we explored this sector and we provide case studies of the MTN ScienceCentre, Canal Walk, Cape Town; Old Mutual-MTN ScienceCentre, Gateway, Durban; Unizul Science Centre, Richards Bay, Kwazulu-Natal.

The Southern African Association for Science and Technology Centres (SAASTEC) lists the following as the main centres:

- The Sci-Bono Discovery Centre, Newtown, Johannesburg
- Tukkies' Discovery Centre, University of Pretoria
- University Of Limpopo Science Centre, Polokwane
- Giyani Science Centre, Giyani, Limpopo Province
- MTN ScienceCentre, Canal Walk, Cape Town
- Old Mutual-MTN ScienceCentre, Gateway, Durban
- Unizul Science Centre, Richards Bay, Kwazulu-Natal
- The Proposed UFS. Boyden Science Education Centre, Boyden Observatory
- Other centers registered on the SAASTEC website are given at the end of the chapter.

2. MTN Cape Town ScienceCentre

The MTN ScienceCentre occupies a large space at the Century City mall and houses a large number of exhibits. The main exhibition room houses over 280 displays. Most of these exhibits are permanent, but some of these travel to other science centres around the country. The Science Centre also has an exhibition hall, where a themed exhibition is housed. Two different exhibitions are put together every year. In addition the ScienceCentre has an auditorium, camera

obscura, computer rooms and laboratories. The ScienceCentre also puts on science-themed plays at regular intervals.

About 60 000 learners a year visit the MTN with their schools. Most of these visits are sponsored. MTN operates on a large sponsorship that is used to subsidise access of limited number of underprivileged children to each of the various initiatives that it hosts. About 45% of the centre's budget is derived from gate takings and the rest through sponsorship.

In addition to the primary activity of visits and interaction with the exhibits there are additional activities. These may consist of workshops, for example Steve Sherman's "Living Maths", where the focus is on enjoying and discovering the relevance of mathematics. Living Maths is not necessarily school curriculum-based. Other typical activities include Grade 10, 11 and 12 mathematics revision workshops. These generally take place in June, July and August. There are sleepovers arranged around different themes, hosting about 100 people at a time, incorporating arranged special lectures. One of the science centre programmes is the SAILI sponsored programme (called SAILI Comets), which involves the grade 8 and 9 learners.

2.1. The SAILI Comets programme

About 35 grade 8 learners are selected each year to be part of the SAILI Comets programme. These learners then continue on the programme in grade 9. Selected learners are offered placement in 'selected schools' with Saturday classes also being part of the programme. Once they complete the Comets programme they join the senior programme, which offers their classes at Stellenbosch University (see NGO section of this report).

Grade 8 and 9 learners attend the programme on alternate Saturdays at the MTN ScienceCentre where they receive non-curriculum-based enrichment. This is to "develop opportunities and change mindsets outside the school curriculum." MTN ScienceCentre was approached to set up a programme, which develop attitudinal mindset in learners that maths is "cool and fun."

The program operates from February to October on a fortnightly basis for 18 Saturdays. The sessions run from 09h00 to 15h00. Learners are bussed in from the townships and spend the day

at the Centre. Each day begins with a one- hour maths revision lesson – not curriculum-based but dealing with core knowledge. This session on core math knowledge was introduced in 2005 because grade 10 (who had been part of the SAILI Comets) learners' knowledge was found to be lacking.

Activities of the SAILI Comet programme are held at a lecture room in the ScienceCentre. The activities involve hands-on practical workshops (not curriculum-based). According to the MTN director, at the grade 8 and 9 level there isn't as much pressure to concentrate on science knowledge and the programme can look at building science interest and attitudes. In addition to activities at the centre there are 2 excursions per year.

The following are typical examples of the types of workshops are:

- Chemistry with explosives
- Steamboats
- Polymer workshop
- Energy transformation
- Structures
- Mechanisms
- Processes
- Electronics and advanced electronics
- Biotechnology
- Energy breakthrough
- Physics and Einstein (this being the year of physics)
- Robotics League Challenge
- Lego Dacta

In 2005 there are 38 grade 8 and 35 grade 9 learners. In 2004 there was a zero drop-out rate and a 100% attendance.

2.2. Costs

The budget (approx) submitted by the MTN Science Centre for 2005 is:

Programme Costs	R210 000
VAT	30 000
Transport	40 000
Total (for 75 learners)	**R280 000**

Cost per learner =R3733. This cost covers 18 contact periods for a year.

2.3. Expansion

This programme offers access to learners who are within daily travelling distance to the Centre. We discussed the possibility of making the programme available to learners from rural areas. This would only be possible if there was a residential course. This could only be held for weeklong periods during school holidays in April, July and September. This would also involve the added cost of accommodation – the viable place would be the UCT campus and rates are around R130 per day.

Proposed cost of a residential type course for learners not within travelling distance is:

Assuming that the programme caters for 35 learners and there are three week long residential courses.

Programme costs	R105 000
VAT	15 000
Accommodation and subsistence (at R200 per night)	R 90 000
Transport	R 20 000
TOTAL for 35 learners	**R 230 000**
Cost per learner	**R6 570**

3. Old Mutual-MTN Science Centre in Durban

The Old-Mutual-MTN ScienceCentre at the Gateway Centre, Durban focuses on science and technology in a fun interactive way. The Science Centre is based in Umhlanga and is close to KwaMashu Township (a township that has 22 high schools).

The ScienceCentre is strategically located near the Cinema complex and Food Court which sees approximately 6 million visitors annually. Last year, the ScienceCentre had over 56 000 visitors (up from 42 000 in 2002), 60 per cent of whom were school learners. In addition, through outreach projects the Gateway ScienceCentre reached an additional 53 000 learners in mostly rural and township areas (up from 35 000 in 2003). Five outside exhibitions were held in 2003 reaching a further 25 000 people, with six exhibitions held in 2004 reaching 38 000 people.

The goal is to excite and inspire learners and to allow them to see science and technology as interesting, accessible and enjoyable. As they state: "Our vision is of a world-class science centre providing excellence in a unique combination of education and entertainment making science and technology accessible to all."

The centre provides a range of fun, hands-on learning programmes which are linked to the school curriculum and which are not always possible in the poorly resourced classroom. In order to sustain itself the ScienceCentre also hosts a number of initiatives with science content that are not necessarily aimed at cultivating science knowledge. For example the ScienceCentre hosts holiday programs for young children that include drumming, lava lamp- crystals-, chocolate-, burglar alarm- and Christmas card- making workshops, magic shows and treasure hunt competitions. Some of these activities are also held throughout the year.

The ScienceCentre also hosts an IT and Electronics expo and an Education and Careers expo. Throughout the year once-off hour-long Chemistry, Electronics and DNA workshops are held. In addition computer courses, teaching basic skills and software packages, for both learners and educators are offered at the centre.

The Gateway centre is similar to that in Cape Town. The Old Mutual - MTN ScienceCentre is a non-profit organisation that is funded by Old Mutual but which is required to operate at such a level that it can sustain its own activities. This means that it has to find additional partners and sponsors. The total value of cash sponsorships received in 2004 was R817 000 (from DST, the Shuttleworth Foundation, SAASTA and Murray and Roberts). In addition the total value of in-kind sponsorships received in 2004 was R304 000. This amount includes donation of 3 exhibits and a computer laboratory.

Some of the activities run by the centre in 2003/04 include:

1. The DST-funded sponsorship of a school-a-day for the duration of 50 school days (120 learners a day). Learners got a hands-on, minds-on experience at the ScienceCentre. Learning programmes were specially tailored to meet the needs of the school curriculum, e.g. The Marvels of Energy and Change, The Magic of Magnetism, The Science of Shopping, or Interactive Space Travel;
2. Hosting 160 young women from around the country taking them through a week of science, engineering and technology programmes in an attempt to inspire them to follow careers in these much needed areas;
3. Conducting teacher training for educators from disadvantaged schools and hosting Biotechnology workshops for educators;
4. Hosting the Science-on-the-Move Outreach project at ten schools, conducting teacher training, performing science shows and affording learners the opportunity to interact with a set of portable exhibits. This reached 6 000 learners and 50 educators;
5. Focusing the Biotechnology Hydroponics for 8 rural schools. This project was aimed at rural areas where communities sustain themselves by growing their own food. About 1 600 learners were taken through the basics in hydroponics;
6. Hosting the Manchester Museum of Science and Industry exhibition, SciQuest, DNA 50, the Science of Sound Programme, the 'Great Inventions that Changed Your World' exhibition and will shortly be showcasing the 'Great South African Inventions' exhibition;
7. The Murray & Roberts Build-an-Exhibit Competition for Primary Schools, where 2 000 sponsored learners, as well as learners from other schools, participated;

8. The Shuttleworth Science of Sound for High Schools, with 1 200 sponsored and 1 200 other learners participating.

At the FET phase of the school curriculum, the centre provides workshops to school groups attending with their teachers. Most schools are from suburban Durban with a learner profile of middle-class background. Workshops mostly take place on weekday mornings from 9-11am. Each workshop consists of a show, a set of interactive exhibits and the allocation of a workbook and worksheet to every attendee. About 60 and 100 learners can be accommodated (from a variety of schools) at any one time and they are split into two groups. Visitors to a workshop are requested to complete a feedback form on their experiences.

The centre's education manager, who has high school mathematics and science-teaching background and his assistant, who is currently studying mathematics and science education, run these workshops. The aim of the workshops is to cover material that is linked to the curriculum without duplicating classroom material.

Thus far two workshops, "Science of Sound" and "Newton's Laws" have been staged by the Gateway ScienceCentre. Currently "Newton's Laws", aimed at Grade 12s is being offered. 1000 learners have attended this in the 1st school term. The program is expected to run up to the 2nd term. This workshop features experiments that relate to the curriculum but are additional to the syllabus. In addition the following two workshops are already planned "Science of Light" and "Science of Electricity". All that the centre needs is funding to kick-start them. The centre plans to offer workshops on every section in the Grade 10-12 physical science syllabi.

"Science of Sound" workshop, inspired by the Gr. 10 curriculum, ran in 2004. This looked at the physics and maths of sound production and music. Sponsored by the Shuttleworth foundation, 1200 sponsored and 1200 paying learners attended this workshop with their schools over three terms. 200 of these learners were subsequently selected to participate in a program competition based on the process of how to generate music with the use of computers. Learners were exposed to experts in their field (music producers, disc jockeys, sound engineers) who came to talk about different careers. The competition was eventually won by a learner from Estcourt. She came from

a disadvantaged background, and she received prize money to the value of R20 000 in the form of a bursary to study sound engineering.

3.1. Programme Expansion and Costs

The centre has a number of workshops and has built up its resources. All its interventions are once off. We broached the idea of a programmatic intervention. The programme proposed is to start with a group of grade 10 learners (or grade 11) and take them to grade 12. In this programme they would be offered curriculum-based interventions in math and science. In addition there would be information about careers and an exposure to science fun and adventure.

Interventions would take the form of a weekly program (say on a Saturday) split evenly between mathematics and science (2 hours each) and be planned and run by the centre's two educational staff working together. The centre's venue can accommodate 50 learners. The ScienceCentre staff thought that this was feasible and they could co-ordinate such a programme. They provided us with the following proposed budget for such a Learner Improvement Programme.

Mathematics and Physical Science

Budget for 1 grade of 30 Learners for 30 Saturdays

2 Hours Mathematics and 2 hours Physical Science

Venue Hire	R900 x 30 Saturdays	27 000
Administration Cost (Tel. Fax etc.)	R100 x 30 Saturdays	3000
Travel Allowance for learners	R20 x 30 Learners x 30 Saturdays	18 000
Subsistence Allowance for learners*	R20 x 30 Learners x 30 Saturdays	18 000
Entry fee to ScienceCentre	R19 x 30 Learners x 30 Saturdays	WAIVED
Facilitators Fee	R600 x 2 Facilitators x 30 Saturdays	36 000
TOTAL		102 000
Plus 13% Project Management Fee		13 260
TOTAL COST OF PROJECT		**115 260**
COST PER LEARNER		**R3842**

* Learners would also be provided with educational material, food and transport.

4. Unizul Science Centre Case Study

4.1 Programme Description

The Unizul Science centre is located in the Richards Bay area. This centre runs a number of activities. Its chief role is to host visits school from a 200km radius around Richards Bay. This area currently has about 500 secondary schools and 1100 primary schools. Over 30 000 learners and educators visit the centre annually. Visits are structured around a four-hour program that includes time spent perusing exhibits, an interactive presentation on a physical science phenomenon and an astronomy workshop. The emphasis is on learner interaction so as to foster enthusiasm in science. The centre also provides teachers with information on presentations, in order to help them answer any questions from learners.

The Science centre contains over 200 exhibits. The focus is on displays that learners from underprivileged areas can relate to. Amongst the exhibits are rooms devoted to automotive subjects, Richards Bay industry and optical phenomena. All exhibit descriptions are in Zulu and English. Derek Fish (the coordinator) estimates the value of the Unizul Science Centre at R4million in buildings (2 warehouse buildings, which includes an auditorium, conference centre and equipment including dark room projector, KwaZulu-Natal's ***only*** planetarium – a portable Starlab in which 30 learners can enjoy a perfectly accurate depiction of the night skies.). And R3 million in exhibits (+/- 200).

The Unizul Science Centre also hosts the Centre for the Advancement of Science and Mathematics Education (CASME). Throughout the year, CASME runs in-service training courses for educators in Science, Mathematics and Biology to consolidate and broaden their skills. CASME also hosts a resource centre of equipment, audiovisual aids and reading matter to allow educators access to these vital teaching-aids. There is a close relationship between the Science Centre and CASME.

Every year during the July school holidays the centre hosts 40 Science educators, taking them to 6 of the largest Richards Bay industries. The purpose of these visits is to familiarise educators with the technology used by the industries, as well at to show how it relates with the school

syllabus. The Unizul Science Centre also hosts competitions, science camps, a Science expo, and a number of particular science-oriented "weeks" – Water week, National Science week, World space week.

The activity performed by the science centre, which best matches the DST's supplementary tuition agenda are the quarterly workshops held to demonstrate the experiments that are examinable in the physical science curriculum. Workshops are repeated at 5 different locations within the centre's 200km catchment area surrounding Richards Bay in order to save learners' travelling costs. This practical work is rarely, if ever, performed in many rural areas. In total, over these five venues, each of the four workshops is presented to over 7000 matriculants.

4.2 Recommendations for program expansion

At the moment the UniZul Science Centre offers once-off experiences and not structured programmes. We discussed the idea of a structured programme for learners that lived close to the Science Centre and for learners who lived a distance from the Centre. We identified a few options for how the UniZul Science Centre could be used to support a supplementary tuition programme.

A. Target learners in schools in the vicinity of the Science centre and offer a math and science input on the higher grade on Saturdays.
B. Bring a small cohort of learners, from more rural areas and away from daily travelling to the Centre during school holidays. This could occur for a week in April, July and September. This model requires providing transport, accommodation, full-time care and other necessary services. Ensure a maximum ratio of 1:25 learners.
C. Target a specific school (that already achieves good results and has good facilitators and motivated teachers) and use as a cluster school for supplementary initiatives. Have facilitators travel to rural areas four times a year over school holidays to give workshops over four or five days.
D. Select a top school in the area to host workshops and as a target for upgrading of infrastructure (if this upgrading will be beneficial in the long-term). This also requires providing accommodation facilities for facilitators. Establish a permanent presence in a rural area for the running of weekly programs. This requires providing

accommodation and other incentives. Investigate the use of volunteers for 6-month, 1 year or 2 year periods.

5. Summary

Science centres are good hosts for supplementary tuition interventions because they can be combined with attached careers centres and thus offer a twin-pronged service. In addition there are fun exhibits for learners to play with during their breaks. Science centres are resource intensive and therefore can be used for the supplementary tuition programmes. Most Science Centres are on soft money and therefore their costs would be more expensive than, say universities.

Some science centres present structured programmes over the year to learners and others offer once off programmes to learners to stimulate interest and awareness. In discussions the science centres all indicated that they would be willing and able to offer supplementary tuition provided that they received funding.

The science centre programme offerings are expensive with programme costs varying between R3700 (for 18 contact sessions) and R3800 (for 30 contact sessions). The cost increases to almost double if it is offered on a residential basis.

It could be useful to engage the discussion with Science Centres about providing a Supplementary Tuition programme through the SAASTEC organisation.

Other centres registered on the SAASTEC website

In addition the following are also members of SAASTEC.

- Port Elizabeth Museum Complex, Port Elizabeth, Eastern Cape Province
- South African Institute for Aquatic Biodiversity, Grahamstown, Eastern Cape Province
- Boitjhorisong Resource Centre, Sasolburg, Free State Province
- Kwazuzulwazi Science Centre at Durban natural science museum, KZN
- Cradle-Ribeiro Observatory, Johannesburg, Gauteng Province
- Delta Environment Centre, Johannesburg, Gauteng Province
- Environmental Education - National Botanical Institute, Pretoria, Gauteng Province
- Gold Reef City Exploratory, Johannesburg, Gauteng Province
- Hartebeesthoek Radio Astronomy Observatory, near Krugersdorp, Gauteng Province
- Johannesburg Planetarium - University of the Witwatersrand, Johannesburg, Gauteng province
- Physics Emasondosondo, Mobile Science Centre run by the University of the Witwatersrand's Schonland Institute, Johannesburg, Gauteng Province
- Somerset Educational, Garsfontein East, Pretoria, Gauteng Province
- South African Agency for Science & Technology Advancement - SAASTA, Pretoria, Gauteng
- Tsebo Koloing - Mobile Science centre, University of Pretoria, Technikon Pretoria and Technikon Northern Gauteng, Pretoria, Gauteng Province
- Ulwazi Partnership, Developing Interactive Science and Cultural Centres, Saxonwold, Gauteng
- Vaal Triangle Technikon, Vanderbijlpark, Gauteng
- Museum for Science & Technology, Pretoria (Discovery Centre at Transvaal Museum)
- Centre for Maths Exploration - University of Limpopo, Polokwane, Limpopo Province
- Hermanus Magnetic Observatory, Hermanus, Western Cape Province
- iThemba Laboratory for Accelerator-Based Sciences, Faure, Western Cape Province
- MTE Studios, Cape Town, Western Cape Province
- Signatures - Makers of Themed Displays, Cape Town, Western Cape Province
- South African Museum, Cape Town, Western Cape Province
- The Discovery Centre, Cape Town, Western Cape

CHAPTER 7
INDIVIDUALISED SUPPLEMENTARY TUITION

In our survey of supplementary tuition service providers, one category that emerged was the provision of individualised tuition at the pace of the learner. This type of tuition is offered by science teachers who provided tuition at their or the learner's home on a one-on-one basis. This is provided on an ad-hoc basis. In addition there are organisations that provide individualised tuition and in our database we documented franchises offering individualised supplementary tuition. The expanding number and size of franchise operations offering mathematics and science tuition illustrates the popularity of this model. We identified Kip McGrath, MasterMaths and Kumon as franchises offering individualised supplementary tuition. MasterMaths, PLATO and Kumon offer supplementary mathematics tuition at the secondary level and we decided to investigate these further. MasterMaths and PLATO are computer-based programmes and Kumon involves pen and pencil interaction. Both provide individualised interaction.

1. MasterMaths Case Study

1.1. Programme Description

MasterMaths (MM) is a computer based teaching system (CBT system) that combines voice and animated graphics in the teaching of mathematics. MM was designed for the use as supplementary tuition where a learner works through a module of work and then solves problems. A tutor is at hand to assist the learner if she has difficulties. In addition to the supplementary, out-of-school tuition format, MM has been selected as the mathematics-teaching software that is used by a Western Cape schools project, which utilises computers as part of in-school teaching.

Supplementary tuition is offered in after-school hours at privately run-and-owned centres. Learners receive individual guidance from tutors whilst engaging with the multimedia material at the computer centre. The size of centres varies from place-to-place. Some place will have as few as 2 or 3 computer workstations and others as many as 40+ workstations.

Subject to computer terminal availability, effectively managed capacity of a MM centre is in the order of a maximum of 1 facilitator to 8 learners at any one time.
Operating a centre for MM purposes requires a full-time person responsible for the task. There are currently over 95 franchise centres in operation, servicing about 10 000 enrolled learners at any one time, with a peak of 13 000 learners around October each year. In addition the system is used in over 110 schools to assist educators in curriculum delivery.

The manner in which MM operates insists on high quality standards on franchisees. MM ensures a level of quality control through the requirement that every franchisee write the matric maths HG exam every year under exam conditions. If additional tutors are employed at a centre they are usually university students (with matric maths) employed on a part-time basis.

Franchise facilitators require training in the MM system before they can set up their own franchise. This should take about 3 months of full-time training to achieve. In addition facilitators are required to have passed mathematics at matric on the higher grade. The Chatsworth facilitator, who did not initially have matric mathematics, reports that her training took an additional nine months of full-time spent (at another franchise) working through material of the various grades she would facilitate, followed by a further three months (spent at Somerset West head office) on facilitation technique and other aspects of the MM system.

MM is strictly linked to the school curriculum and does not involve any other enrichment material or activities. Curriculum development personnel actively work to keep MM software in line with the National Curriculum Statement (NCS) updates.

In studying the MM operation we looked at two dimensions: firstly, the use of MM as supplementary tuition for learners and secondly, the use of MM in a formal in-school classroom set up. We studied the franchise in Glenwood, Durban (an upper-middle class area), which primarily services learners from private and former model C schools. This centre operates between 14h00 and 17h00 on weekdays, and on Saturday mornings. The franchise in Arena Park, Chatsworth (an area demarcated for the "Asian racial group" under the apartheid Group Areas act) is also patronised by learners from middle-class families. This centre operates, for learners, from 14h00 to 18h00 on weekdays and 08h00 and 13h00 on Saturdays.

Our investigation into the in-school application of MM is based on a visit to a school that participates in the Khanya programme – an initiative that is linked to the Western Cape Education Department. We visited the computer centre of Phakama Secondary School in Philippi-East, which is about 50km from Cape Town. It is a former DET school. Almost all learners are English 2nd-language-speakers. The school's computer centre manager is also a fulltime teacher at the school.

Information for this case study was collected from interviews with the CEO and marketing manager of MM, a Khanya facilitator (district manager) and Khanya computer centre manager, facilitators and coordinators from two franchise centres, observing learners at a Khanya centre and the two franchise centres, personal interaction with the program (software), and analysis of manuals and other program material.

1.2. Structure of programme

1.2.1. Supplementary tuition at a MM centre

Before engaging in any tuition, learners need to register with a centre and pay a registration fee. Learners pay for tuition on a monthly basis. The length of time spent by a learner in the program can vary from the time it takes to cover a problematic section of her syllabus (usually a few weeks) to a number of years. The number of weekly visits and length of each visit is determined by her particular enrichment needs and desires, timetable availability and her grade syllabus.

MM splits each grade syllabus into sections (e.g. in Gr. 10 the sections are Algebra, Geometry, Graphs, Measurement, Trigonometry). Sections are further split into topics, which MM refers to as subsections (e.g. Algebraic fractions). MM divides each subsection into a number of modules (for example there are 3 modules in the Algebraic fractions section). Each module is sub-divided into outcomes. Every learner receives a paper-based grade plan that divides their grade's curriculum into modules. This grade plan also indicates the prerequisite knowledge of each module. Within each module, the teaching material and exercises are broken down in the following manner:

1) Revision (of prerequisite material);
2) A teaching component;
3) A mini exercise on work covered in 2);

4) (2) and (3) continue until all teaching components in the module are covered; 5) consolidation;

6) Paper & pencil-based worksheets (if more practice is needed);

7) Computer-based test;

8) Re-test on paper if too many mistakes are made.

Learners usually do not cover all these steps, and the facilitator determines how much of a module the learner covers, based on the material they have already covered at school, their individual ability and their performance on the module.

The lengths of modules vary, but on average should take an hour to complete. This is the average length at the Glenwood franchise. At the Chatsworth franchise, things are organised in a slightly different way. This is because on average it takes two hours to complete a module. In this franchise, after each of the software's teaching and exercise components, learners are taken off the computer and given additional paper-based exercises on the material with facilitator reinforcement.

Learners typically spend two hours a week at the centre engaged in MM modules. At the Glenwood franchise this usually takes the form of two-one-hour sessions, whilst the Chatsworth franchise typically has learners attend for one-two-hour session a week. As final exams approach learners may attend sessions lasting up to three hours at a time. Facilitators also set homework, with parents and students advised to spend 10 minutes a day on such activities. This time is to revise theory and work through 1 or 2 practice examples (from MM grade notes) and also go back over previous modules to refresh older material.

Prior to each learner session facilitators need to update the structured modules that have been set for each learner. As one learner indicates:

Greg (the facilitator) selects the material since he knows each school's curriculum.

This entails accessing the learner's grade plan and seeing what they have done in relation to where they are headed. At the end of each session the facilitator enters comments on the performance of the learner during the session.

The MM system has elements of concept development, drill and practice. The system is underpinned by a philosophy of learning at one's own pace and constant, immediate feedback from tutors.

1.2.2. In a classroom situation

The Khanya project is an ICT-led initiative, of the Western Cape Department of Education. The project aims to install computer centres in all WC secondary schools by 2006.

Khanya was set up to improve participation and performance at the grade 10-12 Maths and Science HG level, using ICT as an enabling technology strategy to assist in this. MM was selected as it was the best mathematics computer based system available. According to MM the use of the system in a school is "to let learners who have fallen behind, catch up or revise their work." MM recommends that the system be used in group work settings. There was an evaluation conducted (Muller J and Louw J (2003) *Computer Assisted Teaching and Learning in Grade 12 Mathematics Classrooms: MasterMath in Khanya Schools*) in 2003 based on 5 Khanya and 5 non-Khanya schools to evaluate the usefulness of the intervention.

This evaluation found that the computer based lesson component generally repeated previous lessons taught, (with the result that the entire curriculum was not covered), in the lessons there was hardly any interaction with students; the trend was for students to work alone on the computers for most of the time. Furthermore, the report documents that teachers found it difficult to construct a coherent, appropriately paced sequence of lessons that took into account the need to move between computers in the laboratory and the classroom according to a pre-arranged schedule. On this aspect, teachers were unhappy with the training they had received, which on average was 2 hours (as opposed to the far lengthier and intensive training required of MM franchisees). Teachers were unfamiliar with MM modules. In addition, the tests on MM modules were used, but were not a substantial feature of teachers' formal assessment practices and therefore not used for diagnostic purposes. Overall the authors found "that teachers have by and large relinquished their mediation role in the computer laboratory."

Interestingly enough, from interviews with both teachers and learners, attitudes towards the software were generally positive. Both groups saw the software as an invaluable resource in assisting them fill knowledge gaps. However, use of the system is inadequately exploited because of limited access to computer laboratories. Learners could only use computers to

revise, fill in gaps, and get extra practice in their own time. All learners said that the computer had improved their performance in maths.

At the school we visited (Phakama), the computer centre consists of 25 workstations and a server. Learners typically start on the system in grade 10, 11 or 12 (although some grade 9s also spend time, space permitting). The school works on an 8-day cycle with each grade 10 and 11 class spending 3 periods of the cycle in the computer centre on the MM software and grade 12 learners spending 4 periods in an 8-day cycle.

During our visit to the school, a class of grade 11 learners (all on SG, most had gotten Gs and Fs as grades in grade 10) were currently working on the same module (I20). Although their understanding of the audio is imperfect, most learners said they wanted English audio instead of Xhosa (their vernacular). They also liked the immediate feedback, which they found preferable to the alternative "self-study" engagement with a textbook.

Although this centre uses the MM software they do not implement the MM system prescribed by the program. Whenever MM is used for class-level exercises on the same module, conceptual gaps cannot be remedied, the instruction is not individualised and learners are not working at their own pace and learners will not be directed to cover previous modules in order to cover conceptual gaps. In the MM individualised system, until those gaps are covered, time spent on "advanced" modules is relatively wasted.

In the lesson we observed, learners worked on their own in the computer terminals. They were working through examples on a factorisation module. On our inquiry about this practice, their teacher indicated that he had introduced the topic in class and now they were doing practice exercises. There were about 40 learners in the class. It seemed a fairly passive process – especially with the teacher leaving the learners to work on their own.

The MM personnel who accompanied us on this visit were disappointed with how the system was operating at this Khanya school. They were unhappy that the teacher put all learners on the same module without these learners mastering the prerequisite modules – the disappointment was in the fact that such practice defeats the purpose of self–paced learning. Our observation of the use of MM in the Khanya schools corroborates the experiences of the Muller and Louw evaluation.

1.3. Evaluation of the software

An introductory module familiarises the learner with computers and operation of the MM software. The Chatsworth facilitator reports that a grade 7 learner, who had no prior experience with computers, took only five minutes to settle into the software. One of the researchers (Berkowitz) engaged with the system as a learner.

PROGRAM ENGAGEMENT EVALUATION

Date of observation: **25 January 2005**
Time of observation: Start ...**3.20**....to ...**4.30**..(Finish)

I engaged in one module of the Grade 12 MasterMaths syllabus. The facilitator who oversaw my progress, Greg, is a white male in his late-40s.

Greg gave me a lesson plan and explained the MasterMaths system to me – each module has its own structure that begins with revision of prerequisite material, and then splits the lesson into sections.
The grade 12 logarithm module I that I was given is split into the following topics:
1) Revision of exponents,
2) Logarithmic and exponential forms,
3) Simple equations and
4) Restrictions.
In addition each of these sections has its own test component (a number of practice questions done on the computer), and a learner needs to inform Greg of her score (which is also indicated on the computer screen) on each test, and have him record this on her grade plan before she can move on to the next section. This provides both the learner and facilitator with feedback on the learner's progress.

Greg chose the lesson "Logs 1" for me, and this module number, as well as the prerequisite material "Exponents" and its module number, is clearly indicated on my grade plan, as are the relevant sections (1,2,3,4 above):

We then logged onto the system and the lesson plan for this module was shown on the screen. The basic structure of a module (as indicated by the software) is:

1. Revision of prerequisite material – with the option of going to this module if necessary;
2. WHAT IS – The teaching component of a section;
3. HOW TO – The testing examples component of a section (Note that 2 and 3 are repeated for each section in a module);
4. Summary – final teaching component;
5. CONSOLIDATE – Final practice examples before the test;
6. Physical worksheets are available for a learner to further practice the material before she takes the test;
7. Computer-based test

From the menu screen I am free to "click" and navigate to any of the above sections, and at any time I can click on the permanently displayed "menu" icon and return to the menu screen. Greg explains that many students (especially those that have covered the material in class, go straight to the "summary" section of a module).

I decide to start at the beginning and left click on a green forward-facing arrow that is displayed in the bottom left-hand side of the screen (alongside an arrow to move back, the "menu" icon, as well as a "repeat" icon).

I find all of this navigation through the system straight-forward because the screen is not cluttered with icons (the only icons that are displayed are the menu, forward, backward and repeat icons). These buttons offer users the opportunity to repeat the current section, scroll back and forth through the module and return to the module's main menu. I'm comfortable on a computer but from my experience I believe that it should not take long for novice computer users to get used to operating the software.

I have my earphones on and the audio starts up (with the screen blank).

The audio is talking about exponents (this is the revision section of the lesson on logs). At first I find that the speaker talks a little too fast and unclearly but I adapt quickly – this may have been the normal 'finding my feet'. I think the reason that I feel this way is my anxiety over the lack of written representation of what she says – maths in school is written and not spoken and it can be difficult to concentrate on the audio when there are no accompanying visuals, such as a face or words on the screen. (Interestingly I have been told by both the franchisor and franchisees that this initialisation was a weak part of the MasterMaths system, and that modules in the new version of the software have updated, far lengthier and more helpful introductory revision sections.) The audio prompts me to left-click in agreement so that we can move on I do, but, given the preceding trepidation outlined, not with much confidence.

The next section, which is actually the first section of the module, is much better. This is because everything that has just been summarized is now slowly and (with the aid of examples) elaborated on and effectively explained. Throughout, the audio and visuals are engaging. More importantly (and this applies to all sections of the module), each bit of the lesson is nicely broken into small chunks (both in terms of time and conceptual knowledge), and requires me to click, in a ploy to actively engage me, in order for me to proceed through the module.

The computerised learning system has been arranged according to an explicit concern to synchronise audio and visuals. This is nice because it shows that the creators of the software have tried to make optimal use of their teaching medium.

Instructions are good. You are prompted (to left mouse-click on a particular area) in order to continue along the lesson.

Screen font is big and clear and uses colours.

In general, repetition of examples is helpful and all the theory and examples is also available in my personal grade file (a bit like a textbook study guide). The lesson is easy to read and the graphics work really nicely and in sync with the audio. This makes things really interactive and, at every single point, it is easy to follow and see what the teaching audio is emphasizing.

What I liked about the first new theory section was that the definition of exponents was repeated, and the important terms in the definition (base, exponent, power) was highlighted to emphasise how logs are linked to exponents. This visual representation encourages me to make the conceptual link between logs and exponents.

The first "HOW TO" test section had three examples, which I found to be helpful and tied in well with theory. I was then told by the software to contact my tutor to advise on my progress before I could click and continue.

Each bit of the lesson is nicely broken into small chunks (both in terms of time and conceptual knowledge), and requires me to click, in a ploy to actively engage me, before proceeding. Although there is the potential for a learner to gloss over material without taking it all in, splitting modules into small, quickly completed sections, and the test at the end of each of these sections, all of which is monitored by a trained facilitator mitigates against this.

Requiring a facilitator to record the score before being allowed to continue to the next section of a module provides an enforced pause in proceedings.

It is important to note that optimal and intended use of this software has a close interaction between facilitators and learners with constant assessment of learner progress, through feedback of learner progress through modules (as indicated by the correct/incorrect response to each question and overall learner's score in each component as well as the pace that a learner moves through a module).

Learners actively interact with the learning material. They determine the pace of their progression and direct their progression through modules.

Learners using the MM system corroborate the ease with which they use it:

- The computer is straightforward and easy. On-screen instructions are easier
- Here it is one-on-one with the computer a perfectly correct personal

However the MM software is not without its problems. The MM software is only available in English and Afrikaans language versions. Non-1st language speakers would have difficulties, which the software as it currently exists, does not address.

1.4. Evaluation of the programme

The program reverses the traditional learner-teacher dynamic in two ways. Firstly, in MM learners are the active members. Instead of standing up and teaching the lesson, instructors facilitate learners' contact with the material. In addition, interactions between facilitator and learner are relaxed and informal.

Actively guiding learners and minimising conceptual gaps instil confidence in learners. The facilitator-software combination in MM is structured to achieve these objectives. Facilitators must be aware of the progress of each learner as learners engage with the computer-based modules. This is central for tracking conceptual problems that learners may have with material. This is why success of the system requires effectively training learners to use the system properly. Most crucially, learners need to be inducted into the practice of notifying a facilitator to record their progress on their grade plan whenever they have completed an exercise section. This is something that should happen a number of times during any session. If a learner has not communicated with a facilitator within a certain time span, the facilitator will need to investigate this further. According to the coordinators interviewed, if a learner has difficulty with a module this may be because the concepts are difficult, or because she has conceptual problems with prerequisite material.

The system is designed to provide feedback to coordinators so that they can assist and facilitate learners with concept development. In this function facilitators are assisted by the software, which incorporates striking graphics such as green and red lights and happy and sad faces to indicate the success of learners in the various computer-based exercises. All of these measures ensure that learners get constant and immediate feedback from the combination of

software and tutors. Coordinators report that the time and attention required by a learner depends on the learner's level of familiarity with the (English) language used in instruction and the learner's ease with the concepts explored in the module.

1.4.1. Learner perceptions of the programme

In our interviews with learners they indicated why they liked MM and its benefits to them.

- **In school there is a class of 22 learners and 1 teacher, so you get less personal attention.**
- **There is no set pattern in school – we skip sections and jump around. We don't get feedback on the steps involved in getting to the answers. The difference from what we learn at school is that MM has better step-by-step development, with lots of examples.**
- **In school we are only tested on entire sections of work at the end of each section. MM has better step-by-step development, with lots of examples and immediate feedback on everything. Each module is assessed straight away.**
- **The facilitator fills in gaps and goes over the work until we understand.**

The cost per learner:

The national fee structure is a once-off registration fee of R90. Notes for a year cost R130 and the monthly cost to a learner attending for two hours a week is R440. That is, the starting cost is R660

Accommodating poor and disadvantaged learners is at the franchiser's discretion. Both Glenwood and Chatsworth reported halving the price for learners already in the program whose parents had lost their jobs.

Cost of setting up a franchise:

The biggest cost associated with a centre is the cost of equipment (computers, printer, etc.). As a result the cost of a centre varies with the number of workstations used.

Other costs include a monthly royalty fee, rent and insurance. There are a number of other "hidden" administrative costs such as electricity, telephone, insurance, paper, postage, equipment replacement, debt collection and advertising.

1.5 Recommendations for program expansion

The MM programme works on individualised instruction set at the learner's pace and involves drill, practice and immediate feedback. It seems a good way to support learners to improve their understanding and performance in mathematics – especially at the senior phases of school and learners studying maths on higher grade.

MM is offered in English and Afrikaans and is offered at mainly urban centres. We had a very useful discussion with the CEO of MM and discussed the possibility of expansion and a partnership between government and MM (as private sector). Government has a responsibility for redress and equity issues and facilitating access to groups that may not be able to afford it. As private sector, business principles apply and profit is a motive, but there are ways of both groups working together to improve mathematics and science in the country.

Our evaluation of this programme was that it is a useful way to build concepts for learners. Given the sites of operation and the medium of instruction, in engaging with the programme we constantly asked how this programme could be accessed by African learners in urban areas (given issues of possible language inaccessibility, lack of financial resources to buy these services and that the centres may not be in township settings and will require transport to the centres) and in rural areas. Two possible developments that could be useful are:

1. Offering bursaries to HG mathematics learners from the townships to attend MM classes. An example would be identifying learners, say from Umlazi, to attend the Chatsworth or Glenwood centres. This would have to include transport for the learners and they may to attend once a week on a Saturday. This bursary scheme could be co-ordinated between DST and MM.
2. In the present programme, the learner sees the text in English (or Afrikaans) and the audio is also in English (or Afrikaans). Learners may have difficulty with the language. We propose that the audio part be translated into African languages and the text continues in English. In this way hearing in English would make the programme more accessible to learners who have difficulty with the English language. This would

operate on a code-switching basis and will involve learners reading in say, English and hearing in say, Zulu. The spin-off could be improved English language skills. The MM CEO indicated that this in fact is doable but will require a great deal of work (because of the technical effort needed) to achieve.

3. For the rural areas, the CEO of Masters Math provided alternatives to the franchise model (which would incur a cost that learners in poor, rural areas might not be able to afford). This involves setting up centres in schools, which will then cater for learners in a few schools or use of the MM technology with a laptop and data projector. [the CEO presented detailed proposals and this will be dealt with further in the costing chapter]

2. KUMON MATHEMATICS

The Kumon Method of learning was developed in 1954 in Japan by Toru Kumon, a high school Maths teacher whose son was struggling with Grade 2 Maths. Mr Kumon was convinced that he could help his son improve his Maths by teaching him the skills one step at a time. Toru Kumon created a series of worksheets for his son to do after school. Today there are over 26 000 Kumon franchises in 43 countries around the world. Supplementary tuition is offered in mathematics and English.

Although much of the worksheet material is common across all 43 countries in which "Kumon Global Network" operates, different operational bodies in different regions around the world administer the Kumon program. For example, Kumon Africa has its head office in Johannesburg and is responsible for all Kumon operations in South Africa, Botswana, Kenya, Namibia and Zambia. Almost 300 franchises operate throughout South Africa. Most of these franchises are concentrated in well-developed urban areas, but Kumon franchises have been established in a large number of centres in all 9 South African provinces. A list of Kumon centres is provided in the Appendix.

2.1 Programme Description

Kumon Mathematics is a supplementary tuition programme that is concept-based. It focuses on "mastery, not mere competence, of mechanical skills." In the Kumon curriculum, one concept is introduced with simple exercises, and the concept gradually increases in difficulty in very small, incremental steps. Students have the opportunity to practice until the concept is

thoroughly mastered. Then the next concept is introduced, building on the foundation established by the first. Worksheets are assigned for learners to work through at the Kumon centre and at home. Worksheets are designed so that material is understandable to learners with minimal outside explanation and intervention. Worksheets must be completed in single sittings in a certain amount of time. Learners may have to repeat assigned worksheets until their performance (a combination of correctly-answered problems and the time taken on the worksheet) qualifies as mastery. The focus is on incremental step-by-step development of concepts.

The emphasis on mastery and self-discipline invariably leads to the diagnosis that learners must start on worksheet-based materials that are a number of grade-levels below their current grade. This insistence on the incremental step-by-step exercises a number of grade levels below the one they are at, may give learners a false sense of security in their conceptual knowledge.

Although the emphasis is on minimal teaching, facilitators still need to be familiar with the content that they prescribe to learners. In-service training is provided to interested franchisors for each worksheet level of Kumon.
Admission into the program is open to all learners that have access to the centre. However access is restricted by fee requirements. At the senior secondary level the cost per learner is R270 (per single subject) per month. This middle-class market is also characterized by active involvement of parents. Involvement of parents extends to the choice of Kumon as a supplementary program for their children as well as supervision of homework.

Enrolment in the program is based on an interview with parents and learner, followed by a diagnostic test. Work is adjusted to the age and ability of the learner. Learners are introduced into the system at a point where they are guaranteed to achieve 100% scores. This is done to fill gaps in foundational knowledge, instil confidence and establish a daily routine.

This case study is based on visits made to two privately owned dedicated franchise centres. Both franchises (Westville and Morningside) are located in upper-middle class areas and service learners from private and model C schools. These centres operate between 14h00 – 17h00 on Monday and Thursday afternoons.

Information was collected from interviews with facilitators from both centers, observing learners in the program and analysis of manuals and other program material.

2.2. Structure of programme

Learners attend Kumon study centres twice a week for up to 30 minutes a time. The time that learners spend at the study centre depends on their grade level. During this time they return their marked and corrected homework to the instructor, who selects appropriate class work based on the homework results. Learners then work on their assigned class work, and hand in the work upon completion. They do corrections on the work if there are any mistakes. Homework is then set based on the results of the class work. The homework selected by the instructor is supposed to enable learners to take each little step on their own, with parents providing encouragement and supervision "at a distance".

Kumon students are asked to focus on their work for 10 to 30 minutes each day for the other five days that they do not attend. Their parents are asked to mark the work using answer books provided by the study centre.

When we attended the centre in Westville, we observed young learners (6-8 years) arriving with their parents. Parents sat on the sidelines whilst the learners got out their grade file and sat down to tackle the exercise worksheets that the instructor had assigned them. This differs from the program structure outlined above in that exercise worksheets were not assigned on the basis of homework that the learners returned upon their arrival but had already been assigned by the instructor before learners had even arrived. Learners then spent about 10 minutes on the exercise worksheets and then gave the completed worksheets to the instructor. The instructor then marked the worksheets and gave learners feedback on their performance. Most of this feedback consisted of praise, but learners were made to do corrections (and redo worksheets) if it was deemed necessary. Learners then left with assigned homework to cover the period until their next visit to the study centre.

2.3. Evaluation of the programme

According to the website information, the Kumon program is geared towards learners from pre-school age to teenagers. Kumon has had limited success with learners enrolled at the high school level. In fact most centres in South Africa do not cater for learners in the senior secondary school phase.

The Kumon program is the antitheses of an outcomes-based education (OBE) philosophy. It is an internationally driven mechanical system that emphasizes mastery of the basics in order to make higher-level maths easy. Kumon does not try to interface with the South African school curriculum.

2.4 Costs

For learners – Learners are required to pay a once-off enrolment fee of R120. The cost per secondary school learner is R270 (per single subject) per month and the cost per primary school learner is R240.

To set up a centre – Kumon head office requires an initial license fee of R7000 from new franchisees. Of the learner's enrolment fee, 50% goes to the instructor and 50% to Kumon head office. Of the monthly tuition, 55% goes to the instructor and 45% to Kumon head office. From these royalties, franchisees are supplied with promotional materials, all learner worksheets, training and advertising is subsidised. Each centre requires very little in the way of resources (table and chairs). Franchisees need to find premises, pay rent and pay any tutors that they employ.

The franchisee that we interviewed told us that a franchisor needs 16 learners a month to break even and that a franchise "only makes financial sense" with a minimum of 50 learners a month.

2.5 Programme expansion

Most centres do not offer the program at senior secondary level. We do not think this programme would be useful in enhancing math and science quality at the senior secondary level.

3. PLATO PROGRAMME

The Plato programme is a computer - based programme which is designed in the US and which provides instruction in the areas of math, science and life skills. The computer programme, by assessing the learner before hand, can direct the learner to her grade level competence. The system has multiple purposes and can be used at different ages. The system

can be seen as an enormous resource based and after careful diagnosis a package and path of instruction can be designed for an individual.

The Plato organisation in South Africa is managed by a group of consultants. It had been installed in different educational institutions. For example in KwaZulu Natal, with sponsorship from Danida it had been installed in a two FET Colleges. With sponsorship from the Department of Science and Technology, the Plato software had been installed in four educational institutions to observe its effectiveness. In the Western Cape it has been bought for installation into the FET Colleges.

I met with the Plato suppliers in South Africa and they discussed the design principles relating to the programme. I invented myself as a learner and went through a few modules. As I had not gone through a thorough diagnostic programme, I may have not been slotted at an appropriate content level. At first glance the modules are not directly linked to the curriculum and it is not easy to gain an insight into what concepts it builds or by practice offers opportunity for drill.

3.1 Programmme description

Plato is totally software based – it has eliminated the human element from it. There is an administrator who will assist the student to get into the system, but thereafter all instructions are computer driven and there is no instructor to assist the learner. The modules can be used in different settings and in most cases has been used as part of the formal lessons. In some resource centres (e.g. Botjihorisong Education Centre in Sasolburg, Zululand Science Centre) it is one of the resources used by learners for Supplementary Tuition. In the case of Botjihorisong Education Centre learners come after school (from 14h00 to 17h00) and mostly use the system for science learning. Learners are registered at the beginning of the year and then come to the centre one day a week. There are about 120 grade 10-12 learners registered at the resource centre.

In addition to the regular Plato teaching and learning programmes, there are also the CDs with Plato Science Simulations. These science simulations (offered in Biology. Chemistry and Physics) they offer interesting opportunities for learners to build up concepts. Some examples of Physics topics are conducting heat, electric generator, mixing colours, radioactive

penetration. I (researcher VR) went through some of the simulations and found them an interesting tool observing and learning science concepts.

3.2 Programme quality and evaluation

There have been no formal evaluations conducted of PLATO in South Africa. I wanted to observe the implementation of the programme in different places but for a variety of reasons this was not possible. At Mthashana FET College in Nongoma, the administrator had left and had not yet been replaced – so the system was not being used. At Sivananda Technical FET College, I had left messages for the Rector but these had not been returned (the Plato consultant had indicated the system was being moved from the Pinetown to the Kwa Mashu campus). At St Albans, the co-ordinator indicated that the system was being moved so it was not possible to see the programmes.

3.3 Cost

One could work on the basis of R15 000 for the license of a single computer and if there are 20 computers then for the license the outlay is R300 000.

The Plato science simulation packs can be bought as the Chemistry set (with 20 chemistry tools) for R22 000; the Biology set (with 13 biology tools) for R14 725; the Physics set (with 12 Physics tools) for R13 750.

4. SUMMARY OF PROGRAMMES OFFERRING INDIVIDUALISED LEARNING

Kumon is a pencil and paper mathematics programme and is said to have more applicability at the lower than higher grades. MasterMath is a computer based mathematics programme designed in South Africa and linked to the South African national programme. The MasterMath design incorporates elements of concept development, drill and practice and there is a facilitator (knowledgeable in mathematics) to assist learners with their mathematics. Plato is a US designed software which offers programmes in mathematics, science and life skills. In addition they supply programmes like Science Simulations, which are designed to demystify science and build concepts. The mathematics is not linked to the South African curriculum. Plato is designed in a way to eliminate the human element. In all these programmes the learner can decide on the particular content at a particular time and can also decide on the pace of the learning.

MasterMath is a private sector business, operating on a franchise model. The franchises operate mostly in middle class areas, where the parents can pay around R400 a month for their children to access the tuition. The MasterMath CEO has provided different options for the programme to operate in poor rural areas. The Plato programme has been installed at various institutions and then it is used in different situations. Both MasterMath and Plato also operate in Resource Centres and learners can access these programmes after school and in the holidays.

MasterMath has both video and audio and the audio is in English and Afrikaans. The audio of the Plato programme is in English.

CHAPTER 8

MASS-BASED SUPPLEMENTARY TUITION

1. Introduction

This chapter focuses on supplementary tuition, which is a mass-based learning initiative. Mass-based supplementary tuition is offered in different ways – this could take the form of radio and television broadcasts, print (newspapers, books and magazines), radio, television, online instruction (internet and multimedia cd-roms) and video and DVD formats. Interventions use different representational media formats to supplement the school curriculum.

In this case study we will focus specifically on the broadcast medium. In South Africa there are two television channels that provide supplementary tuition, both of which have funding from Liberty Life. The first is the Liberty Learning Channel broadcast on public television's SABC3. The second channel is Mindset Activate that is broadcast on the pay per view DSTV satellite service. Both of these television offerings are supplemented with educational materials delivered through other media channels.

2. Liberty Learning Channel on SABC3

On its website, http://www.learn.co.za/, the Learning Channel (Pty) Ltd describes its vision as providing "a multimedia, holistic education solution to education in the developing world." The full package of Liberty Learning Channel on SABC3 products is the television programs, online instruction, videos and cd-roms, printed newspaper supplements and matric revision seminars. We will focus on the broadcast medium and will evaluate it, indicate the product's impact and provide information about the cost of its provision.

Information for this case study was collected from observing the television program, investigating the website, and interviewing Learning Channel staff.

2.1 *Television broadcast*

The Liberty Learning Channel is a school curriculum-focused supplementary tuition program. It generally broadcasts live, phone-in educational programs in mathematics, physical science,

English and biology. Broadcasts are from Monday to Saturday in the mornings on SABC3. The focus of the broadcasts is to prepare learners to pass the matriculation examinations.

2.1.1 Program Description

From January to September every year the Learning Channel follows a structured program timetable. According to William Smith, the originator of the idea for this programme, the program timetable is prepared so that all the topics presented in the November matriculation examinations are covered, with the time spent on each of the sections determined by the mark weighting given to these sections in the exam. For example, according to the program guide, 12 hours worth of television time is given to the Physical Science topic, electric circuits. This is proportional to the number of questions in the examination paper.

An example of a programme guide of subjects and specific topics is provided below. The broadcasts are from 09h30 to 11h30, Monday to Saturday with English on Mondays, Maths on Tuesdays, Biology on Wednesdays, Science on Thursdays and Fridays and a rotating subject on Saturdays. Each of the four subjects (English, Maths, Physical Science, Biology) is allocated a single Saturday every month. The broadcasts from Monday to Friday are during school time.

During term time, from 09h30 to 11h00 the television tutor links up via telephone to a particular school, and in accordance with the program timetable, covers a section of the syllabus with learners from that school. (In the preceding year the school will have booked that particular television slot.) The programs are not pre-recorded and planned, but are 'real-time' teaching sessions conducted live. Tutors respond to questions raised by learners.

For the final half-hour (11h00 to 11h30) learners from anywhere in the country can phone in with specific questions. On Saturdays, during school holidays, and in October and November, the entire 2-hour broadcast is dedicated to learners to phone in with their questions. In addition, during October and November (just before the examinations), SABC3 allocates a further four hours on Sundays for learners to phone in.

Learning Channel's modus operandi is to cover curriculum material by responding to questions posed by learners. This approach contrasts with the traditional teaching model of concept development, which aims to introduce and build up concepts. However, according to

William Smith, television tutors still treat their teaching as if it is the first time learners– the two statements seem contradictory.

Schedule of topics that will be covered from May to July 2005.

MONDAY ENGLISH	TUESDAY MATHS	WEDNESDAY BIOLOGY	THURSDAY SCIENCE	FRIDAY SCIENCE
16 MAY SHAKESPEARE	**17 MAY** Seq&Series 3	**18 MAY** Excretion (1)	**19 MAY** Circuits (1)	**20 MAY** Circuits (2)
23 MAY POETRY	**24 MAY** Comp Interest SG	**25 MAY** Excretion (2)	**26 MAY** Circuits (3)	**27 MAY** Chem Equations
30 MAY POETRY	**31 MAY** Linear Prog	**1 JUNE** Endocrine System	**2 JUNE** Chemical Equilibrium (1)	**4 JUNE** ChemEquilib (2)
6 JUNE POETRY	**7 JUNE** Trig. Identities	**8 JUNE** Nervous System (1)	**9 JUNE** Chemical Equilibrium (3)	**10 JUNE** ChemEquilib (4)
13 JUNE POETRY	**14 JUNE** Trig. Identities	**15 JUNE** Nervous System (2)	**16 JUNE** PUBLIC HOLIDAY	**17 JUNE** PHONE-IN LIVE
20 JUNE Short Stories	**21 JUNE** Trig. Solutions	**22 JUNE** The eye	**23 JUNE** PHONE-IN LIVE	**24 JUNE** PHONE-IN LIVE
27 JUNE PHONE-IN LIVE	**28 JUNE** PHONE-IN LIVE	**29 JUNE** PHONE-IN LIVE	**30 JUNE** PHONE-IN LIVE	**1 JULY** PHONE-IN LIVE
4 JULY PHONE-IN LIVE	**5 JULY** PHONE-IN LIVE	**6 JULY** PHONE-IN LIVE	**7 JULY** PHONE-IN LIVE	**8 JULY** PHONE-IN LIVE
11 JULY PHONE-IN LIVE	**12 JULY** PHONE-IN LIVE	**13 JULY** PHONE-IN LIVE	**14 JULY** PHONE-IN LIVE	**15 JULY** PHONE-IN LIVE

Two researchers (VR and RB) observed the Learning Channel programs. On May 18th we watched the Biology program Excretion I and on May 19th the Science program Circuits I. Both programs followed a chalk-&-talk teaching format, with the camera either focused on the tutor's face or on the whiteboard on which he/she places faxed questions and writes down his/her workings.

The Biology tutor (a white woman) began the lesson on excretion by introducing the concept of excretion ("whatever you take in, will ultimately come out; either through urine or sweat" and "you need water to flush out waste from the kidneys"). As part of the introduction, the tutor laid out her plan for this topic: to chart the flow of excretion by studying the different excretory organs.

The focus of the day's lesson was the kidneys and the tutor spent the bulk of the lesson drawing a diagram of this organ, and charting the flow of blood (carrying wastes) into and (carrying 'clean' content) out of the kidneys, as well as movement of wastes into and out of

the kidneys. The tutor also went off topic to label and describe part of the endocrine system (she took this opportunity since the adrenal gland sits on top of the kidneys).

After 25 minutes the teacher took a 1-minute ad-break, and we rejoined with the tutor linking up telephonically with another learner from the school and continuing the lesson.

The final half-hour was an open line and any learners could phone in with any question related to the biology curriculum. The first caller asked about aerobic and anaerobic respiration. The tutor answered in point form on the whiteboard. The learner also asked what the term photosynthesis is. Interestingly the tutor did not write down anything but, with the camera focused on her face, answered the question verbally (together with hand movements). The next and final caller had faxed through a past exam paper question on a transpiration experiment. The camera zoomed in on the question, which was placed on the whiteboard. Before answering, the tutor emphasised aspects of exam answering technique, underlining important terms (rate, transpiration) and writing notes on the question paper (e.g. rate = time, the name and function of different pieces of experimental apparatus). The tutor stated that writing notes on the question paper is helpful and encouraged learners to do so. The tutor then set out how to answer the particular exam questions.

The Science program, Circuits I, was presented by William Smith. Like the biology lesson, the tutor spent almost the entire two hours (first 90 minutes on Circuits and last 30 minutes of open questions) working through questions, whilst communicating telephonically with a learner.

This particular lesson dealt with Ohm's Law. In introducing the topic, the tutor presented an analogy, comparing the relationship governing pressure to electricity (Pressure = Flow x Friction was presented as the analogue of Voltage = Current x Resistance). Before tackling the particular question that the learner had faxed through beforehand, the tutor illustrated the symbols needed to indicate various components of a circuit (voltmeters, resistors, ammeters).

The tutor then dealt with the faxed question. In answering specific questions that use Ohm's law (such as the voltage, resistance and current of different configurations), the tutor emphasised drawing the circuit using different colours in order to track points in the circuit where electrical current is the same and points where it is different.

2.1.2. Program Evaluation: Quality and impact of the programme

The program manager informed us that she was not aware of an evaluation of their product. The presenter William Smith informed us that the show is popular with different audiences and he has been voted third most popular presenter on SABC. We were keen to evaluate the programme from the point of view of the conceptual knowledge of the learners.

We are not able to assess the impact of the Liberty Learning channel in terms of the effect that the program has on learners' conceptual development nor its effect on matriculation outcomes from the learners' perspective. However, we will evaluate the programme according to other criteria.

Firstly, the broadcast time (9:30 – 11:30am weekday mornings) raises doubts that the program reaches its intended audience, i.e. matric learners, since this is a time when learners are supposed to be in school. William Smith asserts that a large number of learners do watch the broadcasts since there is a surfeit of callers. In addition he contends that others (learners, teachers and schools) record the show. Apparently a significant number of viewers are professionals, residents in old-age homes and other people who stay at home. Although these groups are not targeted viewers, their viewing is an artefact of public broadcasting.

Secondly, we raised the question why the broadcasts are not used to demonstrate experiments or something that the learner would not see in the normal classroom. William Smith contends that they cannot do a live show with experiments and other demonstrations because questions are faxed through without sufficient time to prepare experiments. He also mentioned that experiments are time-intensive exercises and that the question-and-answer structure of the Learning Channel is a more effective way to use the allocated broadcast time.

Thirdly, when evaluating educational interventions, researchers attempt to evaluate effective pedagogy. In television (as in all educational contexts), certain techniques are more effective than the alternatives. We do not know what the optimal practices in television are. However we list a number of the pedagogical observations of the Learning Channel broadcasts that we made that we made to highlight features that we think effective educational broadcasting could address:

- The attention-capacity of learners varies and will peak a number of times. These are two hour long broadcasts and in a 40 minute classroom teaching situation, learners

would pay attention for the first 10 minute or so and then attention wanes. How much of the two session do learners actively interact with, given that the learners watch and do not have to do anything actively?

- There is an overload of new terminology and concepts in any one programme. For example during a 12-minute segment of the Biology lesson, the television tutor drew, labelled and explained a diagram of the kidneys. This segment featured the introduction of 10 biological names and concepts. In first-time instruction (which is the assumption that the programme makes), there will be points (such as this one) where learners must process a large number of facts.

- There are times when the camera spends a significant amount of time focused on the teacher's face. This requires the listener to follow the tutors word very carefully.

- The layout of faxed questions is difficult to follow because the camera needs to focus on different areas so learners cannot see all the parts of the question at the same time.

- With regard to learner-tutor interaction, the teaching styles of the two television tutors that we observed were different. One notable difference is the kind of questions that the tutors ask the learners whom they are communicating with over the phone. The Science tutor tends to ask very general questions that are end up being rhetorical (e.g. "do you follow me?" "are you happy?"). During our observation no learners answered such questions negatively. In contrast the Biology tutor asks learners questions that require specific answers. In other words, the Biology tutor's questions assist her to evaluate whether the learner on the other end of the line understands the material and is keeping up with the lesson. Although this is an effective evaluation technique, this does not mean that it translates into seamless teaching broadcasts. We observed one learner who demonstrated good knowledge and correctly answered most of the tutor's questions correctly. However another learner showed minimal familiarity and understanding of the material and almost none of the tutor's questions met with successful answers. The tutor did not allow the learner's difficulties to affect the pace with which she presented the material. In mass-based initiatives, we are concerned with the educational experience of all viewers, rather than only the particular educational experience of the learner on the telephone. We need to consider what

teaching approaches encourage learners watching the television to actively engage with the educational material being presented.

- A programme that is not interactive but more lecture-method-type-teaching makes it difficult to determine how much even those learners who watch actually understand. Furthermore, all presenters are White and speak in English (No codeswitching).

2.1.3. Learners perception of the program

The Liberty Life Learning Channel faxed us a list of learners who regularly call in. We interviewed 5 of these learners telephonically. The interviews were structured around five areas: Biographical, Frequency of watching, Program quality, program impact and suggestions for program expansion.

We interviewed three boys and two girls. The learners interviewed live in Cape Town, Mamelodi, Lusikisiki, Volksrus and Port Elizabeth. All five learners are writing SCE exams at the end of the year. One learner is retaking Mathematics and Physical Science by correspondence whilst the rest all attend school. All learners interviewed study mathematics and physical science – 2 learners study Mathematics HG, 3 study Mathematics SG, 4 learners study Physical Science HG and 1 learner studies Physical Science SG. All the learners interviewed use textbooks and other resources in addition to watching the Learning Channel.

All learners claim to watch the Learning Channel every Saturday. All these learners have been watching since their Grade 11 year. During the week, two of the learners manage to watch the full two-hour Learning Channel broadcasts every day – one learner's school timetable is structured around class viewing of the Learning Channel, whilst the learner rewriting SCE subjects by correspondence watches at home. Another learner manages to watch about 45 minutes everyday, as he comes home from school during tea break. All three learners with videocassette recorders record the learning channel. One learner who misses the weekday broadcasts on account of school, tapes each and every broadcast and spends her weekend watching that week's broadcasts. The other learners tape the programs that they feel are more difficult and require greater attention.

All five learners had similar views of the quality and value of the Learning Channel programs. These learners singled out the motivation of seeing other learners ask similar questions, and

battling with similar material, whilst being provided with a toll free number and free assistance. Learners also like the learning approach of the television tutors, who emphasise understanding and step-wise progression through material over rote learning. Some learners commented that the television tutors show more concern for the caller's understanding of questions and the correct answer than their schoolteachers. Learners also have more confidence in the knowledge of the television tutors than their schoolteachers. One learner said that the Learning channel's tutors go into more detail in their answers then his teachers at school. The learners specifically identified that broadcasts are an effective form of exam preparation, teaching them how-to answer questions, emphasising the particularly important material.

Learners also had very similar suggestions on how the Learning Channel can be improved. Suggestions include extending daily morning broadcasts by 30 minutes and dedicating this time to learner question phone-in and providing a further two-hour broadcast in the afternoon. One learner wants the number of mathematics sessions to be increased so that the entire syllabus can be covered. Another learner suggested that learners who call in should be given follow-up assignments and be required to cal back and report on their progress the following week. Two learners requested that the Learning Channel use a set of "regular" callers to ask specific questions. This is because they feel (particularly in Biology) that many callers "waste" valuable broadcast time by asking general and irrelevant questions.

2.1.4. Cost of the programme

There are many costs involved in Learning Channel broadcasts. These costs include the cost of television broadcast time, the cost of paying tutors and broadcast crew, studio and equipment costs and the cost of telephone calls. We do not have cost information.

For learners to receive the Liberty learning channel on SABC3 they need to have a television and TV-license, an aerial and have access to electricity. If they are recording programmes they need a video recorder and tapes for the recording.

2.2 Online Instruction

The Learning Channel's website, http://www.learn.co.za/, offers a number of services to learners. On this website you can access the 'grade 12 classroom', 'electronic library', 'archive (old site)', 'past exam papers', 'buy cds and videos' and the '2005 TV guide'.

2.2.1.Online Instruction Description

This website does not feature a hit counter so we cannot report how popular/used the website is. The Learning Channel homepage provide links to 'electronic library', 'past exam papers', 'buy cds and videos' and a 'TV guide'. This resource provides some simulated 'experiments' in Biology, Geography and Science. As researchers, we are not confident about the effectiveness of these experiments. The simulations describe what an experimenter would observe without giving any indication of the underlying science that explains these observations. When observing a simulation on-line, the evaluation question is how does this medium add value to the experience, or put another way, what does online instruction offer that is different from what is offered in a textbook.

The website links to web pages that feature content in a number of subjects covering Accounting, Biology, Business Economics, Computer Science, Geography, History, Mathematics and Science. The particular subjects covered and the numbers of sections that are covered vary across grades. The current homepage (www.learn.co.za) only links directly to the grade 12 classroom and thus grade 12 content.

One of the researchers (R.B) surfed through the lessons and has categorised the lessons into four types:

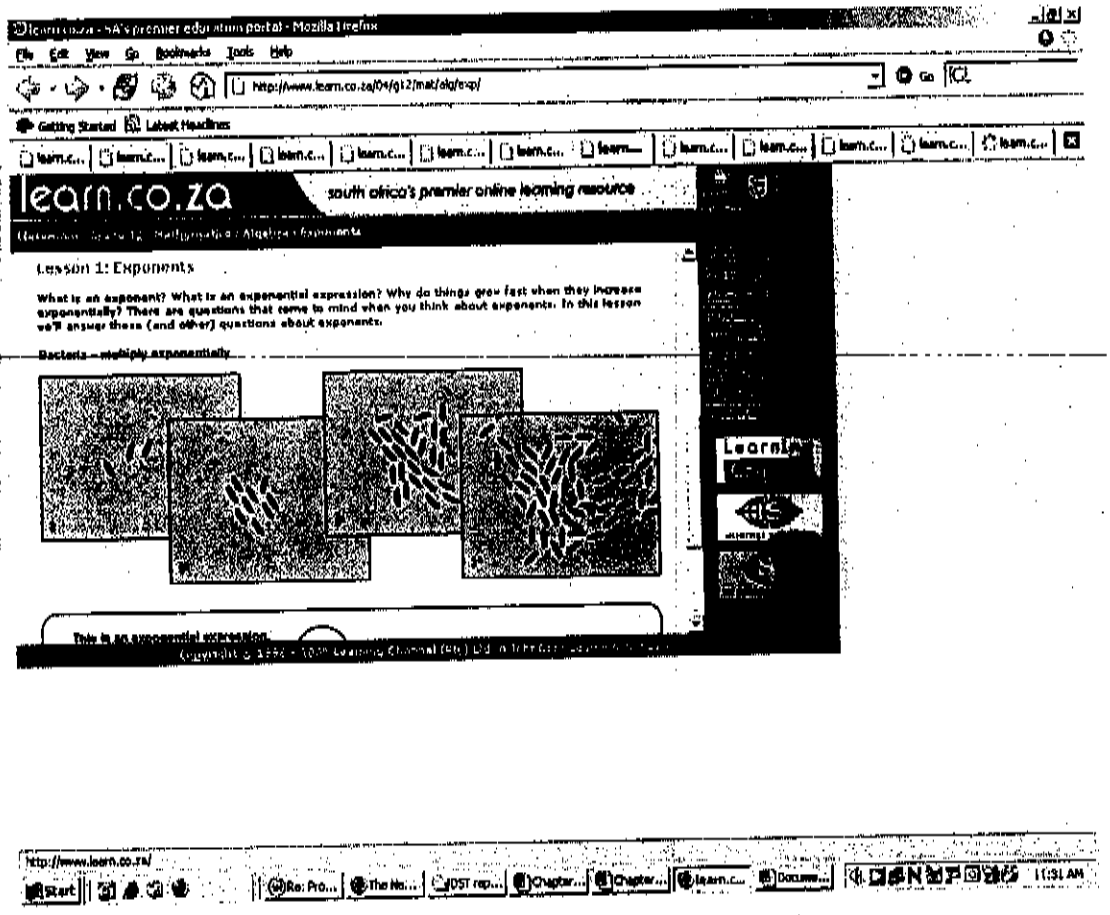
1. A full textbook-style exploration of the material. Here theory is interspersed with examples and concepts are developed from basics

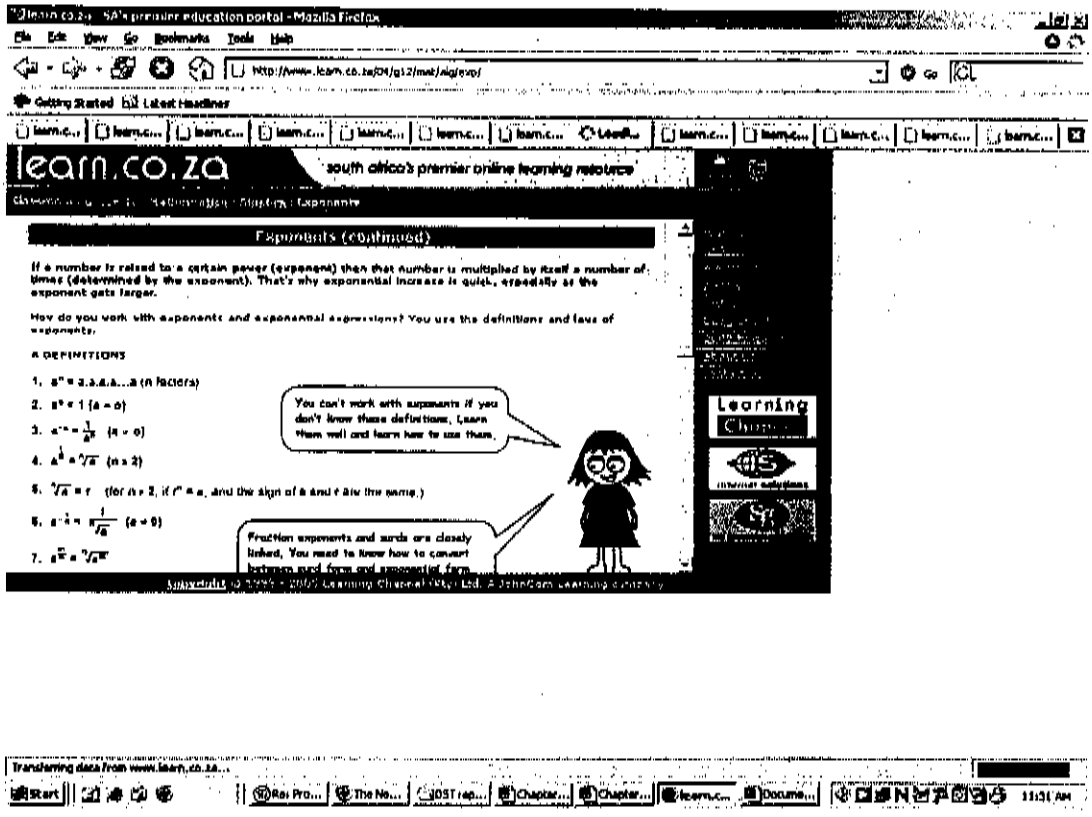
2. An interactive textbook-style exploration of the material. Here step-by-step explanation is interspersed with interactive worked examples, where the user is supposed to 'click' through steps in the examples

3. Point-form summary approach listing the bare facts of 'what you need to know' without any investigation of the material

4. Simulation of experiments with minimal descriptive explanation.

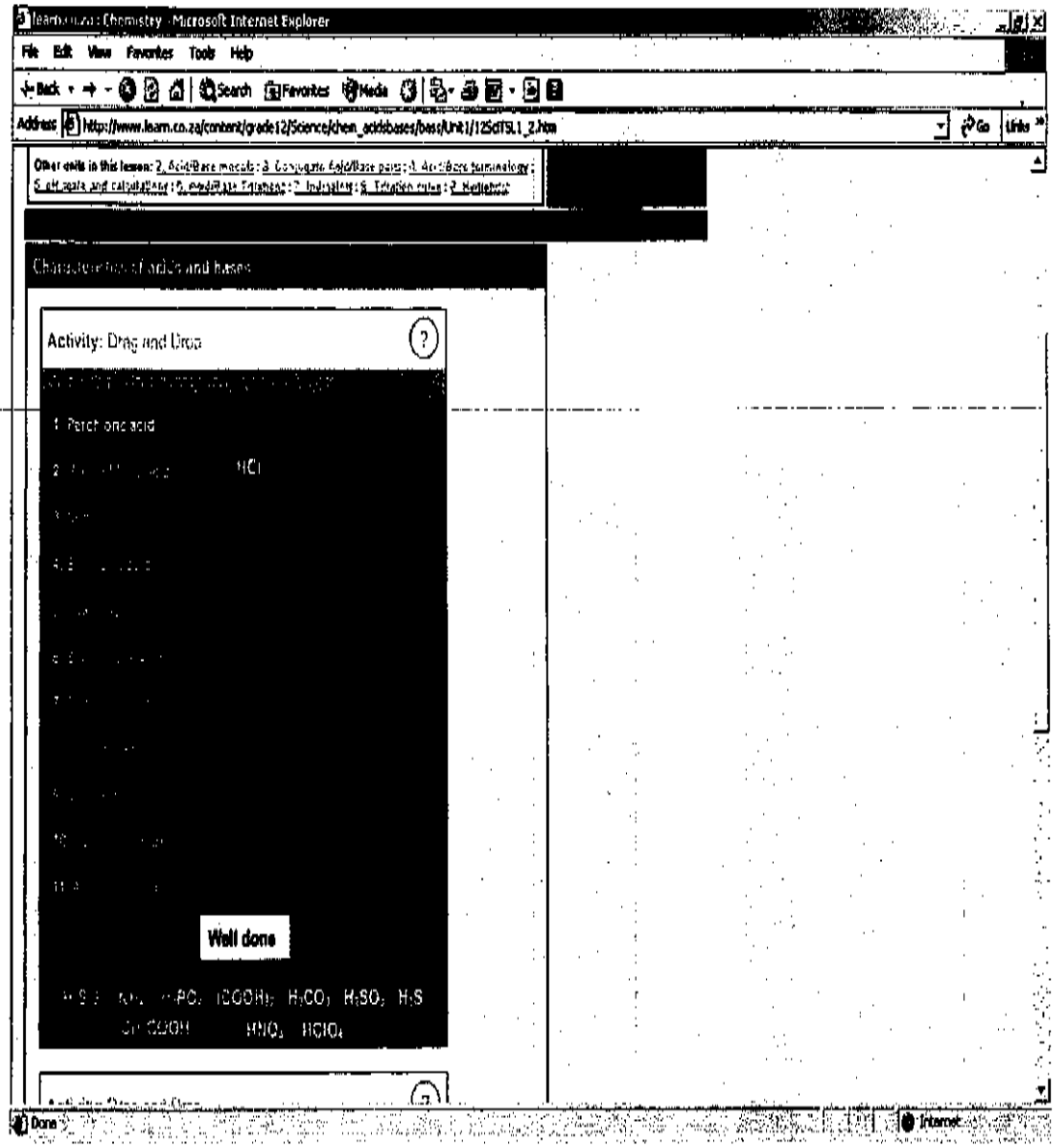
Below an example of type 1 lesson is drawn from the Grade12 Maths lesson on Exponents.





The lesson above has a 'textbook feel', with theory interspersed with a few examples. Except for the requirement to scroll down the page and click on continue, there are no inbuilt mechanisms to ensure that learners engage with the material. In this lesson's web pages; many of the graphs and text on the graphs are ineligible. Perhaps the computer screen that I used to view the web page is too small.

An example of a type 4 lesson is drawn from the Grade 12 Science lesson 'Acids and Bases'. As can be seen from the example below, the laboratory simulation approach sacrifices depth of knowledge in favour of a much simpler level of knowledge – something more akin to association. The exercise below does not test anything beyond matching chemical formulae to their scientific names. This can be achieved through trial-and-error without actually learning anything.



Learners who have a computer and Internet are the ones who could access the on-line instruction. This could be a powerful medium to show aspects that one is not able to view in a textbook. It does not seem that the potential is utilised in this medium.

2.3 Learning Channel videos and cd-roms

The Learning Channel has video and cd rom learner materials available. These are split between in-depth learning modules, revision videos and videos that cover past exam papers.

2.3.1 *Videos and cds Description*

In-depth learning modules that build concepts up from basics are offered at the Grade 10, 11 and 12 levels, for each section of the Maths and Science syllabi. At the Grade 12 level, videos and cd-roms centred on syllabus revision and videos and cd-roms that tackle a particular year's past exam paper are also available. The length of syllabus revision videos varies between 15 and 20 hours.

According to the Learning Channel, the majority of sales are made to private individuals. Maths and Science are the biggest sellers. Although all 9 provincial education departments have purchased the videos in the past (to distribute to schools), only the Eastern Cape and Mpumalanga departments have made purchases in the last few years. This may be because of the imminent introduction of a new curriculum and that durability of the medium (VHS video cassettes) mitigates against the need to purchase videos regularly.

The videos also feature significant use of demonstrations (such as experiments) whereas the live television programs do not present any experiments at all. According to William Smith, the videos are not effective learning tools and Learning Channel will be discontinuing this product.

The cost of a video topic caries widely, but mostly appears to be determined by the length of the topic. The lowest price video is R69 (a 49 minute module) and the most expensive is R689 (a 12 hours 50 minutes module). Similarly the cost of buying an entire series of in-depth learning modules of a syllabus varies, from R2178 for all the episodes of Grade 10 Maths HG to R3840 for the Gr. 12 Science syllabus.

For both Maths and Science, revision materials are split into Paper I and II. For both subjects, the combined cost of revision materials for both Paper I and II is R876 for the cd-roms or R918 for the videos. Similarly, for both subjects, the cost of worked solutions to the 2003 examination papers is R149 per paper.

3. Mindset Learn channel on DSTV

Mindset Learn was launched in February 2003 and is the first channel offering of the Mindset network (Mindset Health is another initiative that has been launched by the Mindset network. This channel focuses on HIV/AIDS education). According to the website, Mindset Learn "is an extraordinary concept in education which offers a complete curriculum content for Grade 10, 11 and 12 via satellite television."

The materials of Mindset Learn are designed according to present national curriculum. Mindset Learn is broadcast on DSTV Channel 82 (this is a pay station) from Monday to Friday 08:30 to 20:30. In addition to these televised broadcasts, Mindset also publishes and distributes print supplements and hosts interactive web lessons on its website. The Mindset products are: television programs, print supplements and online instruction.

Information for this case study was collected from observing the television program, investigating the website and interviewing the education manager at Mindset.

3.1 TV Program

The Mindset Learn channel broadcasts between 08h30 and 20h30 from Monday to Friday. It offers lessons in English, Science, Mathematics, and Financial Literacy. The average length of each lesson is between 12 and 18 minutes.

3.1.1.Program Description

Broadcasts on the Mindset Learn channel typically arrange lessons into "program blocks". The length of subject material broadcast in one session can vary between 30 minutes and 2 ½ hours. The blocks of material are repeated during the day and during the week. For example, during the 5 day period of the week April 11th – 15th, there was 6 ½ hours of unique grade 10 Mathematics and 3 ½ hours of unique grade 10 science were broadcast. Lessons were repeated; in some cases lessons were repeated as many as 5 times during that week. The Mindset TV-schedules for April and May 2005, do not indicate any broadcast material for Grade 11 and 12.

As in the Learning Channel, Mindset Learn has different tutors teaching different the different subjects. In contrast to the Learning Channel however, Mindset lessons are not broadcast live but are scripted and pre-recorded. Specifically, Mindset's modus operandi is to build up concepts according to a lesson plan. Tutors teach in a systematic form and reference is always

made to a previous lesson. During each lesson there is revision of material which has been covered before.

One researcher (RB) watched two episodes of Mindset's lessons:

On April 11th I watched two episodes of the Grade 10 Maths Hyperbolic Functions lesson. The first episode, *The shape of a hyperbolaI* lasted 6 minutes. The second episode, *The shape of a hyperbola II* was a 12-minute lesson. Each lesson starts off with a slide indicating the outcomes to be covered in that slot.

Both lessons followed a chalk and talk teaching format and four different kinds of screen-and-voice-over shots were featured:

i) Shot of television tutor's face with the tutor talking into the camera;

ii) Shot of slide, or the tutor's graph or table workings with tutor voice-over;

iii) Shot of Lerato (the program's "model student") with tutor or Lerato voice-over;

iv) Shot of Lerato working (on a table or graph) +with Lerato's voice over.

The lesson progresses by switching between shots of the teacher, 'model student', slides, graphs and tables. In addition 3-second 'breaks' are inserted at the end of each learning outcome.

The Maths tutor (a black male in his late-20s) began each lesson talking into the camera as if addressing the viewer personally. The screen switches to a slide listing the set of outcomes for the lesson. In the first lesson I observed the outcomes were:

1. Find input and output values of a rational function and
2. Recognise a hyperbolic function,

In the episode, *The shape of the hyperbola I,* the teacher briefly revised two functions that learners should be familiar with – linear and quadratic functions – emphasising the graphical structure of each, stating that hyperbolic functions are a different class of functions.

In the revision part, the camera switches between the teacher's face to the graphical description of each function. In this process the teacher uses his pen to indicate specific features (e.g. intercepts, curvature) of the graphs.

The teacher introduces the viewer to the topic of hyperbolic functions through a 'real-life' example of a company that wants to raise R1million through the sale of raffle tickets. The company needs to determine the price of each ticket and the number of tickets it needs to sell to raise R1million.

The teacher then calculates the number of tickets that will need to be sold to raise R1 million at different ticket prices. This is shown through a screen-shot of a table with the teacher trying out different values. Next, the teacher shows that as the ticket price increases, the number of tickets needed to be sold decreases – that is input and output values were calculated.

At this point in the lesson the Mindset logo appears for 3 seconds. From a technical perspective this pause is used to "break" up the lesson according to the stated outcomes given at the beginning of the lesson.

The lesson resumes with the teacher repeating the point that the rate of change of the hyperbolic function is not constant. The screen shows Lerato, the program's "model student", plotting the points of the table of values onto a graph.

For the rest of the program the teacher illustrates the drawing of a curve through these points. He explains that it is perfectly acceptable to join up the points in this manner, and that a line would form if we expanded the table with ticket price and ticket number values in-between the ones chosen. The resulting curve is a hyperbola.

The broadcast of the first and second episodes was separated by a 4 minute "break". During this break, an outreach initiative (featuring a sponsor's logo in the corner of the screen) was broadcast. This insert recounts how the relevant charity set itself the goal of providing Mindset in 100 schools.

The second episode, focused on the formula of the hyperbola. It follows the format of the first episode, outlining the outcomes of the lesson and revising relevant material (formulae of linear and quadratic functions). Lerato revises the outcomes of the first lesson.

In deriving the general formula for hyperbolic functions, $y = k/x$, the lesson utilises graphs and tables and relates each variable to the initial raffle problem. In exploring the values that x

and y can take on in the raffle-ticket fund-raising example, the teacher emphasised that learners need to use common sense when talking about functions and real life.

I watched the beginning of the next program, a grade 10 Science lesson on "Current". The science teacher (a white male in his early-40s) was standing (the maths teacher sat during the lesson) and used hand gesticulations a lot. In addition the science lesson did not feature a 'model student' and the lesson mostly featured the teacher working through examples.

3.1.2 Quality and impact of the programme

Mindset was originally set up a supplementary tuition broadcast. Since its set up in 2002, it has undergone a change in course. It now operates as an additional resource to teachers in a classroom. Now there is a set of resource videos in schools and teachers can play that to supplement their lessons.

Mindset's DSTV modus operandi is to build up lessons according to a lesson plan. The lessons are presented on the assumption that viewers encounter material for the first time. In other words episodes are not designed simply to reinforce classroom learning. From a pedagogical point of view the lesson format of revision of prior concepts and the step wise development of the new concept is sound. The filling in of values on the graph was useful to illustrate how an hyperbolic shape was generated. I (RB) found the development of concepts easy to understand (but have to also declare that I had covered these topics in my high school years). In addition to building the concepts there is an explicit attempt to ground the material in the real world through the choice of examples used and the implications of material with reference to the examples.

Just as with the Liberty Life Learning Channel we are not able to assess the impact of the Mindset Learn channel in terms of either the effect that the program has on learners' conceptual development or its effect on matriculation outcomes from the learner's perspective. However, we will evaluate the program according to other criteria.

Firstly, the Mindset channel broadcasts on DSTV's Channel 82. By its broadcast nature, it is accessible only to schools that have the necessary receiving satellite dishes.

From the episodes of Mindset that I (RB) viewed, the important pedagogical observations to list are:

- The pacing of lessons is sufficient for the teacher to illustrate his point but not long enough for someone watching to make their own notes without falling behind.

- The lesson uses technical terminology (for example, hyperbola, quadratic), this is inevitable. Episodes are scripted using simple, straightforward words. Both the television tutor's and Lerato's elocution is slow and clear. On the basis of the two episodes I watched, I found the material to be presented in a simple manner (I am an English first language user), even when difficult conceptual content was covered.

- Learners passively interact with the televised learning episodes – there is no direct interaction between tutor and viewers or even the model student. For example the teacher does not invite learners to follow him in drawing up their own tables or graphs at home. However screenshots emphasise the tutor's face, as a way to maximise eye contact with viewers.

- Lerato takes the role of 'model student'. She is used to identify the learning experience of learners with the 'action' on screen. Lerato is never shown talking, but a voice-over is used to communicate her 'thoughts' to viewers – i.e. pre-empting possible learner difficulties. In this way, potentially confusing material is communicated to viewers, and we are 'told' what and how to think when grappling with tasks such as plotting a graph or answering the teacher's conceptual questions.

Further discussions with DSTV educational manager revealed that Mindset recognised that the current modus operandi was not very successful and they were moving to more Inset programmes with teachers, rather than working directly with learners. In addition the modules are linked to the grade 10 curriculum and work could not be proceed with the other grades until the new curriculum statements were confirmed.

3.1.3 Cost of the programme

Mindset advertises on providing the "Mindset solution" to a school which does not have a satellite dish or TV or video machine. The cost of this package is R15 000. Of this amount, R8 000 covers the cost of a television set, video recorder with 10 blank video tapes, satellite system, security cage and installation of all components. A further R5 500 is for technical

training, educator orientation and ongoing support (two school visits and access to the Mindset call centre for a year). The remainder is budgeted to cover the cost of call centre use in future years. The detailed breakdown is given in the Appendix.

3.2 Online Instruction

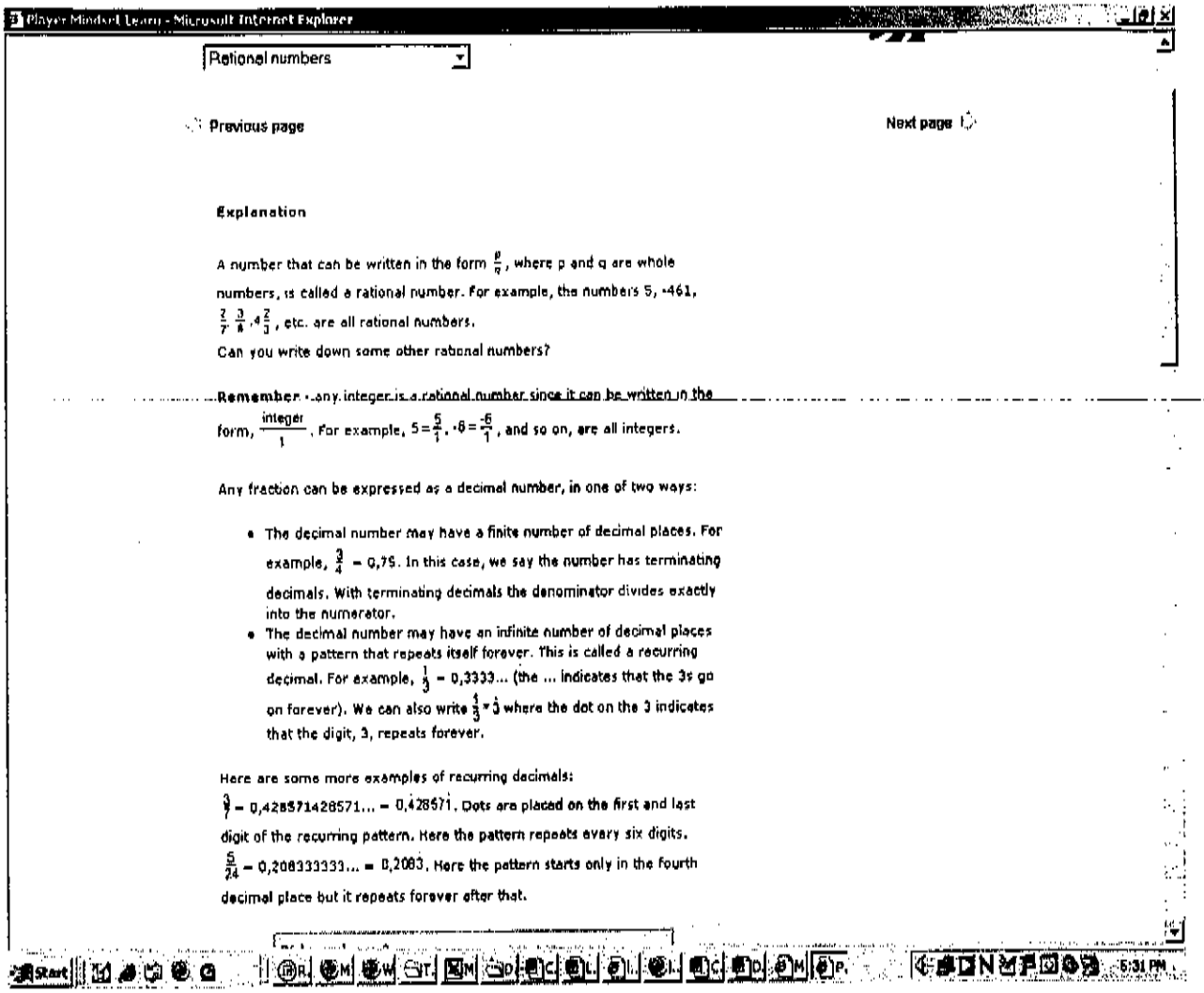
The Mindset website, www.mindset.co.za, offers a online lessons

3.2.1 Online Instruction Description

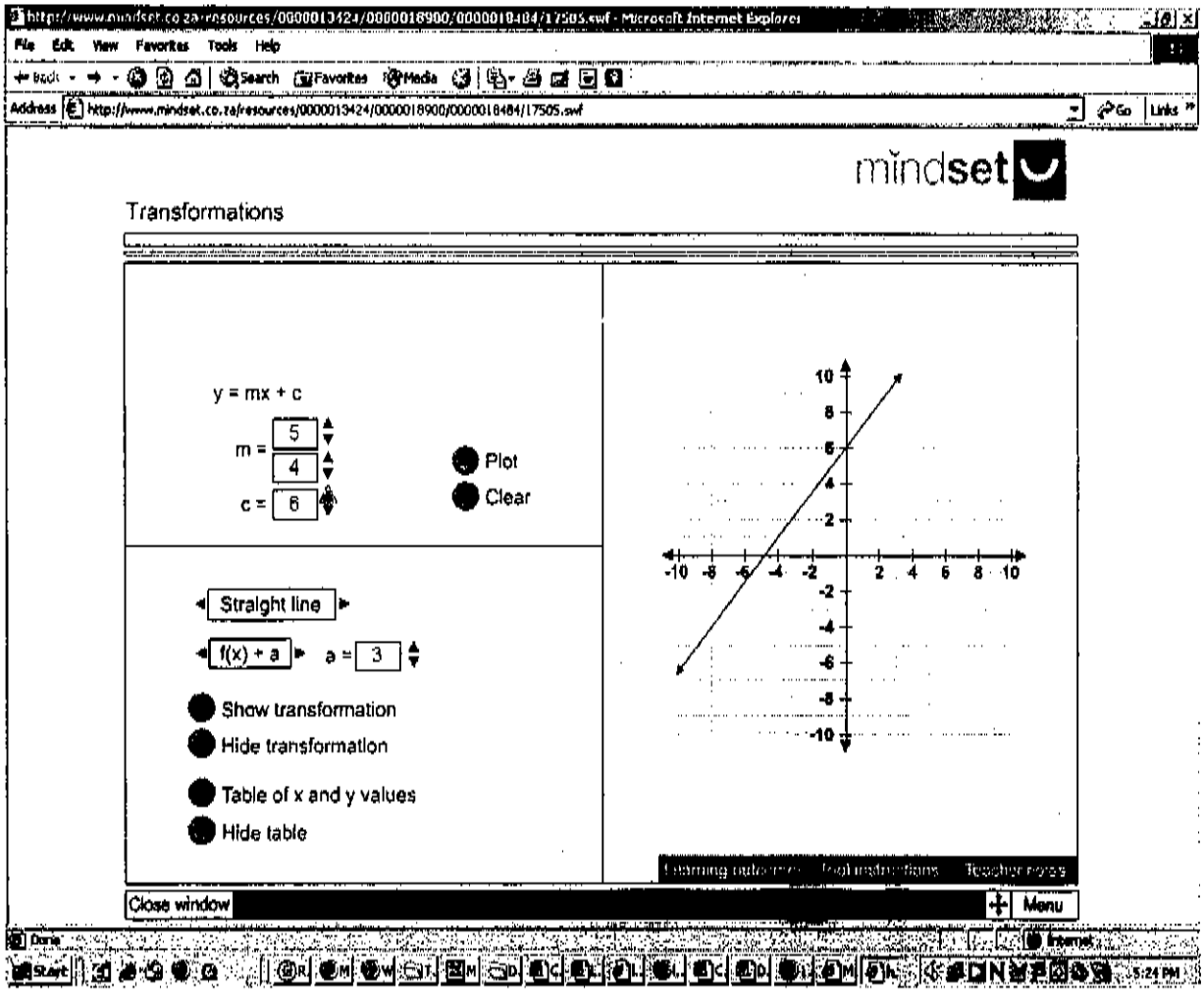
As is the case with the Liberty Learning Channel website, the Mindset website does not feature a hit counter so we cannot report how popular/used the website is. Interactive web lessons are available for English First Language, Science, Mathematics, Financial Literacy (and, according to the website, in the near future Information Technology).

There are online lessons available for grade 10, 11 and 12 for English First Language, Science, Mathematics and Financial Literacy. In additions to theory sections that are particular to an online lesson, every online lesson contains sections that cover "prior learning", "Lesson objectives", "Revision notes", "Glossary", "Teacher tips".

In general Mindset's online lessons follow a textbook-style exploration of the material, with theory interspersed with examples and concepts.


Player Mindset Learn - Microsoft Internet Explorer
Rational numbers
Previous page
Next page
Explanation
A number that can be written in the form $\frac{p}{q}$, where p and q are whole numbers, is called a rational number. For example, the numbers 5, ·461, $\frac{7}{7}$, $\frac{3}{8}$, $4\frac{2}{3}$, etc. are all rational numbers.
Can you write down some other rational numbers?
Remember: any integer is a rational number since it can be written in the form, $\frac{\text{integer}}{1}$. For example, $5=\frac{5}{1}$, $\cdot 6=\frac{-6}{1}$, and so on, are all integers.
Any fraction can be expressed as a decimal number, in one of two ways:
The decimal number may have a finite number of decimal places. For example, $\frac{3}{4}$ = 0,75. In this case, we say the number has terminating decimals. With terminating decimals the denominator divides exactly into the numerator.
The decimal number may have an infinite number of decimal places with a pattern that repeats itself forever. This is called a recurring decimal. For example, $\frac{1}{3}$ = 0,3333... (the ... indicates that the 3s go on forever). We can also write $\frac{1}{3}=0.\dot{3}$ where the dot on the 3 indicates that the digit, 3, repeats forever.
Here are some more examples of recurring decimals:
$\frac{3}{7}$ = 0,428571428571... = 0,$\dot{4}28571\dot{}$. Dots are placed on the first and last digit of the recurring pattern. Here the pattern repeats every six digits.
$\frac{5}{24}$ = 0,208333333... = 0,208$\dot{3}$. Here the pattern starts only in the fourth decimal place but it repeats forever after that.
Start
5:31 PM

Below is an example of an interactive learning aid and its associated note on its Learning outcomes.



Interactive resources are very similar to video support resources – the only difference ostensibly being that they are not linked to particular television lessons.

It is not clear who uses the on-line lessons. We found that the lessons were fairly pedestrian but interactive resources made use of the on-line medium to demonstrate concepts.

4. Summary and potential for expansion

The TV medium has the potential to reach a large number of learners. The SABC programme operates on a respond to question basis and the DSTV programme has changed course from being a learner supplement, which operated with pre-recorded lessons being broadcast, to

working with teachers and providing educational resource which they can use as a resource in their classroom.

The present set up of the programmes are inaccessible to the majority of learners because the SABC programme is broadcast on weekday mornings from 9h00 to 11h30 (when most learners are in school) and the DSTV programme is only accessible to learners who have cable TV (involves a big cost for families).

The TV medium can be very effective to demonstrate aspects of science that most learners will not see in their classrooms (e.g. when teaching the topic excretion have a skeleton available and constantly link to it).

The TV medium should include a pedagogy of getting students involved. The learner who raised the question is involved in the solving of the problem – for others it is about listening and thus being passive.

The interview with learners could not ascertain students conceptual gains, but many learners indicated the benefit was motivational.

The medium of instruction is English. It would be useful to investigate how code-switching could be effected (given that South Africa has 11 official languages).

CHAPTER 9

FINDINGS AND RECOMMENDATIONS FROM THE CASE STUDIES TO THE DEPARTMENT OF SCIENCE AND TECHNOLOGY

1. Introduction

The Department of Science and Technology (DST) is committed to supporting the Supplementary Tuition sector as a way of improving the learner performance in mathematics and science at the senior secondary level. To assist with the policy formulation process, the DST commissioned the HSRC to firstly, develop a database of service providers in order to develop a typology of supplementary tuition providers and secondly, to evaluate the usefulness of supplementary tuition programmes and present the DST with a strategy document of how to expand the programme to allow access to a larger number of learners.

The first part of the research is reported in Reddy V, Lebani L with Davidson C (2003) Schools Out Or Is It?.....Out of School interventions for mathematics, science and computer studies for secondary school learners. In that study we developed a database (not comprehensive) and a typology of supplementary tuition service providers. We identified five typologies of Supplementary Tuition providers: (1) Programmes linked to tertiary institutions; (2) NGO programmes i.e. both established NGOs and newer community based programmes; (3) Science Centre programmes; (4) Franchises providing instruction to individuals and (5) Media based programmes (e.g. TV, newspaper supplements).

This report answers the questions in the second part of the commission. The key research questions in this second part of the study are:

1. To evaluate the usefulness of supplementary tuition programmes in terms of quality, impact and cost of the different types of interventions.
2. To develop models of supplementary tuition interventions that can serve different types of learners and which can be replicated in different parts of the country.
3. To present a strategy document (including resources) to expand the programme to allow access to a greater number of learners.

2. Need for Expansion of the Supplementary Tuition Sector

1. There is a concern with the state of mathematics and science education in the country. This concern is based on the fact that very few learners pass matric mathematics and physical science in this country. This creates a negative chain reaction in that there are few students who register at tertiary institutions, resulting in South Africa being in need of professional scientists, and a lack of suitably qualified mathematics and science teachers. One indicator of the poor state of mathematics and science education is the number of mathematics higher grade passes in the country. In 2002, of those who wrote the national department of education examinations, there were 19 798 HG passes and of these 4 637 were Africans learners. Of the 4 637 African learners who passed mathematics HG, 2889 learners came from ex DET schools and 1557 came from ex HoA schools. This number must be increased and as this example shows, the biggest concern is with the number of African learners passing with higher grade mathematics.

2. Any strategy for the improvement of the state of education or the state of mathematics and science education in South Africa will have the competing demands of either having a policy that responds to improvement of mathematics and science for all or targeting the interventions so that there is a greater concentration of resources to a few. Both positions are valid, but one has to make judgments based on the perceived return on the investment and the leverage for change.

3. Supplementary tuition has generally been accessible to learners who could afford to pay for the tuition – therefore it is inaccessible to poor learners.

4. Our key recommendation is that the DST strategy targets learners who most need the assistance – that is to target learners in African, ex House of Representative and House of Delegates schools. Further, learners who are enrolled for mathematics at the higher grade in these schools must be targetted. This is to ensure that the number and quality of higher grade passes in these schools is increased and thus giving access to the more

disadvantaged learners to enter scientific and technical careers through tertiary level training.

5. In 2002, in the Senior Certificate examination there were 7184 female African learners and 9634 male African learners taking HG mathematics. Of these 1638 females and 2999 males passed. The supplementary tuition strategy should therefore be explicit about the participation of males and females in the programme.

3. Findings and Recommendations for Expansion

3.1. Our original categorization of the typology of interventions can be reduced to three:

A. Face to face instruction to **groups of learners** (1, 2 and 3),

B. **Individualized** instruction (4),

C. Media based programmes for **mass education** (5).

3.2. In face to face instruction to small groups

Findings

1. There are different types of organizations offering programmes –tertiary institutions, non governmental organization, community based organizations, science centres. Some of these organizations have their own infrastructural resources for the teaching of mathematics and science and others not.

2. Generally these programmes offer mathematics, physical science, maybe life skills and a small amount of career guidance. The science and mathematics offered in supplementary tuition, at the FET phase are closely linked to the school curriculum.

3. Most programmes are designed as structured inputs, offered on Saturdays and, maybe a block period during the July vacation, in the grade 10, 11 or 12 years or grade 11 and 12 year of schooling.

4. Most programmes operate in urban areas and transport is offered to learners as part of the programmes.

5. Most programmes target higher grade learners, because they recognize this as the leverage point.

6. The tutors on the programme may be school teachers from the area, or a teacher from the ex Model C or private schools or postgraduate students at the tertiary institutions.

7. The instructional programme is generally offered on a 'chalk and talk' basis. That is, the tutor stands in front, does most of the talking, introduce or revise key concepts. There is very little experimental work or demonstrations and most of the instruction in the Saturday classes mirror what happens in schools and this is especially so where the Saturday tutors are school teachers.

8. The effective programmes are those offered in small groups where the optimum learners to tutor ratio is 25:1. These small numbers ensure high quality outputs.

9. There is a cost incurred for learners and in the case of the small group instruction this cost is provided by social responsibility funds of private sector.

10. The length of the programme and the cost per learner in the different programmes varies. Programmes which have a residential component are more costly.

11. An evaluation of the impact of the programme indicates that the learners who attend do pass with math and science on the higher grade and many proceed to tertiary studies. Many of the university offered programmes include the incentive of scholarships to students who had participated in these programmes.

12. Learners could proceed with science based studies or studies in either scarce areas (e.g. actuarial science). The Supplementary Tuition programme has also offered learners insights into the 'non-conventional' career choices.

13. The cost of the programme varies from R800 per learner (in institutions where a number of costs are absorbed by the institution) to around R3215 (for a residential course) in the tertiary sector programmes; from around R1700 to around R7000 (for 52 contact sessions and where every part has to be paid for the NGO) in the NGO sector and for around R3700 for the science centre offered programmes.

Recommendation

1. Organisations which offer supplementary tuition to learners in small groups are effective. Therefore in looking at the case studies of typology 1, 2 and 3 we would recommend that this mode of supplementary tuition be supported.

2. The organizations which have the infrastructure and experience to offer these courses should be utilized. These organizations must continue with the supplementary tuition programmes that they currently offer and be encouraged to offer these programmes to other cohorts of learners.

3. The primary target group should be rural learners, as there are no programmes for them.

4. The DST should make available money for these institutions to access. It is recommended that the institutions should then apply (according to requirements set down by DST) for this money so that they can offer the programmes.

Criteria for the operation of programmes

1. Institutions must offer a quality supplementary tuition programme and the initial target must be rural learners in African and ex HoR schools. These would be poorer learners and not be able to afford supplementary tuition.

2. The learners must be registered for mathematics on the higher grade (in the present curriculum) and in the new FETC the target would be learners taking mathematics (not mathematical literacy).

3. The programme is offered from June/July of the grade 10 year and runs until July of grade 12 year (i.e. 2 years).

4. The programme targets a cohort of 50 learners (no more) and instruction is offered in the ratio of 25:1 (learners: tutors).

5. The programme curriculum must be mathematics, physical science and career guidance. Students must be introduced to other career options than the ones that they traditionally know.

6. The curriculum of the programme must be both knowledge based (and the Saturday programme should try to be in sync with the curriculum pacesetters which inform the school programme) and experience based.

7. The programme must be taught by tutors with a high-level of expertise (experienced and knowledgeable teachers who will do something different in the supplementary tuition classes than their own classroom instruction). Graduate students should be encouraged to participate in such programmes. It is key that the tutors are knowledgeable, motivating and inspiring to the Saturday learners.

8. In the programme, books and resources must be offered to facilitate learning and preparation for examination – textbooks with lots of examples, past year exam papers.

9. In terms of admission criteria for learners to the programme, students should be registered for higher grade in mathematics and physical science. The students should be registered when they are in Grade 10 to be eligible to start the programme in July. Admissions into the tuition programme should be dependent on June grade 10 marks. Part of the programme may involve negotiating with the schools to ensure that they do offer mathematics on the higher grade.

10. Admission process: The programme should operate in such a way that enrolled students are offered a bursary. This bursary will be offered on the basis that students had applied and were accepted to participate in the programme. In the application students must write an essay stating why they should be admitted into the programme. The school should endorse the application and a letter of consent from parents should be provided. These conditions are to avoid students dropping out of the programme. Although the programme will be bursary based, students must pay some minimal amount to show their ownership of the programme and it is not a 'handout basis'.

11 Learners must remain in the programme and be committed to the programme. Therefore the programme needs to be advertised and offered on a bursary system basis with an eventual partnership between the institution, parents and school. It is important for parents to be part of the programme and offer the support and guidance for learners to ensure that it continues. Schools need to be partners in assisting identify learners and ensuring that higher grade math is offered at schools so that the learners can be part of that programme.

12 The length of the programme should be 20 contact session a year (40 over the two years). For urban-based learners the programme could be on alternate Saturdays and for rurally-based learners it could be in blocks during the holidays (say 3 blocks of 5 days each for the April, July and September). These block interactions could be in the rural area, in the urban area or a combination.

13 The venues for programmes should be the most resourced places so that learners could have access to the resources – for example tertiary institutions or science centres.

14. Possible links on this programme with SAUVCA/HESA. This is important because endorsement by SAUVCA can ensure that tertiary institutions willingly take up the challenge as one of their community development programmes. Also, this will mean that universities increase the supply of science students that can enter tertiary institutions.

15. Tertiary institutions must be encouraged to offer bursaries to this group of learners for future studies.

16. There must be an equal number of males and females participating in the supplementary tuition programme.

Return on the investment

1. The returns on a supplementary tuition programme could be an increased number of higher grade passes or increased quality of the higher-grade pass.

2. There are 23 public higher education institutions in the country and organizations like SAUVCA/ HESA should be encouraged to go into partnership with the DST on these institutions providing supplementary tuition programmes.

3. If the 23 institutions each offer the programme to 50 African learners from ex DET, ex HoR and ex HoA schools then there is a possibility of an extra 1000 learners graduating with either a mathematics higher grade pass or a better mathematics higher grade pass.

3.3. In individualized own pace settings

Findings

1. There are computer based programmes, like MasterMath and Plato, which are based, offered on a modular basis and learners work at their own pace.

2. MasterMath modules are based on the South African curriculum and Plato has a number of generic modules that can be put together as a set for the learner.

3. In these computer-based programmes, learners may enroll for a particular section of work that they feel they need extra attention in or enroll for a longer period (payment is on a monthly basis).

4. Instruction is offered for the material that the learner wants, and the learner works at her pace on the material. The programme involves diagnosis of the student understanding of the section, revision of prior concepts (if necessary), building up of the concept, practice exercises and immediate feedback from tutors.

5. The MasterMath programmes operate mostly in urban centres and in suburbs where parents could afford to pay for the extra tuition and the Plato programmes have been installed at FET institutions.

6. In the MasterMath programme there are facilitators who have competence in the FET math curriculum, the Plato system is 'free of human element' and may have an administrator for the programme.

Recommendations

1. The computer-based programmes are useful when the learner wants to work on specific areas of the curriculum at their own pace.

2. There are different ways in which this programme could be supported by DST so that learners who otherwise do not have access to the programmes can gain access.

2.1. Provide the MasterMath software/ licenses for math and the Plato (especially the Science Simulations) for science to Resource Centres around the country and this could be part of the programmes offered by the resource centre to learners.

2.2. Provide bursaries to a few learners from the township settings (where these franchises do not exist) to attend these supplementary tuition classes. These bursaries would include transport and the learners could attend the classes on a Saturday. The DST

should work in conjunction with MasterMath to set up this bursary scheme. Again this bursary should be available to learners attending African and ex-HoR schools.

2.3. Look at mechanisms to ensure that the franchises can operate in rural and poor areas. The CEO of MasterMath has provided different options and is willing to enter into discussion with government to pilot such programmes.

3. The programmes are in English and Afrikaans (for MasterMath) and English only (for Plato) and there is a video and audio dimension to the programme. To make the language more accessible it is recommended that the audio dimension be available in different African languages. This will involve an investment into developmental costs, but the return could be high as this would operate as 'codeswitching' with the audio in an African language and the video in English (or Afrikaans), thereby building both concepts and developing language proficiency.

Return on the investment

1. If the programmes are installed at Resource Centre, and if we use the Botjihorisong Resource Centre, as a model, then each centre can register at least 100 students to attend the math and science programmes.

3.3. Mass based instruction

Findings

1. There are different forms of mass based instruction for supplementary tuition– e.g. television broadcasts, newspaper supplements, textbooks, study guides.

2. In the broadcast sector there are 2 different types of broadcast: one involves tutors setting up the topic for a section of work, e.g. electric circuits and linking up to a school where learners send in their questions and the tutor works through the example with linking up to concepts – the presenter does all the talking. In the other type of broadcast, the lesson is pre-recorded and there is a building up of the concepts.

3. The broadcast times in both programmes are, on weekdays, during school time and on Saturday morning. The viewership for these programmes is not only school learners but parents, people in old age homes etc. Access for school learners will be for those that are at home or by taping the programme and watching at a different time.

4. The television programmes involves learners watching the programme and may be non-interactive. In one programme the tutor talks all the time and the medium is not used to demonstrate or illustrate concepts. It is difficult to assess what and how cognitive or higher order learning skills and knowledge are gained by learners.

5. Newspaper supplements are useful resource for learners to work past year examination papers.

6. Good textbooks, which both develop the concept as well as provide learners with practice examples are a good resource of structured learning materials.

Recommendation

1. The broadcast medium could be a very effective medium to ensure accessibility of concepts and experiences for large mass of learners. It is important to investigate this medium far more.

2. The role of DST could be with the funders (e.g. Liberty Life, MTN) to engage the development of quality programmes, which ensures an active participation in the learning process. This could allow much greater access for more learners.

Return on the investment

Good programmes, which build up concepts and screened at the appropriate time could have mass based appeal and this type of programmes should be studied in conjunction with the other science awareness activities of the DST.

CHAPTER 10

COSTING THE SUPPLEMENTARY TUITION PROGRAMMES

All programs have an associated financial cost, which is either paid by the learner and her family or by the organisations that sponsor the supplementary tuition program. In this chapter we will identify the financial or budgetary costs associated with the provision of services using an Activity Based Costing framework.

In our research we have identified three distinct typologies of supplementary tuition:

- Face to Face Tuition in small groups
- Individualised Instruction
- Mass Based Education.

The reason why DST has decided to support this sector is to improve the number and quality of mathematics and physical science passes produced at the grade 12 level. Supplementary tuition occurs outside the schooling system and traditionally learners who can afford to pay for this service have access to it. Given that learners with very little financial resources form the majority of the poorest performers, government's agenda to target the poorest of learners will also contribute towards creating equity. Therefore the recommendation is that the most disadvantaged learners are the ones who should be first targeted – i.e. African learners in rural areas.

In this chapter we will provide the costs associated with each of the three models highlighted above. We also consider variations to each model.

In providing an account of the costing process we will use the following procedure:

1. Identify the target population group i.e. who do you expect to gain from the initiative;
2. Identify the supplementary tuition model, and the variations of the model i.e. what is the nature of the programme's operation.
3. Identify the relevant resources needed to support the program;
4. Costing of program – what are the costs of the programme and who bears them;
5. Identify the projected outputs/return on the investment;

6. Identify other opportunistic or incidental benefits that arise from the program;
7. Conduct a sensitivity analysis based on the projected numbers of learners reached.

1. For Face to Face Tuition in Small Groups

1. The target population group

- The DST intends to fund supplementary tuition interventions at the FET-learning phase.
- The target population is African learners from African and ex HoR schools who are registered for higher grade mathematics and physical science.
- There will be urban based and rural based programmes. Therefore we will provide two costing scenarios: one for a programme targeting rural learners and the other for a programme targeting urban learners.
- The DST's initial priority is the rural based programme.

2. The supplementary tuition model

- The model is a classroom format, with a tutor teaching a group of learners.
- The ratio is 1 tutor to 25 learners.
- There will be inputs in mathematics, science and different career opportunities.
- The programme will start at the middle of the grade 10 year and learners must be part of this structured programme until the middle of the grade 12 year.
- The programme will involve a mixture of knowledge and skills, building a repertoire of experiences, incorporating site visits and other field trips.
- There will be 40 contact sessions (each of around 6 hours) for a 2 year period.
- Organisations/ institutions will apply for funds to offer this programme in addition to their present supplementary programme.
- The funding to the organization will be determined on a pre-determined cost per learner basis.
- Learners will then apply to attend the programme (bursary basis) with continuation dependent on progress in the programme.
- For **urban learners** the programme will be offered on 16 Saturdays and 4 days over the July holiday period.

- For **rural learners** the programme will be in the form of 3 x 5 days contact sessions per 12 month period and these contact periods will be costed on the basis of (1) the learners came to an urban setting; (2) tutors go to a rural setting and (3) combination of (1) and (2).

3. Resources for the program

The institutional setting (whether the program is rural or urban-based) is particularly relevant to this assessment. Relevant resources to include

- Venue
- Transport
- Materials
- Educators/ tutors
- Administrative centre
- Rurally based programme requires accommodation.

4. Financial Costs

We then cost the program according using these particular resources.

4.1. Urban based programme

For the urban based programmes the DST should work on the basis of between R1 500 and R2 000 per learner in the programme.

4.2. Rural based model

Scenario 1: Rurally based learners having the 20 days in an urban based centre.
Cost is determined by transport from rural area, accommodation and costs for offering the programme.
This will be R4000 per learner

Scenario 2: Programme is offered in the rural setting on alternate Saturdays and tutors from the university travel to the programme.

The costs will involve travel for tutors and the programme costs. This will be costed at R2000 per learner per year.

Scenario 3: Part of the programme is in the rural area and part at the tertiary institution in an urban area.
Cost per learner is R3000.

5. Rates of return on the investment

These are the outputs that we can expect from each program intervention that the DST invests in. If the 23 public higher education institutions plus four science centres plus 3 NGOs apply to participate in the programme, the out could be 50 x 30 = 1500 learners.

6. Opportunistic benefits associated with program

These benefits are more than an increase in the number of learners that will go into the university system and lead to future increases in South Africa's human and social capital. It could include improved physical and human capital investment in rural areas (if a rural-based model is chosen), and the quality of learners' experience (if an urban-based model is chosen).

7. Sensitivity analysis

Sensitivity Analysis is usually used to show how the total costs change with the size of the project, in this case the number of learners reached. In this case increasing the number of learners reached has infrastructure or resource implications.

In this case the expansion of the programme at the institutions could lead to decrease in quality, if it is not well managed.

8. Summary for face to face

In this model, organizations and institutions who have provided supplementary tuition at the grade 10-12 level should apply to the DST for funds to EXTEND their programme.

The DST funded programme must be in addition to that offered currently.

Institutions which have the infrastructure to support student learning (e.g. tertiary institutions and science centres) should be strongly encouraged to apply. This would reduce investment for set up costs and concentrate on the ongoing expenditure.

Summary of the cost of the programmes offered by the different institutions:

UP with Science:	14 contact sessions a year; R800 per student per year. Cost covers tutors, printing, transport (for a few). Subsidised cost Small groups Venue is provided free, lecturers and materials from the Dept are free
Ikateleng:	big group lectures by practicing teachers R1000 per learner
Upward Bound	Big groups of learners who come to residentially based courses at the university R5200 per student per year.
SAILI	18 contact sessions (4 hours each) plus another 5-day vacation school Cost for 18 contact sessions: R1696 per learner (including transport).
Imfundo:	Very small groups 52 contact sessions per year Cost at the moment is R7361 (includes tutors, field trips, textbooks, transport)
Science Centre (CT)	group of 35 18 Saturdays a year

COSTS ASSOCIATED WITH THE MODEL FOR FACE TO FACE INSTRUCTION

Target Pop	Model Description	Resources	Financial Cost	Projected outputs	Opportunistic benefits	Sensitivity analysis	Cost per learner
Urban based African learners from ex black schools. Admission to the programme is based on students who are enrolled for HG math – applying, and being given a 'bursary'.	Model follows the traditional classroom format, with a tutor teaching to a group of learners. SEE MODEL ABOVE	Organisation/ institution with infrastructure and a track record to provide this service Lecture room Tutors Administration of the programme Textbooks Transport arrangements	Programme costs	Addition 25 learners per programme with HG or quality HG passes.	Students attending an institution separate from their school will provide them with different opportunities e.g. career choices. Gaining a bursary could be motivational for other aspects of learning.	Universities have the infrastructure to offer experiential learning in science and therefore using these institutions provides a saving on start up costs. New organisations will require start up costs.	Urban based = R2000 per learner per year (subsidised costs);

Target Pop	Model description	Resources	Financial Cost	Projected outputs	Opportunistic benefits	Sensitivity analysis	Cost per learner
Rural based African learners from ex black schools. Admission to the programme is based on students who are enrolled for HG math applying and being given a 'bursary'	Model as above with the difference being the timing when the interactions occur. For **rural learners** this will be in the form of 3 x 5 days contact sessions and these contact periods will be costed on the basis of 1. learners traveling to an urban setting; 2. tutors traveling to a rural setting and 3. Combination of 1 and 2.	As above plus accommodation	Programme costs Transport Accommodation and subsistence	As above	As above PLUS For those attending in urban areas there is exposure to opportunities at the urban institutions plus an experience with the resources at the institution.	As above PLUS Each variation will have a cost.	Model 1: travelling to urban setting: R4000 Model 2: in the rural setting R2000 Model 3: both urban and rural setting R3000.

FOR INDIVIDUALISED INSTRUCTION

In our research we found the software offered by MasterMath and Plato could be effective for learning. The model can be used to meet the goal of improved performance in mathematics and science in different ways:

1. Providing bursaries for learners (African learners in black schools) who are registered for mathematics and science at the higher grade level and are unable to afford supplementary tuition to attend the Master math classes on a Saturday.

2. Setting up infrastructure in rural areas (where MasterMath franchises do not operate now and where it would not be feasible to have such a private sector venture).

3. Provide software and the licenses to resource centres for them to install the programmes and then the resource centre can manage the supplementary tuition programme for learners.

COSTS ASSOCIATED WITH THE MODEL FOR INDIVIDUALISED INSTRUCTION

Target Pop	Model Description	Resources	Financial Cost	Projected outputs	Opportunistic benefits	Sensitivity analysis	Cost per learner
African learners in ex African, ex HoR and ex HoD schools in urban areas	Learners apply for a bursary to attend MasterMath classes. They attend from gr 10-12 and granting and continuation of the bursary is dependent on taking math at HG, and on monthly MM reports of student commitment and performance. The bursary is administered in a partnership between DST and MM	MM package Bursary to include transport costs. MM administer bursary and write reports on students	Present cost of MM is R440 a month and a 10 month year will be R4400 – this can be negotiated with MM. Transport costs will be R100 a month.	MM has high success rate and those learners that are supported will leave with a HG math pass or a higher quality math pass.	Students will interact with learners from other schools	Vary the number of hours (and the associated costs) that a high-performing and poor-performing learner spends at the MM franchise	Maximum cost per student will be R5000 a year, but this price could be negotiated with MM.
In rural areas for African learners in ex African schools	Setting up a 'traditional' MM centre MM CBT system on a franchise basis. Total private sector, business arrangement	No role for DST	None to DST	MM has high success rate and those learners that attend will leave with a HG math pass or a higher quality math pass.	Infrastructural and skills investment in underdeveloped area	This would be a difficult model to sustain in a rural area because it would be difficult for learners to pay for the services	

Target Pop	Model description	Resources	Financial Cost	Projected outputs	Opportunistic benefits	Sensitivity analysis	Cost per learner
For African learners in ex African schools in rural areas.	Franchising 'networked system' set up and supported by DST DST sets up a centre (e.g. in a classroom in a school) and in the afternoons identified learners come for supplementary tuition	Secure classroom Refurbished laptops Wireless network	Set up cost = R105 000 On going expenditure for a year = R276 770	50 students per centre with increased math knowledge MM has high success rate and those learners that are supported will leave with a HG math pass or a higher quality math pass.	Resources can be used for teachers and other activities in the school Infrastructural and skills investment in underdeveloped area	There would be the challenges of managing a rurally based prog and the technical skills needed to manage this programme.	R485 per student per month or R5335 per student per year (ongoing expenditure only – i.e. excludes set up costs)
For African learners in ex African schools in rural areas	Franchising with data projector DST sets up a centre where teaching is done using MM software, laptop and data projector.	Classroom Laptop Data projector	Set up costs = R60 000 Ongoing expenditure = R243 100	100 students per centre with increased math knowledge	Resources can be used for teachers and other activities in the school Infrastructural and skills investment in underdeveloped area	There would be the challenges of managing a rurally based prog and the technical skills needed to manage this programme.	R220 per student per month or R2420 per student per year (ongoing expenditure only – i.e. excludes set up costs)

Target Pop	Model description	Resources	Financial Cost	Projected outputs	Opportunistic benefits	Sensitivity analysis	Cost per learner
African learners in the vicinity of resource centres	DST purchases site licences for MM or Plato for the Resource Centres. In addition DST purchases the PLATO Science Simulations	Well run Resource Centre	Site licences will be negotiable with the programme co-ordinator.	Higher number of students with math and science HG passes.	The programmes would be available to more than the gr 10-12 learners.	Effective benefits from the software is dependent on how the programme is implemented	Each provider indicated that they would negotiate the price with government.

MASS BASED EDUCATION

This is a long-term goal for the DST - how to use the public broadcasting system to broadcast mathematics and science supplementary educational programmes to the masses. Our research indicates that it is could potentially be a useful medium. One of the public broadcasts that we investigated broadcasts mostly in the mornings when learners are at school and learner and teacher access to the programme is dependent on taping of the programmes and then watching the tapes. The other broadcaster is a pay channel and they have changed their provision from its original intention – as a learning supplement for learners - to being an additional resource to teachers to use as a supplement in their teaching.

Both programmes offer valuable insights for how the DST could possibly, if it wanted to, engage with the use of the television for providing mass based supplementary tuition.

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APPENDICES

Appendix 1

FRAMEWORK FOR THE DST SUPPLEMENTARY TUITION STUDY

The key research questions are:

1. To evaluate the usefulness in terms of quality, impact and cost of the different types of interventions.

2. To develop models of Supplementary Tuition interventions that can serve different types of learners, which can be replicated in different parts of the country.

3. To present a strategy document (including resources) to expand the programme to allow access to a greater number of learners.

Framework for data collection

	INDICATORS	DATA SOURCES	INSTRUMENT
PROGRAMME DESCRIPTION	Detailed description in terms of Structure of programme, Contact time, Curriculum, situation of programme in the institution Admission criteria Evaluation of the programme	Int. co-ordinator/ prog doc Int. co-ordinator/ prog doc Curriculum documents of prog Int. co-ordinator/ prog doc Int. co-ordinator/ prog doc Collection of evaluation documents	
EVALUATION OF QUALITY	Philosophy of the programme (e.g focus on exams or broad vision of ed). Mode of interaction with learners plus assessment Who are tutors? Class size Infrastructure for the programme	Int with learners, tutors and co-ordinators Int with learners, tutors and co-ordinators PLUS observation of the programme in action (incl photos). Interviews and observation Interviews and observation Interviews and observation	
PROGRAMME IMPACT	No. of learners per year (enrolments) Who are the learners: Geographical space Race Gender Age Throughputs to subsequent years of prog (staying power of learners). Matric pass rates (incl. HG) Tertiary level choices	Statistical info Analysis of Statistical info Analysis of Statistical info Analysis of Statistical info Tracer studies of students who have been on the prog Analysis of Statistical info	

	Tertiary level pass rates		
COST	Cost paid by individuals Incentives for learners on prog Cost of programme	Co-ordinator int Co-ordinator int Co-ordinator int + financial statements	
PROGRAMME EXPANSION AND REPLICATION	Capability of present prog to take more student. Capability of other institutions to offer the programme GIS plot of present infrastructure to look at access for learners.	Institutional interview Other institutional inter + SAUVCA, CTP Plot plus high schools with 30 (?) km radius	

Appendix 2

THE INSTRUMENTS: EXAMPLE IS SET OF INSTRUMENTS FOR UNIVERSITY SECTOR PROGRAMMES

1. Coordinator's Interview Protocol

Program Name: _____

Coordinator's Name: _____ Date: _____

1. Description of the program:

1.1 Briefly describe the program in terms of its

Aims

Objectives

Philosophy

1.2 What was the motivation in setting up this program?

1.3 How does the program interface with the rest of the university programs?

1.4 What is the structure of the program in terms of:

1.4.1 its length?

1.4.2 when it takes place?

1.4.3 how the day is structured?

1.4.4 the nature of the interaction between the tutors and learners? (What activities take place on a particular day?)

1.5 Who are the tutors in the program?

1.6 How are the tutors selected into the program?

1.7 Is there any reason why you use these particular tutors?

1.8 What can you say about the commitment of the tutors?

1.9 Do you offer any incentives that are meant to keep the tutors in the program?

2. Selection criteria (learners):

2.1 What is your admission policy?

2.2 Who are the learners who participate in the program?

2.2.1 how do you select the learners?

2.2.2 what is the academic proficiency of the learners?

2.3 What is your policy on representativity in terms of:

2.3.1 the gender of learners?

2.3.2 the race of learners?

2.3.3 geographical distribution of learners?

3. Program incentives (learners):

3.1 Can you comment on the attendance of learners over the period of the program?

3.2 How do you keep learners motivated to attend for the entire duration of the program?

3.3 Apart from program activities, is there anything else that learners receive?

4. Program evaluation:

4.1 Has the program been evaluated:

4.1.1 internally?

4.1.2 externally?

If yes, please supply us with evaluation documents

5. Funding:

5.1 How do you source funds for this particular program?

5.2 Do learners pay to be in the program? [If yes, how much]

5.3 Do you offer help to learners who cannot afford to pay?

5.4 Could you outline the cost per learner per year?

6. Program impact:

[6.1, 6.2, 6.3, include the statistics tables to be completed]

6.1 What are enrolment records since program inception?

6.2 Can you give an indication of the pass rates of individuals before they joined the program?

6.3 What has been the throughput in terms of learners who qualify to register for higher education study?

6.4 How have learners who qualified for higher education study performed at that level?

6.5 Could you give an indication of the success of the program at different stages?

6.6 What anecdotal success stories can you provide about the program?

7. Program expansion:

7.1 What do you think would happen if you were to say double the size of this program?

7.2 What do you think it will take to do this?

7.3 What will be the challenges in terms of:

7.3.1 staff?

7.3.2 costs?

7.3.3 infrastructure?

For the expansion of the program

2. Tutor's Interview Protocol

Program Name: _____

Tutor's Name: _____ Date: _____

1. Biographical information

Gender: _____

Age: _____

Race: _____(for research purposes only)

Highest qualification: _____

What is your full time job: _____

What subject do you teach in your job: _____

What subject do you teach in the program: _____

2. Description of the program:

2.1 What do you see is the philosophy of this program?

2.2 What do you feel about this philosophy?

2.3 Do you feel programs that encourage learners to be excited about mathematics and science are necessary?

2.3.1 Why?

2.4 Do you think this particular program contributes to the need to encourage learners to study mathematics and science when they complete it?

3. Teaching in the program:

3.1 What can you say about the subject you teach and the learners participating in the program?

3.1.1 What is their proficiency in the subject?

3.1.2 What grade level (e.g. Higher) do learners take the subject?

3.1.3 How would you describe your learners' attitudes to your subject?

3.1.3 Are you prepared to teach and so encourage your learners to take higher grade?

3.2 What preparation do you engage in for the program, and how long does this take you?

3.3 In teaching your subject, what would you say you do differently for learners to understand it better?

3.4 How do you structure your teaching? (what do you emphasise) in terms of:

3.4.1. Projects?

3.4.1. Hands on activities?

3.4.1. Assignments etc.?

4. Subject incentives (learners):

4.1 What would you describe as the greatest attributes of your learners?

4.2 What would you describe as weak attributes of you learners?

4.2.1 How do you help these learners to improve these attributes?

4.3 Can you comment on the attendance of learners in your subject over the period of the program?

4.4 How do you keep learners motivated to attend classes for the entire duration of the program?

4.5 Apart from subject activities, what other skills would do you impart to learners?

5. Impact on learners:

5.1 Can you give an indication of the pass rates of individuals before they joined the program?

5.2 What has been the throughput in terms of learners who qualify to register for higher education study?

5.3 How confident are you of learners' performance in higher education after going through the program?

5.4 What anecdotal success stories can you provide about learners in taking your subject in the program?

6. Expansion:

6.1 What would you feel if say your class were to be doubled?

6.2 Do you believe you were to have the same impact?

6.3 If it were to double anyway, what do you feel it would take for you to have a positive impact on those learners

3. Learner Interview Protocol

Program Name: _____

Learner's Name: _____ Date: _____

1. Biographical information

Gender: _____

Age: _____

Grade: _____

Subjects you attend in the program: _____

2. The program:

2.1 What do you think is the purpose of this program?

2.2 Why in your view do you think there is need for Supplementary Tuition programs?

2.3 How did you join the program?

2.4 How did you find out about the program?

2.5 How easy was it for you to join the program?

3. Quality:

3.1 What do you find to be different between what you learn at school and in the program?

3.2 What is different about the approach followed in the program and at school?

3.2.1 Which approach do you prefer? (Give reasons)

3.3 How do you use what you learned in the program at school?

3.3.1 How easy or difficult have you found it in trying to apply what you learned in the program at school?

3.3.1 Why do you think it was easy or difficult to apply what you learned in the program at school?

3.4 Are there any differences between the topics covered at school and those covered in the program?

If yes,

3.4.1 which topics are covered at school and not in the program?

3.4.2 which topics are covered in the program and not at school?

4. Attendance:

4.1 What makes you want to attend the program every time it is scheduled?

4.2 How long does the program last on a particular day?

4.3 How long would you like the program to last over a day?

4.4 What are some of the reasons that make it difficult for you to attend the program?

4.5 Do you know of any learners who dropped out of the program?

4.5.1 What do you think was their reason for dropping out?

5. Impact:

5.1 How did you feel about for example, mathematics before you joined the program?

5.2 How do you feel about for example, mathematics after you joined the program?

5.3 What would you say you have gained by attending a Supplementary Tuition program?

5.4 In what way has the program made you understand mathematics and science better?

5.4.1 Has there been a change for example, in your mathematics marks at school?

5.4.2 Has there been a change for example, in your interest in reading science books?

5.5 How has the program changed your approach to your schoolwork?

5.6 What would you tell another learner wanting to or about to join the program for the first time?

5.6.1 What would you describe to that learner as the strong points of the program?

5.6.2 What would you describe to that learner as the weak points of the program?

6. Funding:

6.1 Do you pay fees to participate in the program?

If yes

.6.1.1 How much are the fees?

6.2 Are your parents willing to pay the fees to participate in the program?

4. STATISTICAL INFORMATION TO BE COLLECTED

1. Indicate the number of learners that have participated in the programme in the following table.

	Grade 10	Grade 11	Grade 12
1996			
1997			
1998			
1999			
2000			
2001			
2002			
2003			
2004			
2005			

2. Complete the following table wrt to the race and gender of learners involved in the programme.

	Black males	Black females	White males	White females	Total
1996					
1997					
1998					
1999					
2000					
2001					
2002					
2003					
2004					
2005					

3. Which schools do your learners come from in each of the years

	Names of schools of learners in the programme
1996	
1997	
1998	
1999	
2000	
2001	
2002	
2003	
2004	
2005	

4. Record of matric math and physical science passes of learners on the programme

	Math passes	Physical science passes
1996		
1997		
1998		
1999		
2000		
2001		
2002		
2003		
2004		
2005		

5. **Observation Schedule**

This observation schedule is a guide to observing a day of the Supplementary Tuition Programme.

Date of observation

Time of observation: Start .....to .....(Finish)

1. Collect information of the programme for the day.
2. How many students in the class.
3. Describe the activities that the learners are involved in for the day

Time	Activity
1st hour	
2nd hour	
3rd hour	
4th hour	
5th hour	
6th hour	

4. To what extent are the activities of the day?:

4.1. Linked to the school curriculum

4.2. Linked to conceptual development of subject matter

4.3. Linked to developing positive attitudes to math and science

4.4. Linked to career guidance.

6. TRACER STUDY WITH A GRADUATE OF THE PROGRAMME

Two or three graduates of a programme who are now in tertiary institutions will be selected and interviewed about the impact of the programme in their educational trajectories.

7. LEARNER QUESTIONNAIRE

Program Name: _____

Learner's Name: _____

Date: _____

1. Gender: _____

2. Age: _____

3. Grade: _____

4. Please indicate (with an **X**) whether you take Standard or Higher Grade the in the following subjects at school:

		SG		HG
4.1 Mathematics				
4.2 Physical Science				
4.3 Biology				

5. Please indicate (with an **X**) the year in which you joined the Supplementary Tuition program

1999	2000	2001	2002	2003	2004

6. The purpose of this Supplementary Tuition program is

_____

_____

_____

7. How did you find out about the Supplementary Tuition program?

_____

_____

_____

8. I joined the Supplementary Tuition program because (Please select 1 below)

8.1 My parents wanted me to _____

8.2 My teacher recommended it _____

8.3 I chose to _____

8.4 My friends are in the program _____

8.5 Any other reason (please write it here) _____

_____

9. What steps did you have to take to join the Supplementary Tuition program?

_____

_____

_____

10. Indicate the subjects you attend in the program: _____

_____

10.1 The difference between what we learn at school and in the Supplementary Tuition program is?

_____

_____

10.2 At school (indicate with an **X**)

	All the time	**Sometimes**	**Never**
10.2.1 experiments are demonstrated for us in the laboratory			
10.2.2 we conduct experiments on our own in the laboratory			
10.2.3 notes are written and given to us by our teachers			
10.2.4 we are told what to read and then write our own notes			
10.2.5 the teachers do all the talking and we just listen			
10.2.6 we are allowed to share our ideas in the classroom, even if they may be wrong			

10.3 In the Supplementary Tuition program (indicate with an **X**)

	All the time	**Sometimes**	**Never**
10.3.1 experiments are demonstrated for us in the laboratory			
10.3.2 we conduct experiments on our own in the laboratory			
10.3.3 notes are written and given to us by our teachers			
10.3.4 we are told what to read and then write our own notes			
10.3.5 the teachers do all the talking and we just listen			
10.3.6 we are allowed to share our ideas in the classroom, even if they may be wrong			

11 (a) The differences in teaching and learning approaches followed between the out of school program and at school are:

_____

_____

11 (b) The similarities in teaching and learning approaches followed between the Supplementary Tuition program and at school are:

_____

_____

12. For each of the statements below, indicate with an **X** your feelings about the subjects you attend in the Supplementary Tuition program.

After joining the Supplementary Tuition program I feel that

	Much better	**A little bit better**	**Nothing has changed**
12.1…this has helped me understand Science			
12.2…this has helped me understand Mathematics			
12.3…my ability to solve Science problems is			
12.4…my ability to solve Mathematics problems is			
12.5…my confidence in writing Science tests is			
12.6…my confidence in writing Mathematics tests is			
12.7…my interest in studying Science further is			
12.8…my interest in studying Mathematics further is			
12.9…my interest in following a career in the scientific field is			
12.10…my knowledge of science ideas/concepts is			
12.11…my knowledge of mathematics ideas/concepts is			

13 (a) To what extent do you apply the knowledge you learned in the Supplementary Tuition program, in your school work (indicate with an **X**)

All the time	**Sometimes**	**Never**

13 (b) What do you feel you gain from the Supplementary Tuition program?

_____

_____

_____

14 (a) On which days is the program held? _____

14 (b) What time does the program start and when does it end? _____

14 (c) Would you like the program to be longer or shorter? _____

14 (d) Why? (Please explain)

_____

_____

15 (a) How often have you been absent in the Supplementary Tuition program (indicate with an **X)**

Once or twice	**More than three times**	**Never**

15 (b) Do you have any difficulties in attending the program (indicate with an **X)**

All the time	**Sometimes**	**Never**

15 (c) If you do, please explain what the difficulties are

_____

_____

16 (a) Of the learners you started attending the Supplementary Tuition program with, how many did not continue attending?

_____

16 (b) Why do you think they dropped out of the Supplementary Tuition program?

_____

_____

17. Another learner wants to join the program and ask you about it, what would you say?

_____

_____

18. Suppose you were asked to suggest changes to the programme, what would you like to be done differently?

_____

_____

19 (a) Do you pay fees to participate in the program? Yes or No

19 (b) If yes, how much do you pay? _____

20. Are your parents able to pay your fees to participate in the program? Yes or No

----------000 Thank You for your time 000----------

8. Checklist of Documents to be collected from Programmes

1. Programme brochures
2. Curriculum documents
3. Evaluation conducted
4. Statistical info
5. Financial statements

Appendix 3

MASTERMATHS APPENDIX

Sites where MasterMaths operates

According to the June 2004 website information, MM operates in the following centres

Schools

- The Glen High School, Pretoria
- Weston, Western Cape
- Wynberg Boys High, Western Cape

Eastern Cape

- East London
- Grahamstown
- King Williams Town
- Cleary Park, Port Elizabeth
- Newton Park, Port Elizabeth
- Port Shepstone
- Umtata

Free State

- Bloemfontein
- Fichardt Park – Bloemfontein
- Qwa Qwa
- Welkom

Gauteng

- Alberton
- Benoni
- Bergbron

- Boksburg
- Bryanston
- Centurion
- Edenvale
- Elardus Park
- Florida
- Florida Park
- Fourways
- Glenanda
- Heidelberg
- Kempton Park
- Kensington
- Krugersdorp
- Lenasia
- Mayfair
- Meyersdal
- Midrand
- Northcliff
- Arcadia, Pretoria
- Menlyn, Pretoria
- Pretoria Boys High school, Pretoria
- Pretoria North, Pretoria
- Queenswood, Pretoria
- Silverton, Pretoria
- Randpark Ridge
- Roodepoort
- Roosevelt
- Rosebank
- Sandringham
- Sandton
- Springs

- Vereeniging
- Wonderboom

KwaZulu-Natal

- Amanzimtoti
- Chatsworth
- Glenwood, Durban
- Durban North, Durban
- Midlands / Hilton
- Pietermaritzburg
- Kloof

Limpopo

- Makhado
- Polokwane
- Potgietersrus (Mokopane)

Mpumalanga

- Middelburg
- Nelspruit
- Witbank

North West Province

- Klerksdorp
- Potchefstroom
- Rustenburg

Northern Cape

- De Aar

- Kathu
- Upington

Western Cape

- Athlone
- Belville High School
- Blouberg
- Brackenfell
- Cape Town
- Clanwilliam
- Claremont
- Edgemead
- Fish Hoek
- Franschhoek
- George
- Hout Bay
- Kuilsriver
- Mitchells Plain
- Langenhoven Gimnasium, Oudtshoorn
- Highschool Oudtshoorn, Oudtshoorn
- Paarl
- Paarl Boys High School, Paarl
- Parow
- Pinelands
- Somerset West
- Stellenbosch
- Thornton
- Tokai
- Tygervalley
- Worcester

Appendix 4

KUMON CENTRE

SA – Eastern Cape – Port Elizabeth & Surrounds

Port Elizabeth – Blue water Bay,	Maths Only
Port Elizabeth – Framesby	Maths & English
Port Elizabeth – Kumon West	Maths Only
Port Elizabeth – Mill Park	Maths Only
Port Elizabeth – Newton Park	English & Maths
Port Elizabeth – Summerstrand	Maths Only
Port Elizabeth – Walmer	Maths & English
Port Elizabeth – Woodridge	Maths Only
Port Elizabeth North – Booysens Park	Maths Only
Uitenhage	Maths Only

SA – Eastern Cape – other regions

East London - Greenfields	Maths Only
East London – Master Minds, Vincent	English & Maths
East London - Mdantsane	Maths Only
East London - Southernwood	Maths & English
East London – Supermaths, Beacon Bay	English & Maths
Gonubie	English & Maths
Graaff Reinet	Maths Only
Grahamstown	Maths Only
King Williams Town	English & Maths
Komga	English & Maths
Port Alfred	Maths Only
Queenstown	English & Maths
Stutterheim	Maths Only
Umtata	Maths Only

Free State

Aliwal North Kumon	Maths Only
Bethlehem	English & Maths
Bloemfontein – Fichardtpark	English & Maths
Bloemfontein – Universities Kumon	Maths Only
Brandwag	English & Maths
Colesberg	English & Maths
Ficksburg	Maths Only
Hoopstad	Maths & English
Kroonstad	English & Maths
Loskuil	Maths Only

SA – Gauteng – Centurion

Bakenkop Kumon	Maths & English
Centurion - Cornwall Hill	Maths & English
Centurion - Doringkloof	Maths Only
Centurion - Irene	Maths & English
Centurion - Lyttelton Manor	Maths & English
Centurion - Pierre van Ryneveld	Maths Only
Eldoraigne	Maths & English
Erasmia	Maths & English
Hennops Park	Maths & English
Laudium	Maths & English
Rooihuiskraal	English & Maths
Swartkops Valhalla	Maths & English
The Reeds	English & Maths
Wierda Park	Maths & English

SA – Gauteng – Johannesburg

Alberton - Randhart	Maths & English
Alberton – Brackenhurst	Maths & English
Alberton - Verwoerd park	Maths Only
Azaadville	Maths & English
Bedfordview - Bishop Bavin School	Maths & English
Bedfordview - Dunvegan, Kumon Whiz Kidz	English & Maths
Bedfordview - Leeuwenhof	English & Maths
Benoni - Beyerspark	Maths Only

Benoni - Lakefield	Maths & English
Benoni - Newby	Maths & English
Benoni - Rynfield	Maths & English
Benoni Central - St. Columba's	Maths & English
Blackheath	Maths & English
Boksburg - Freeway Park	Maths & English
Boksburg - Morganridge	Maths Only
Boksburg - Sunward	Maths & English
Boksburg - Witfield	Maths Only
Boksburg Central - St. Dominic's	Maths Only
Brakpan - Brenthurst	English & Maths
Brakpan -Dalview & Dalpark	Maths & English
Broad Acres	English & Maths
Bryanston - Bryandale Primary	Maths & English
Bryanston - St. Peters (Paulshof)	English & Maths
Dainfern	Maths & English
Deborah Freemantle	English & Maths
Dewetshof (Near Cyrildene)	English & Maths
Edenvale - Hurlyvale	Maths & English
Eldorado Park	Maths Only
Emmarentia - Master it	Maths & English
Fourways – Chartwell North	English & Maths
Germiston - Elsburg	Maths & English
Germiston - Primrose	Maths & English
Glenhazel	Maths & English
Kempton Park - Birchleigh	Maths & English
Kempton Park - Bonaero Park	Maths & English
Kempton Park - Edleen	English & Maths
Kempton Park - Glen Marais	Maths Only
Kempton Park -Birchleigh & Glen Marais	Maths & English
Kensington	Maths & English
Kensington - Jeppe Prep	Maths & English
Kyalami	English & Maths
Kyalami Japanese	Maths and Japanese
Lenasia - Protea	Maths & English
Lenasia South - Daxina	Maths & English
Linden	Maths & English
Mayfair	English & Maths
Midrand - Beaulieu	Maths & English
Northcliff	Maths & English

Norwood - Patterson Park	Maths & English
Observatory - Sacred Heart	Maths & English
Parktown North	Maths Only
Parkview	Maths & English
Randburg - Blairgowrie	Maths & English
Randburg - Ferndale	Maths & English
Randburg – Malanshoff	Maths & English
Randburg - Sharonlea	English & Maths
Randburg – Sundowner	English & Maths
Rosebank - Melrose Estate	Maths & English
Sandton - Kelvin	Maths & English
Sandton – Marlboro Gardens	Maths & English
Sandton - Morningside	Maths & English
South – Glenvista	English & Maths
South – Mondeor	English & Maths
South – Robertsham	Maths & English
South – Winchester Hills	Maths & English
Soweto – Pimville	Maths Only
Soweto – Rockville	Maths Only
Springs	Maths & English
Springs - Petersfield	English & Maths
Thokoza	Maths Only
Waverley - St. Mary's	Maths & English
West Rand – Discovery	Maths & English
West Rand - Featherbrooke Estate	Maths Only
West Rand – Horison	Maths & English
West Rand – Krugersdorp - Kenmare	Maths Only
West Rand – Little Falls	Maths & English
West Rand – Randfontein	Maths Only
West Rand - Roodekrans	Maths & English
West Rand – Weltevredenpark	English & Maths
Zakariyya Park	Maths & English

SA – Gauteng – Pretoria

Akasia Kumon	English & Maths
Arcadia	Maths & English
Atteridgeville - Amogelang	Maths Only
Bronberg	Maths Only
Bronkhorstspruit	Maths Only
Brooklyn	Maths & English
Constantia Park	English & Maths
Elarduspark	Maths & English
Faerie Glen	English & Maths
Garsfontein	Maths & English
Hartebeespoort	Maths Only
Kruin Kumon	English & Maths
Lynnwood	Maths & English
Menlo Park	Maths & English
Meyerspark	Maths & English
Monument Park	Maths & English
Moreletapark	Maths & English
Mountain View	Maths & English
Presda	Maths & English
Pretoria North	Maths & English
Riviera Rietondale	Maths & English
Sinoville	English & Maths
Soshanguve Kumon	Maths & English
Theresapark	Maths & English
Waverley	Maths & English
Wonderboom	Maths & English
Woodhill - Doxa Deo School	Maths Only

SA – Gauteng – Vaal and Surrounds

De Deur	Maths Only
Meyerton	Maths & English
Sasolburg – Zamdela	Maths Only
Sebokeng – Sedibeng	Maths Only
Sharpville – Inkanyezi preschool	Maths Only
Sharpville Kumon	Maths Only
Vaaldriehoek	Maths Only
Vaalpark	Maths Only

Vanderbijlpark	Maths & English
Vanderbijlpark - Roshnee	Maths & English
Vanderbijlpark - Kleuterland	Maths & English
Vanderbijlpark – Kollegepark	Maths Only
Vereeniging – Henri's Kumon	Maths & English
Vereeniging Kumon	Maths & English

SA – Kwa- Zulu Natal – Durban and surrounds (031)

Chatsworth	Maths & English
Durban – Berea	Maths & English
Durban – Morningside	Maths & English
Durban – Yellowwood Park	Maths Only
Durban North	English & Maths
Durban South - Isipingo	Maths & English
Glenwood	Maths Only
Hillcrest	Maths Only
Kloof	Maths & English
Kumon Academy Pinetown	Maths & English
Morningside	English & Maths
Phoenix	English & Maths
Queensburgh	English & Maths
Reservoir Hills	Maths Only
Umhlanga – La Lucia	Maths & English
Westville North	Maths & English
Westville South	English & Maths

SA – Kwa-Zulu Natal – other regions

Ballito	Maths Only
Empangeni	Maths & English
Eshowe	Maths & English
Estcourt	Maths & English
Harburg	Maths Only
Kokstad	Maths & English
Ladysmith	Maths & English
Mtubatuba – Kerry's & Grantleigh	Maths & English
Mtunzini	Maths Only
New Castle	Maths Only

Pongola	Maths & English
Port Edward	Maths Only
Richards Bay - Kumon Kids	Maths Only
Scottburgh	Maths Only
Shelly Beach – Leigh's Kumon	Maths & English
South Coast Tweni	English & Maths
South Coast Uvongo	English & Maths
Stanger – Kwa Dukuza	Maths & English
Verulam Kumon	Maths & English
Vryheid	Maths & English

SA – Limpopo

Amandebult	Maths & English
Bela-Bela	Maths Only
Ellisras	Maths Only
Hoedspruit	Maths & English
Letsitele Kumon	Maths & English
Louis Trichardt, – Kumon Kids	English & Maths
Mariepskop	Maths Only
Naboomspruit	English & Maths
Nylstroom Kumon	English & Maths
Phalaborwa	English & Maths
Pietersburg – Brainy Bunch	Maths & English
Pietersburg Central	Maths & English
Polokwane Capricorn	English & Maths
Potgietersrus	Maths & English
Swartklip	Maths Only
Thabazimbi	English & Maths
Tzaneen – Annie's Kumon	Maths & English

SA – Mpumalanga

Barbeton	Maths Only
Delmas	Maths & English
Ermelo	Maths Only
Ermelo Central	English & Maths
Middelburg	Maths Only
Middelburg 2	Maths Only
Nelspruit - Laerskool	English & Maths
Nelspruit - Penryn CollegeLowveld	English & Maths
Nelspruit - Shammima's Kumon	English & Maths
Piet Retief	English & Maths
Riverview Malelane	Maths Only
Secunda	Maths & English
Standerton	Maths Only
White River	Maths Only
Witbank	Maths Only

SA – North West

Bergsig Kumon	Maths & English
Brits - Kumon Worx	Maths & English
Brits - Madibeng	English & Maths
Carletonville	Maths & English
Hartebeespoort	Maths & English
Klerksdorp	Maths & English
Koster	English & Maths
Lichtenburg	Maths & English
Mafikeng	Maths & English

SA – Northern Cape

Douglas	English & Maths
Hartswater	Maths Only
Jan Kempdorp	Maths & English
Kimberley	Maths & English
Newpartk	English & Maths
Prieska	Maths Only

SA – Western Cape -- other regions

Caledon	Maths Only
Ceres	English & Maths
De Dooms	Maths Only
George	Maths & English
Knysna	Maths & English
Knysna - Sedgefield	Maths & English
Langebaan	Maths Only
Robertson	Maths & English
Swartland Malmesbury	Maths & English
Vredendal	Maths Only

SA – Western Cape – Cape Town and surrounds (021)

Bergvliet – Bergvliet Primary	English & Maths
Brackenfell	Maths Only
Camps Bay	Maths & English
Constantia	Maths & English
Durbell	Maths & English
Edgemead	Maths & English
Fishhoek	Maths & English
Heldervue	Maths & English
Kenilworth	Maths & English
Kenridge	Maths Only
Newlands	Maths & English
Orangezicht – St. Cyprians	Maths & English
Panorama	Maths & English
Pinelands	Maths & English
Rondebosch 1	English & Maths
Rondebosch 2	Maths & English
Rondebosch 3 - St Josephs	English & Maths
Sea Point	Maths & English
Somerset West	Maths & English
Stellenbosch	Maths & English
Strand	English & Maths
Table View & Parklands College	English & Maths
Tableview 3	Maths & English
Tokai - Star of the Sea Kumon	Maths & English
Wynberg - Mohammedia School	English & Maths

Appendix 5

Implementation cost of Mindset Learn per school

Roll out of equipment	
Television	R2,223.00
Video recorder & 10 video tapes	R770.00
Satellite & smart card (MCA)	R670.00
Installation & distribution	R1,745.00
Travel	R520.00
Security cage	R2000.00
Sub total	**R7928.00**
Training and ongoing support	
Technical operator training	R530.00
Educator orientation (*see below*)	R2,560.00
Ongoing support (*see below*)	R2,410.00
Sub total	**R5500.00**
Call center fee for year 1	R850.00
Projection fee at 5%	R 722.00
Total per school	**R15000.00**

Appendix 6

1. **Tertiary Sector**

Information	UP with Science	Ikateleng	UWC Outreach	UDW Upward Bound
Connection to school curriculum	Not linked to school curriculum – Learners participate in projects of different University departments	Linked to school curriculum	Linked to school curriculum - Grade 10 to Grade 12 mathematics and science software developed at the university is used	
Where offered	University of Pretoria	3 University of the North West sites (Vanderbijlpark, Potchefstroom & Taung)	On-site computer assisted learning facilities in different township and rural schools	UKZN campus (Durban-Westville)
PHILOSOPHY	Expose learners to different scientific areas – Involves learners observing scientists at work, learners participating in hands on experimental activities, and being exposed to typical role models.	Improve the overall examination results and symbols of matric learners to enable them to meet admission requirements of tertiary institutions. Core Life skills component	"… Engender the philosophy of self-sustaining community involvement with the ultimate goal of community upliftment"	Assist learners to pass matric and prepare for university life through a "social life skills" component

Information	UP with Science	Ikateleng	UWC Outreach	UDW Upward Bound
Program Aim:	Increase the number of students graduating in science at university. This is achieved by: (a) Encouraging learners' interest in science as a field of study and specialisation (b) Providing information on possible career paths and opportunities in science.	Enable learners to meet admission requirements of tertiary institutions	Using computer-assisted learning environments to improve Grade 12 mathematics and physical science results of poorly performing schools in townships and rural areas in the Western Cape.	Address access to higher institutions, particularly in scarce skills fields such as engineering, mathematics, and commerce Primary feeder scheme of learners from disadvantaged backgrounds into higher educational institutions
No. of learners:	50 in each of grade 10,11,12 so 150 in any one year Must be doing HG.	1000 learners in 3 sites in grade 12. Must be doing HG.		Initially 2000 –500 in each of grade 10, 11 and 12, and further 500 undergraduates. Finally 120 learners (40 in each grade) and 60 teachers.
Racial composition of learners:	Whites, Africans and Indians	All African	Coloured and African	African
Learning approach:	Hands on experimentation and observation of experts.	Seems like large group teaching.	Computer-enabled environment	

Information	UP with Science	Ikateleng	UWC Outreach	UDW Upward Bound
Program length **No. of sessions**	7 ½ hours a day June gr 10-June gr 12 1 week winter school Total 14 days per year and 33 days altogether	1 year (Gr. 12) Approximately 20 Saturdays	Varies: In 1999/2000, total contact time was approximately 450 hours	10 days twice a year in Gr. 10 and 11. One 10 day session in Gr. 12
Tutor background	Tutors are post-graduate students + some university lecturers	Tutors are good mathematics and science teachers from the area.		Initially mostly undergraduates. Finally Upward Bound program staff.
Post-program (i.e. tertiary) arrangements	Prog involves offering bursaries to students who continue with a B. Sc at UP subject to performance			Initially designed to source bursaries and place learners. Did not work
Cost:	Difficult to know. Learners pay for transport except where they cannot afford.	Learners select minimum of 2 subjects and pay R50 per subject. Estimated cost to UN-W is R1000 per student		Each stay costs R1750 participant and R2600 per learner – i.e. R3500 per participant per year and R5200 per learner per year
Expansion:	Not too keen – happy with current arrangements	Keen but constrained by cost		No. Don't believe this to be manageable

Information	UP with Science	Ikateleng	UWC Outreach	UDW Upward Bound
Impacts	• Increased English usage • Exposure to other science careers • Improved understanding of Science concepts • Familiarity with university environment • Emphasis of importance of HG math and science	± 56% of intake estimated to qualify for tertiary study In 2003, ± 26% of learners enrolled at the University of North West Learners learn how to cope with stress Learners report improved self-esteem and self-confidence; improved study skills.	Grade 12 physical science and mathematics results in participating schools increased by 20% and 10% respectively. From 1999 to 2002, 70% more learners were successful in matric mathematics standard grade. From 2000 to 2002, 90% more learners were successful in matric mathematics standard grade.	

2. NGO Sector

Information	SAILI	Imfundo
Connection to school curriculum	Linked to school curriculum	Linked to school curriculum
Where offered	Gr. 8&9: MTN Sciencentre Gr.10-12: University of Stellenbosch	Nedcor Buildings in Sandton
PHIL	Initially to encourage learners to pursue engineering careers; Currently to provide supplementary tuition to math and science higher grade learners Focus on HG	Helping improve learner's Mathematics and Science knowledge with the aim of improving their future prospects. Focus on HG
Prog aim:	Providing learners from historically disadvantaged communities with opportunities in science and engineering; Learners to pass well in Maths and Science on HG.	Providing support to learners in science and mathematics Providing career guidance to learners and introducing them to practical examples of entrepreneurship and technology
No. of learners: **Racial composition of learners:** **Learning approach:**	38 grade 8 and 35 Gr. 9 40 grade 10, 40 grade 11 And 40 grade 12 Coloured and African Gr. 8&9: hands-on experimentation + large group teaching Gr. 10-12: Large group teaching – telling method	12 gr 11 (?) 13 Gr. 12s(?) African Large group teaching - teacher working through examples and introducing new work. + small tutorial groups working through the examples set by the teachers

Information	SAILI	Imfundo
Program length **No. of sessions**	February - October Approximately 4 ½ hours every second Saturday (2 hours Maths and 2 hours Science) Total of 18 sessions per year Plus weeklong winter school	09h00 until 14h00 Every Saturday (38 Saturdays) Weeklong courses in vac time Total of 52 contact days a year
Tutor background	Gr. 11 & 12 Maths and Science tutors are qualified school teachers in these subjects Gr. 10 tutor (of both Maths and Science) is an actuary.	Professional educators Volunteer black professionals around 22 or 23 years old - they have degrees in Engineering, computers, actuarial science
Post-program (i.e. tertiary) arrangements	Have a careers advisor SAILI assists learners in securing placement at university for their chosen fields of study and in securing bursaries to finance these studies	Trying to arrange bursaries etc
Cost:	Learners pay for own transport to SAILI pick-up points. Otherwise SAILI finances all costs all costs (fees, books, lunch money, transport, sport kits) At Gr.10-12 level, cost of Supplementary program is R1696 per learner (for 18 Saturday contact sessions)	Imfundo provides transport for the learners from Alex to Sandton, textbooks for science and math and science, math sets as well as stationary Cost per learner is R7361
Expansion:	Does not mind setting up a residential course for out of town learners.	The programme intends expanding to grade 10 learners in 2006 and the budget for 50 learners is projected at R247 546 and the cost per learner is R4951 At the moment the unit cost per learner is very high – this is because it is a very small class size. To be viable there needs to be more students per unit group. The accommodation at Nedcor will only allow a maximum of 20 learners.
Impacts	Further exposure to, knowledge and understanding of, and better problem-solving technique in maths and science;	Positive impact on learners understanding of Mathematics and Science;

	Improvement in conceptual knowledge and understanding of maths and science; Interest in studying both maths and science further is much higher and following a scientific field; Improved confidence in writing tests In 2004 the mathematics average for the Grade 12 group (26 learners) on their final matriculation mark was 64% - all on HG. Nine learners obtained As in mathematics. The average for the Science HG (25 learners) was 68% with nine As in science	Improved problem solving abilities; Improved confidence in writing both Math and Science tests; Improved knowledge in both math and science; Improved interest in studying Math further and pursuing science as a career

3. **Science Centres**

Information	SAILI Comets at MTN Sciencentre in Cape Town	Science Workshops at Old Mutual-MTN Sciencentre in Durban	Unizul Science Centre Outreach workshops
Type of programme	Gr 8 and 9 learners in a structured programme for the two years	Once off workshops	Once off visits
Connection to school curriculum	Not linked to school curriculum	Experiments that relate to the curriculum but are additional to the syllabus	Linked to school curriculum
Where offered	MTN Sciencentre, Cape Town	Old Mutual-MTN Sciencentre at Gateway	5 different locations within the centre's 200km catchment area surrounding Richards Bay
PHIL	Develop attitudinal mindset in SAILI learners of maths being "cool and fun"	Combination of education and entertainment to excite and inspire learners and to allow them to see science and technology as interesting, accessible and enjoyable	School experiments and examination preparation
Prog aim:	Develop opportunities and change mindsets outside the school curriculum	Cover material that is linked to the curriculum without duplicating classroom material	Demonstrate the experiments that are examinable in the physical science curriculum
No. Of learners:	In 2005 there are 38 grade 8 and 35 grade 9 learners	Depends on length of workshop run – approximately 1000 learners per term. Generally works on maximum of 60 learners per group or 100 learners split into two groups	In total, over these five venues, each of the four workshops is presented to over 7000 matrics
Racial composition of learners:	African and Coloured	Depends on participating school	African
Learning approach:	day begins with a 1hr maths revision lesson followed by a fun, group hands-on practical workshop	"Science of Sound" and "Newton's Laws": set of interactive exhibits and the allocation of a workbook and worksheet to every attendee	Perform experiments and provide learners with exercise books on experiments

Information	SAILI Comets at MTN Sciencentre in Cape Town	Science Workshops at Old Mutual-MTN Sciencentre in Durban	Unizul Science Centre Outreach workshops
Information	**SAILI, MTN Sciencentre**	**Old Mutual-MTN Sciencentre**	**Unizul Science centre**
Tutor background	People from outside teaching	Mathematics and science education – linked to teaching expertise	Science education – linked to school teaching expertise
Cost:	R3733 per learner		
Expansion:	Making the programme available to learners from rural areas through week long periods during school holidays in April, July and September, providing residential accommodation	Fun, careers and curriculum-based weekly program for 30 FET maths and science learners (2 hours per subject) at a cost of R3842 per learner	A. Target learners in schools in the vicinity of the Science centre and offer a math and science input on Saturdays; B. Bring a small cohort of learners, from more rural areas and away from daily travelling to the Centre during school holidays. Ensure a maximum ratio of 1:25 learners; C.Target a specific school (that already achieves good results and has good facilitators and motivated teachers) and use as a cluster school for supplementary initiatives. Establish a permanent presence in a rural area for the running of weekly programs.

4. For Franchises

Information	MasterMaths	Kumon
Connection to school curriculum	Linked to school curriculum	Not linked to school curriculum
Where offered	Schools and MasterMaths centres nationwide	Kumon centres nationwide
PHIL	To develop confident and competent students, linked to developing knowledge base	Limit teaching through small learning steps and repetition. Drill and practice – mastery learning
Prog aim:	Raise learners Maths marks by setting attainable goals	Mastery of mechanical skills
No. of learners:	Depends on size of centre and time of year. Generally works on principle of 8 learners per facilitator Nationally there are 10000 learners enrolled across 95 franchise centres at any one time with a peak of 13000 learners in October	18 000 learners in 550 centres in SA and other African countries, 3.5 mil worldwide.
Racial composition of learners:	All races – linked to middle class and affordability	All races – linked to middle class and affordability
Learning approach:	Facilitators directing module-based learning, centred around a computer based teaching system (CBT system) that combines voice and animated graphics – at the learner pace	Worksheets must be completed in single sittings in a certain amount of time. Learners may have to repeat assigned worksheets until their performance qualifies as mastery
Program length **No. of sessions**	Determined by learner Approximately two hours a week	Attend Kumon study centres twice a week for approximately 30 minutes each time; Learners spend between 10 and 30 minutes a day on work at home five days a week
Tutor background	Anyone with competence in areas facilitated. Usually require matric maths	Facilitators need to be familiar with the content that they prescribe to learners. In-service training is provided
Post-program arrangements		

Information	MasterMaths	Kumon
Cost:	Learners: Registration fee of R90; Notes for a year cost R130; Monthly cost to a learner attending for two hours a week is R440 Franchise: cost depends on number of workstations. A 20% royalty fee is paid monthly	The cost per learner is R270 per month The cost of starting a franchise is R7000 with a 45% royalty fee paid by franchise owners every month.
Expansion:	1) Franchising – networked system which is a derivative of the current system; 2) Group teaching using data projector 3) Offering bursaries to students who cannot afford but show potential to attend (HG only); 4) Language development	We do not think this programme would be useful in enhancing math and science quality at the senior secondary level

5. Media Based

Information	Learning Channel (SATV)	Mindset (DST)
Connection to school curriculum	Linked to school curriculum – cover curriculum material by responding to questions posed by learners.	Linked to school curriculum –, Mindset lessons are not broadcast live but are scripted and pre-recorded.
Where offered	Television broadcasts on SABC3, online instruction at www.learn.co.za, pre-recorded videos and cd-roms, Newspaper supplements	Television broadcasts on Mindset Channel 82 on DSTV, interactive web lessons on www.mindset.co.za, print supplements in the Sunday Times
PHIL	Providing "a multimedia, holistic education solution to education in the developing world."	"… The personal, social and economic upliftment of all Africans through better education."
Prog aim:	To prepare learners to pass the matriculation examinations.	To provide a dedicated and integrated education service
No. Of learners:	Unknown	Unknown
Racial composition of learners:	Learners accessing TV	Learners having DSTV
Learning approach:	During term time, from 09h30 to 11h00 the television tutor links up via telephone to a particular school, and in accordance with the program timetable, covers a section of the syllabus with learners from that school. Tutors respond to questions raised by learners. For the final half-hour (11h00 to 11h30) learners from anywhere in the country can phone in with specific questions. On Saturdays, during school holidays, and in October and November, the entire 2-hour broadcast is dedicated to learners to phone in with their questions.	Mindset's DSTV modus operandi is to build up lessons according to a lesson plan. The lessons are presented on the assumption that viewers encounter material for the first time. In other words episodes are not designed simply to reinforce classroom learning. Tutors teach in a systematic form and reference is always made to a previous lesson. During each lesson there is revision of material which has been covered before.

Information	Learning Channel (SATV)	Mindset (DST)
Tutor background	Reputable school teachers	Reputable school teachers
Cost:		Mindset advertises on providing the "Mindset solution" to a school, which does not have a satellite dish or TV or video machine. The cost of this package is R15 000.
Expansion:		Mindset was originally set up a supplementary tuition broadcast. It now operates as an additional resource to teachers in a classroom. Now there is a set of resource videos in schools and teachers can play that to supplement their lessons.

Appendix 7

LIST OF PEOPLE INTERVIEWED

Organisation	Contact person	Contact details
IKATELENG - North West University	Mr Chris Windell	Marketing and Communication Dept. North West University (Potchefstroom Campus) P/Bag X6001 Telephone: 018 299 2769 Mobile: 082 568 1501 Email: bkkwcw@puk.ac.za
UP WITH SCIENCE – University of Pretoria	Ms. Helga Nordhoff	Discovery Centre @ TUKS Faculty of Natural and Agricultural Sciences University of Pretoria 0002 Pretoria Telephone: 012-420-2638 Email: upscience@postino.ac.za
OUTREACH PROGRAMME: University of the Western Cape	Prof. Cyril Julie	School of Science & Mathematics Education University of the Western Cape Private Bag X17 Bellville 7535 Telephone: 021 959-2680 Email: mpeters@uwc.ac.za

Upward Bound	Nomsa Dlamini Professor Elizabeth de Kadt	Executive Director: Access University of KwaZulu-Natal Durban 4041 South Africa **Dekadt@ukzn.ac.za** Tel: 031 260-2456/2294 Cell: 082 466 3346 Fax: 031 260-3360
SAILI	Robbie Gow-Kleinschmidt Pete Van Jaarsveld	**robgk@chec.ac.za** Tel: 021 659 7163 Fax: 021 659 7176 Cell: +27 (0)83 4406015 Work: +27 (0)21 6597168 Home: +27 (0)21 5322186 email: primeset@mweb.co.za cc: pete@chec.ac.za
Maths Champ CC	Dimakatso Mabitsela	P O Box 205 Diepkloof, 1864 Tel. 011 528 1060 Fax. 011 895 1536, 011 528 1060 Cell. 082 398 1684
Imfundo	Ntuthuko Shezi	P O Box 786586 Sandton 2147 Cell. 083 441 5549
MTN ScienceCentre	Mike Bruton	**Physical Address:** MTN ScienCentre, 407 Canal Walk, Century City **Tel:** 529 8100 **Fax:** 529 8179 **Cell:** 083 212 7609 **E-mail:** mike.bruton@mtnsciencentre.org.za
Unizul Science Centre	Derek Fish	**Director : Unizul Science Centre** **Ph/fax : 035-7973204** **Cell : 0824528566** Gate 1, ZCBF Community Park, South Central Arterial, Alton, Richards Bay, South Africa Postal address : PO Box 553, Mtunzini, 3867 (South Africa)

MasterMaths	Johan Welgens	Master Maths Head Office PO BOX 573 SOMERSET WEST, 7129 Tel: 021 851 5660 Fax: 021 851 5300
	Greg Connellan	Master Maths Glenwood Franchise Address: 237 Bulwer Rd, Glenwood, Durban, 4001 Tel :(031) 2021133 Fax :(031) 2021133 Cell :0823758332 Email Address: gregconnellan@ananzi.co.za
	Soraya Hoosain	Master Maths Chatsworth Franchise P.O. Box Address: P.O. Box 561484, Chatsworth, 4030 Physical Address: 148 Arena Park Dr, (Rd 601), Arena Park, Chatsworth, 4092 Tel :(031) 4041649 Fax :(031) 4041649 Cell :0837865736 Email Address: shoosain@absamail.co.za
Kumon	Kevin Mayo	Westville North Franchise 464 4739 083 784 4739
Liberty Life Learning Channel	William Smith	**Physical Address:** First Floor 20 Baker Street Rosebank Johannesburg 2196 **Postal Address:** PO Box 1654 Saxonwold 2132 **Contact Numbers:** Tel: 011 214-7100 Fax: 011 214-7110 **General Information:** info@learn.co.za
Mindset Network	Fatima Adams	Education and Content Director, Mindset Network Tel: (+27 11) 408 3299 Fax: (+27 11) 339 1570 Email: info@mindset.co.za

PLATO	John Bredenkamp	Tel: 27 11 4520507 Fax: 27 11 6093246 Cell: 0825753032 john@plato.co.za
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	Peter Makari	Cell: 082 557 9242 Email: kwatiron@icon.co.za or peter@plato.co.za