

ZENÉX

F O U N D A T I O N

Putting language
into the mathematics
and science equation





The Zenex Foundation is an independent donor organisation that focuses on mathematics, science and language education in schools. Its mission is to educate and empower historically deprived learners so they can contribute towards growth, development and democratisation in South Africa.

The Foundation values innovation and prizes its partnerships with government, donors and service providers. It has forged partnerships with the Department of Education so it can make a sustainable impact and create models that government can build on.

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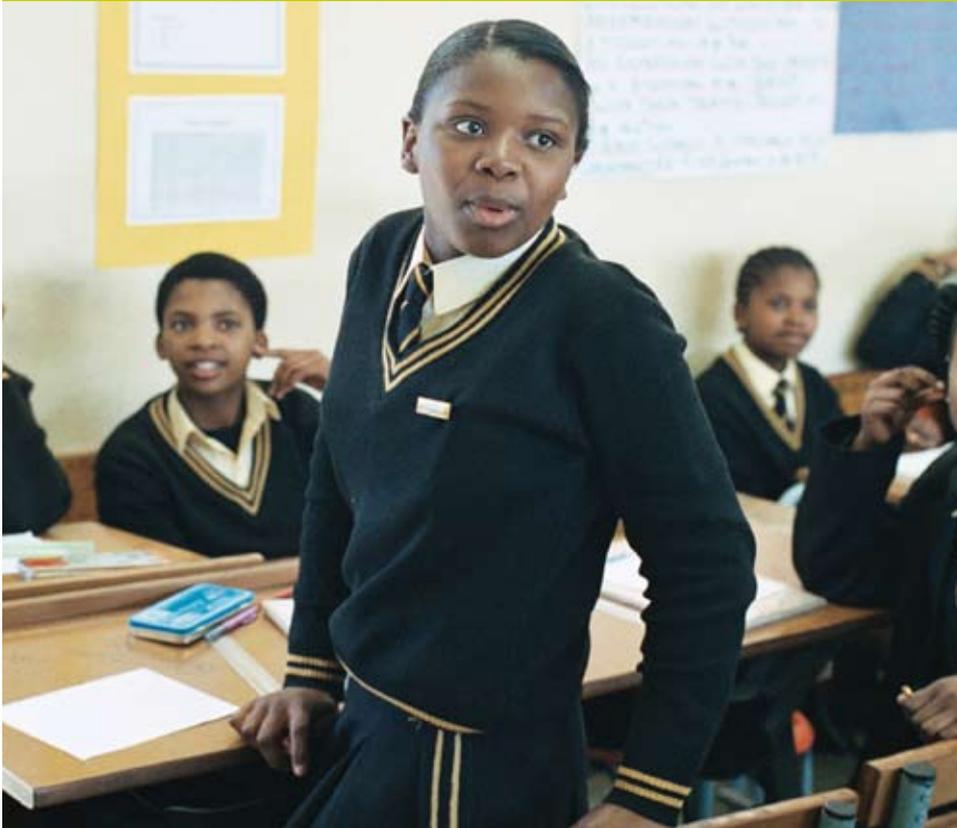
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Contents

2	Introduction
4	Understanding the challenge in mathematics, science and language education
6	The relationship between language and learning
10	Language and learner performance in mathematics and science
12	Strategies to address the problem
12	• The Department of Education's strategies to fast-track mathematics and science education
12	• The Zenex Foundation's support for the Dinaledi Project
13	• The Zenex Foundation's contribution to mathematics, science and language education
15	• The role of the private sector
17	References

Introduction



South Africa currently faces one of the gravest threats to its future prosperity – a serious shortage of skilled people to drive the growing economy. This shortage derives largely from the fact that many South African school-leavers lack basic skills in mathematics, science and English language, and are therefore not able to pursue further education opportunities in medicine, scientific research, engineering, information technology or accounting, nor in a host of other occupations requiring technical training.

It is in this context that the Zenex Foundation has focused its ten-year strategy for 2006 to 2015 on supporting primary and secondary school projects in the key areas of mathematics, science and language.

Since 1995 the Zenex Foundation has disbursed some R237-million in the South African education sector. The impact of this expenditure has been evaluated through extensive research and enquiry, and important lessons have been learnt about how donors can support the improvement of learner performance at school level. The results of a meta-evaluation conducted in 2006 show that interventions need to focus on project design, impact and the roles of donors and government.

One of the lessons learnt is that a close partnership with the Department of Education is critical to the impact of private sector spending in education. As a donor, the role of the Zenex Foundation is not to compensate for

gaps in state policy, but to develop and grow partnerships that increase the capacity of South African institutions to impact on mathematics, science and language teaching.

The nature of the partnership is therefore a close and creative one. In practical terms, it involves aligning strategies and sharing information, as well as pooling financial resources and expertise. The Zenex Foundation is committed to basing its interventions on empirical research, and over the past ten years it has commissioned 23 programme evaluations of its school-based interventions in mathematics, science and language.

This booklet has been produced to mark the launch of the Zenex Foundation's three-year, R10-million partnership with the Department of Education's Dinaledi II Project that aims to improve learner performance in mathematics and science. The partnership was formed in response to the Department of

Education's call in 2006 for funders to join the government's Dinaledi II initiative, and the Zenex Foundation's role is described in more detail below.

The booklet outlines the scale of the challenge facing South Africa in respect of increasing its mathematics and science capability, and identifies the factors that impact on learner performance in these fields. Research has clearly demonstrated that one of the most significant factors is language. This is why the Zenex Foundation has chosen to support Dinaledi II by developing an English programme for grades 10 and 11 that is similar in nature to the Dinaledi mathematics and science programmes.

The booklet concludes by outlining the strategies currently being adopted by the Department of Education, the Zenex Foundation and other players in a national effort to strengthen South Africa's efforts to help teachers and learners excel in mathematics and science.

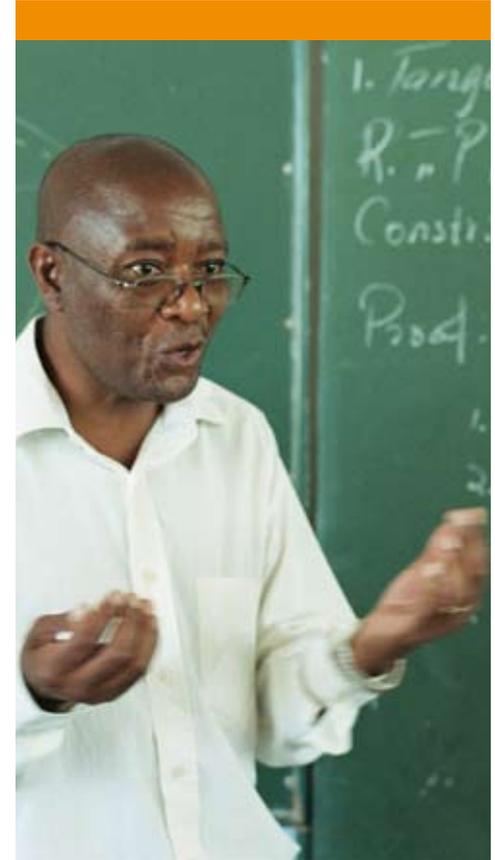
Understanding the challenge in mathem

South African education currently faces the daunting challenge of attempting to arrest and turn around the downward spiral in the teaching of mathematics and science, with its corresponding requirement that learners attain a certain level of language competence. These deficits are all too evident in the poor performance of school-leavers over the last few years:

- Of 508 363 learners who wrote the Senior Certificate in 2005, only 26 383 (5.2 per cent) achieved higher-grade passes in mathematics.
- In the 2006 Senior Certificate examination, 25 217 (only 4.8 per cent) passed higher-grade mathematics – fewer than in 2005.
- Most disturbing is the small number of African school-leavers with higher-grade mathematics passes. In 2004 there were only 7 236, of which only 2 406 achieved the minimum C symbol necessary for university entrance.

Research has shown that these results stem from a range of factors, including the critical shortage of mathematics and science teachers. Only 15 per cent of current mathematics teachers have the required qualifications to teach the subject, and only half of the secondary schools in the country are able to offer mathematics at higher-grade level.

The new National Senior Certificate makes mathematics or mathematical literacy compulsory for all learners in the Further Education and Training (FET) phase, but the shortage of suitably qualified teachers presents a real challenge in making this a reality. An added challenge is the introduction of the new FET curriculum for mathematics. Mathematics experts have noted that the curriculum content is excellent and will prepare learners well for tertiary level education. However, the implementation of this new curriculum will be hampered by the critical shortage of qualified mathematics teachers in our schools.



atics, science and language education

“What we have working in our favour, are South Africa’s school enrolment rates that approach 100 per cent, and the fact that the national Department of Education has strongly encouraged partnerships with donors and civil society organisations in its efforts to innovate and find solutions to the skills shortages that beset our country.”

Sizwe Nxasana, Chair of Zenex Foundation Board of Trustees and Chief Executive of FirstRand Bank

As South Africa attempts to halve poverty and unemployment by the year 2014, more and more key stakeholders in education are calling for efforts to be stepped up to deliver quality mathematics, science and English language education at schools. Successful teaching of these subjects is universally considered to contribute to sustained economic growth.

One of the more vocal and active stakeholders is the Zenex Foundation, which celebrated its tenth anniversary in 2006. According to FirstRand Bank Chief Executive, Sizwe Nxasana, who is also the chair of the Zenex Foundation’s Board of Trustees, South African education has some positive features that could assist in dealing with the challenges.

Nxasana says the Zenex Foundation’s focus on mathematics, science and language education is firmly aligned with the objectives of the Accelerated and Shared Growth Initiative of South Africa (AsgiSA), which was launched

in 2006 by Deputy President Phumzile Mlambo-Ngcuka. The Foundation currently works in four of the nine provinces and plans to expand into others over the coming years.

The next section identifies the language factors that impact on learner performance in mathematics and science. It is followed by an overview of the strategies being adopted by government and private sector players to put mathematics and science education on a new path.

The relationship between language and

There is a critical relationship between children's acquisition of language in their early years and their ability to learn. At a very young age they acquire the cognitive skills and information that equip them for further learning.

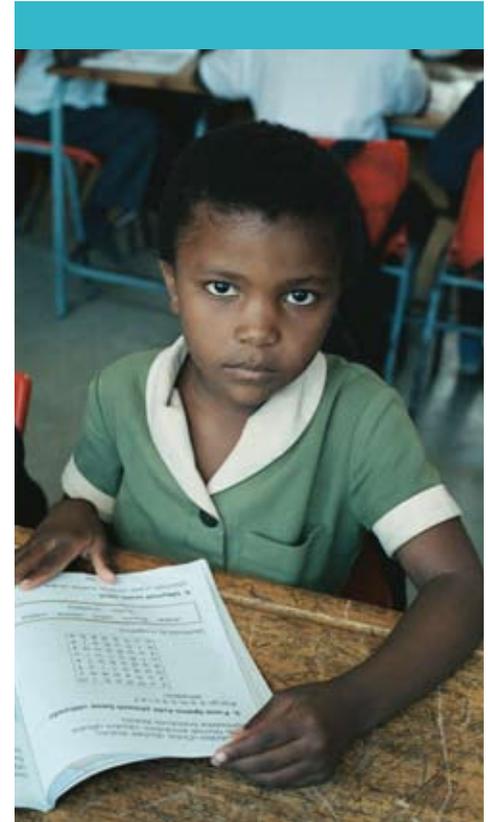
However, the National Systemic Evaluation of literacy levels in South African schools shows that learners are not achieving age-appropriate literacy levels, even in their home languages. In addition, most learners learn through the medium of an additional language, which in most cases is English.

The National Department of Education language policy promotes learning in the home language in the Foundation Phase. The philosophy behind this policy is that learners require a solid grounding in their home language in order to establish the skills necessary to engage with further learning. In Grade 4, learners switch to English as the language of learning and teaching. However, the majority of learners do not have enough exposure to English,

either at home or at school, to enable them to develop the English literacy skills necessary to cope with learning through the medium of English.

Poor English language skills among both teachers and learners have thus been identified as one of the key factors that impact negatively on mathematics and science results. At the same time; language issues are embedded in a range of other contextual issues such as learners' socio-economic background, teachers' subject knowledge, teaching practices, resources and school management and discipline.

The majority of our learners are from economically deprived backgrounds and do not have access to print-rich environments. For this reason, READ advocates that learners need to enjoy a rich literacy and language experience at school and gain access to well written and well illustrated South African and African fiction. The school must recognise its essential role in providing a stimulating environment that will nurture a love of reading.



learning

There is much research on this subject: most notably by Carol Macdonald in the Threshold Project research (1990); Heugh (2005, 2006) who strongly advocates that learners should learn through the medium of their home language for as long as possible; and the various South Africa TIMSS reports (Howie, 2001; Reddy, Kanjee, Diedericks & Winnaar, 2006). MOLTENO and READ, two of the most renowned organisations working in literacy education in South Africa, are both proponents of home language education at Foundation phase.

The Language-in-Education Policy (1997) advocates that learners learn better through their home language. However, the power of English in the political economy is such that parental opinion is strongly in favour of English medium education as a means to acquiring English and thus securing access to economic resources. Learning through the home language is sometimes constrained by negative associations with apartheid education, and currently

the range of African language resources required for teaching through the medium of African languages is not available.

“While home-language instruction is preferable, the rudimentary nature of the academic register in most South African languages for physics, chemistry and mathematics still requires the development and agreement on a multitude of technical terms. This development would take massive inputs of resources and time.”

Dr Nick Taylor, Jet Education Services

The Department of Education’s language policy acknowledges the multilingual nature of our society and articulates the official policy of additive bilingualism. This means that, along with the continued use of the mother tongue, more and more English is systematically introduced into the primary school

curriculum, so that the child’s language proficiency is gradually built up and he or she is fully prepared to change to English as the language of learning and teaching in the higher grades. The amount of mother-tongue teaching that takes place in schools is still at the discretion of individual provinces, and school communities have the authority to decide on the actual languages that a school will offer.

Decisions about school language policy are left in the hands of school governing bodies. As a result, for a range of reasons that have little to do with improving classroom teaching and learning, parents and teachers have tended to opt for English as the language of learning and teaching.

Margie Probyn from the Institute for the Study of English in Africa states that in many cases, teachers are caught between teaching content and language: if they focus on the content and use the learners’ home language to get

concepts understood, they are perhaps compromising their role in teaching English; if they focus on the English, they may compromise the extent to which content is understood. Teachers claim that they have received no training in how to deal with these problems in the classroom.

Implementing home-language education at Foundation phase is not without challenges. In urban areas, such as Gauteng, a large variety of home languages are spoken by children in any one school. On the other hand, in areas such as the Eastern Cape, where the vast majority of teachers and learners are isiXhosa speakers, it would seem practical to use isiXhosa for teaching and learning. Much also needs to be done to educate parents on the value of home-language instruction.

Some possible solutions for addressing the important challenge of language in learning are the following:

- A massive focus on literacy for both learners and teachers: schools need

adequate supplies of appropriate and interesting reading materials in learners' home languages and in English so that learners can read extensively and develop the literacy levels required for academic learning.

- Training for teachers on
 - how to teach literacy;
 - upgrading subject knowledge; and
 - the role of language in learning and how to utilise the learners' home languages in the classroom in a planned and strategic manner.
- Provision of the necessary resources for science and mathematics teaching and training in how to use and retain resources.

“Lack of proficiency in the language of learning and teaching is a major obstacle to efforts to access the curriculum and to reduce educational inequality. Quality improvement initiatives that do not recognise this obstacle are unlikely to have significant impact.”

English Language Education Trust (ELET)



“One way or the other, it appears inevitable that English will remain the language of learning and teaching after, at least, Grade 3 except, perhaps, in rural areas. Consequently, it is of the utmost importance that serious and sustained attention is paid to improving the level of competence in this language if we are to have any hope of improving the quality of the outcomes of the education system. And we must also pay attention to a host of other factors that affect learner performance if gains in language competence are to translate into gains in content subjects.”

Eric Schollar, evaluator and co-author of the Report on the Zenex Foundation Meta-evaluation of Maths and Science (2006)

Language and learner performance in m

A number of studies have examined factors that contribute to the poor performance of South African learners in mathematics and science. For example, drawing on the work of Adler, Kebeka, Vinjevold, Kahn and Setati over the last decade, Sarah J Howie identified the following factors:

- inadequate subject knowledge of teachers;
- inadequate communication ability of learners and teachers in the language of instruction;
- lack of instructional materials;
- difficulties experienced by teachers to manage activities in classrooms;
- the lack of professional leadership;
- pressure to complete examination-driven syllabi;
- heavy teaching loads;
- overcrowded classrooms;
- poor communication between policy-makers and practitioners; and

- lack of support due to a shortage of professional staff in the ministries of education (Howie & Plomp, 2003).

According to Howie, other factors that impact on children's ability to succeed at mathematics and science include learners' personal aspirations and peer attitudes, classroom factors such as teachers' competence and qualifications, learner access to computers, and factors that operate at school level, such as leadership, efficient school administration and time on task.

Sharanjeet Shan, Executive Director of the Maths Centre in Johannesburg, explains the challenge as follows:

“Mathematics has its own specialised language (vocabulary) that uses symbols and notations for describing numerical, geometric and graphical relations. Mathematics ideas and concepts build on one another towards creating a coherent whole. If there

is a gross mismatch between the teacher's vocabulary and the learner's received language, misinterpretation and incomplete understanding results. Over a long period of time, if left unresolved, this will lead to demotivation and disaffection.”

Mamokgethi Setati's study undertaken with Adler, Reed and Bapoo on code switching (Setati, Adler, Reed & Bapoo, 2002), notes the importance of talk as a tool for thinking and therefore for learning.

“Although it is appropriate for much of this learning to be in the learners' main language(s) they also need opportunities to speak, read and write in English in the English class.”

In the mathematics class, learners have to understand and use formal mathematical and scientific discourse through the medium of English. Teachers therefore need to consider two different dimensions of 'learning talk':

athematics and science

“Exploratory talk, which is a necessary part of talking to learn and which is likely to be most effective in the learner’s main language ...” and “the discourse-specific talk, which is part of learners’ apprenticeship into the discourse genres of subjects in the school curriculum.”

(Setati et al, 2002)

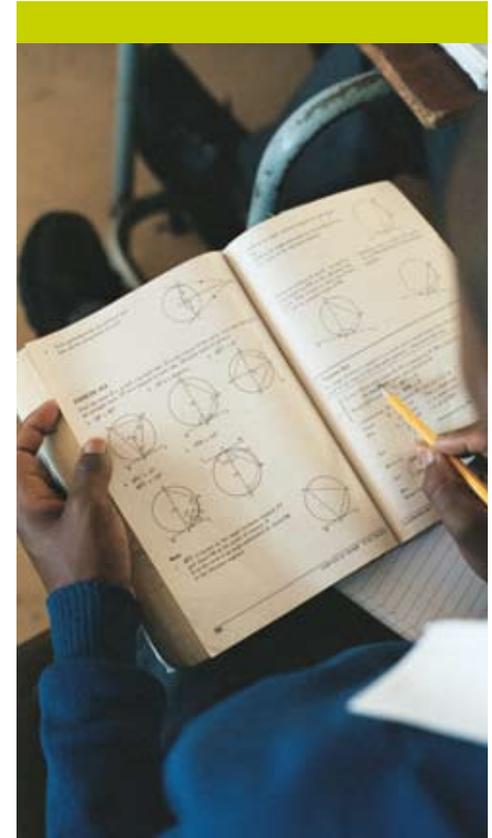
It is the second type of talk that proves most problematic for the majority of learners who are not proficient in English.

Learners explore ideas using their main language, and code switching can therefore be a vital resource in the teaching of mathematics. There is evidence that the amount of exploratory talk has increased in our schools, indicating that some learning is taking place. However, it may be that the amount of time spent on this kind of talk is working to the detriment of the

consolidation of the learning into written work. Setati et al (2002) stress that it is essential for learners to move from informal discussion to the consolidation of concepts by means of written work in English.

Teachers who are confronted with the dilemma of how much code switching is appropriate, and how to introduce learners to the realm of mathematical discourse in English, should keep in mind that their main goal is to make sure that their learners are, eventually, completely autonomous in English. Setati et al (2002) argue that proficiency in English must be acquired not only through the formal English class, but in the course of learning mathematics as well.

These are some of the factors that led the Zenex Foundation to target Grade 10 and 11 English teachers in 65 Dinaledi schools in an effort to improve the standard of mathematics and science teaching and learning at FET level.



Strategies to address the problem

The Department of Education's strategies to fast-track mathematics and science education

"... we are going to change the way we teach maths and we are going to change the outcomes ..."

Minister of Education, Naledi Pandor, at the opening of the AMESA Conference, 2004

Dinaledi is a programme implemented in 2004 by the Department of Education to develop secondary schools as centres of excellence in the teaching of mathematics and science. In 2006 Dinaledi II was launched, with the purpose of identifying learners who are talented in mathematics and science. Four hundred public schools all over South Africa are involved in the programme. The aim is to double the number of African students achieving university entrance passes in mathematics and science by 2009. Teachers are also being tested, trained and incentivised.

According to Mohamed Enver Surty, Deputy Minister of Education, the Dinaledi programmes are already making a difference:

"We do have a shortage of qualified math and science teachers. The shortage has been there since about 1960, and exists in almost every country in the world. As a Department, we have made a good start with the Dinaledi Project ... Through this project, we have been able to address the professional development needs of our math and science educators, provide resources and establish support structures for the selected schools."

(National Assembly, June 2004)

Apart from the Dinaledi II programme intervention, the Department of Education's strategy to improve learner performance in mathematics and science can be summarised as follows:

- incentivise current mathematics and science teachers to keep them in the system;
- bring in a cohort of foreign mathematics and science teachers as a short-term measure to address the critical shortage;
- re-hire qualified mathematics and science teachers who left teaching with the severance package system; and
- put in place a comprehensive bursary programme to encourage young people into the teaching profession.

The Zenex Foundation's support for the Dinaledi Project

The partnership between the Zenex Foundation and the Department of Education was formed in response to the Department's call in 2006 for funders to join the government's Dinaledi II initiative.

The Zenex Foundation agreed to commission the development of an English programme for grades 10 and 11

that is similar in nature to the Dinaledi mathematics and science programmes. A programme for English First Additional Language has been developed by the Institute for the Study of English in Africa (ISEA) at Rhodes University, together with a 36-week work schedule that guides English teachers through the curriculum. The materials have been uploaded to the Thutong website for the benefit of all schools.

The Zenex Foundation also agreed to pilot the training and distribution of materials to selected Dinaledi schools in four provinces: KwaZulu-Natal, Limpopo, Gauteng and the Western Cape. This programme is being rolled out in 65 schools and will reach 280 teachers.

Sufficient numbers of textbooks are being supplied to reach every Grade 10 and 11 learner in these schools (15 298 and 15 364 learners respectively). Every participating English teacher will receive 60 hours of theoretical training along with core reference resources. Each

teacher will also receive eight classroom support visits and mentorship support visits from English language experts. In addition, each school in the pilot receives a start-up classroom library kit to support the introduction of an extended reading programme. The Zenex Foundation staff have been working very closely with the National Department of Education and the Dinaledi co-coordinators in the various provinces to facilitate the rollout of the programme.

The service providers who are introducing the Zenex-funded programme in four provinces are the English Language Educational Trust (ELET), the University of the Witwatersrand's Professional Development Unit, and the University of Cape Town's School Development Unit.

The Zenex Foundation's involvement in Dinaledi II grows out of the Foundation's extensive involvement in education in South Africa over the past eleven years. Since 1995, the Zenex Foundation has

supported interventions in three key areas of education: early childhood development, numeracy and literacy in primary schools and mathematics, science and English in secondary schools.

The Zenex Foundation's contribution to mathematics, science and language education

The findings of the meta-evaluation conducted by the Zenex Foundation in 2006 pointed to the fact that the Foundation needed to integrate its mathematics, science and language interventions in a holistic manner. Previously, the Zenex Foundation undertook independent programme interventions in either mathematics or languages or science. Evaluations showed consistently that a poor grasp of the language of instruction impacted on learner performance in mathematics and science.

Going forward, the thrust of the Zenex Foundation's ten-year strategy is thus to

integrate the offering at school level in mathematics, science and language as follows:

- Promote mother-tongue education at Foundation Phase level, along with numeracy.
- Promote English language interventions at Intermediate Phase with mathematics continuing up to Grade 6.
- Focus on English language interventions at FET level for English teachers as well as English across the curriculum training for mathematics and science teachers.

Looking ahead to 2015, the Zenex Foundation will focus on supporting school-based projects in selected districts. Partnerships have already been brokered in Gauteng (Johannesburg South), Western Cape (EMDC), KwaZulu-Natal (Port Shepstone) and Limpopo (Vhembe) to roll out these projects. The interventions will include teacher training, coaching and mentoring

of teachers, working with learners with potential, and providing school management support and educational materials.

The school-based programmes form the core of the Zenex initiatives. At the same time, the Foundation also promotes innovation and research. As such the Zenex Foundation is involved in a number of innovative language interventions to contribute to the sector.

One such intervention was undertaken with the READ Organisation to develop Grade 1 literacy materials in isiXhosa and isiZulu and to train teachers to use them. Research has shown that a serious lack of home language materials is one of the root causes of poor literacy levels in our schools. Because it is so important that initial literacy be taught in the home language, Zenex has funded a project for READ to develop a set of literacy materials in isiZulu and isiXhosa. The programme included the development of a series of books and teacher guides

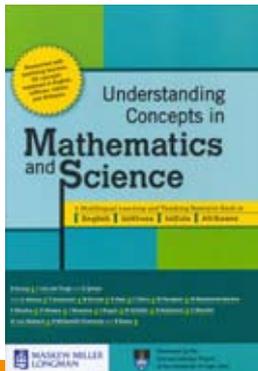
that can be used for teacher training with Foundation Phase teachers.

In 2006 the use of home-language materials was piloted in 100 primary schools in the Eastern Cape and KwaZulu-Natal. Evaluations of the home-language materials was conducted by Professor Sarah Murray of Rhodes University, while the training of the teachers in the use of these materials was undertaken by JET Education Services. The evaluation provided evidence that learners who had access to quality instruction and materials in their home language achieved better results in literacy.

The Zenex Foundation is also piloting an accredited training programme in literacy, numeracy and life skills for 80 Foundation Phase teachers. This pilot project will run until 2008, and the training will be accredited by the University of South Africa (Unisa). The Tlhabane EDSC in Bojanala and the Vuselela EDSC in Bophirima in the North

West Province will support the initial implementation of the project.

In partnership with the Concept Literacy Project and Maskew Miller Longman, the Zenex Foundation has supported the publication of an exciting new resource book for teachers. Entitled *Understanding Concepts in Mathematics and Science: A Multilingual Learning and Teaching Resource*, the book gives clear explanations of scientific and mathematical concepts in four languages: isiXhosa, isiZulu, English and Afrikaans.



The book is beautifully produced, with state-of-the-art graphics to support the verbal explanations. As well as making mathematics and science more accessible to other language communities, it represents an exciting breakthrough in the development of indigenous languages for use in schools and institutions of higher learning.

Another exciting pilot is the Family Literacy Project being run in the Western Cape for parents as part of the support to a school-based programme. This is the first time the Zenex Foundation is working with parents as well as teachers to support literacy. The programme will include a series to guide parents on how to assist their children at home.

The role of the private sector

In her article "Unlocking Maths and Science Potential", Ann Bernstein, the Director of the Centre for Development Enterprise (CDE), makes a strong case for the private sector to continue supporting

efforts to improve mathematics and science education and, in particular, to back government in its Dinaledi Project, in which 'dedicated' schools are developed as centres for quality science and mathematics teaching (Bernstein, 2005).

According to Bernstein, in spite of 'energetic commitment' by both government and the private sector, the situation has not improved much. However, all parties must persist in their efforts. "South Africa does not have the capacity to change everything at once ... It is therefore essential to focus our very limited resources through a step-by-step incremental programme" (Bernstein, 2005:233).

As a first step, the private sector should review the support it has given to mathematics and science education with a view to aligning it with the proposed national thrust and CDE's recommendations for effective intervention. Private sector support

should be focused more strategically. To maximise return on investment, schools, teachers and learners with the highest potential should be targeted, rather than wasting resources on overly ambitious attempts to upgrade the situation nationally.

According to the latest CDE research report, *Doubling for Growth: Addressing the Maths and Science Challenge in South Africa's Schools* (October 2007):

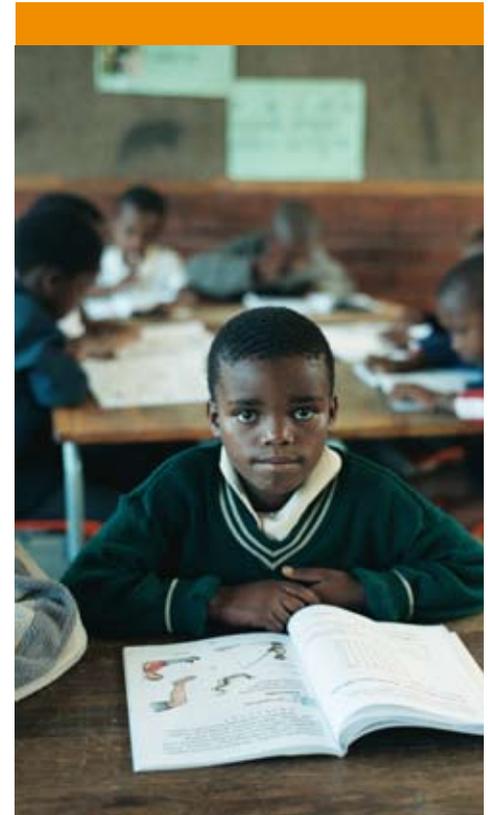
“Experiments with innovative systematic programmes are likely to motivate policy changes aimed at achieving significant increases in the number of HG maths and science passes.”

CDE, 2007

One private sector initiative launched in 2007 by the Independent Schools Association of Southern Africa (ISASA) is a Mathematics and English (M&E) Programme that aims to use ISASA member schools to produce 300 black school-leavers with university entrance passes in mathematics

and English by 2010. It will also train or retrain more teachers in mathematics and English through teacher learnerships, and provide support to under-resourced public schools. In line with its overarching focus, the Zenex Foundation together with FirstRand Foundation and the Optima and Epoch funds of Anglo American are providing support to this initiative.

In some cases, private sector organisations are supporting programmes in the provinces in which they are operating. For example, Impala Platinum and ABSA are two companies supporting mathematics, science and language programmes in North West and Mpumalanga respectively. These programmes target learners and teachers with strategies to improve curriculum delivery, teacher development and professional support and for improving learner performance through better resources, strengthened language proficiency and support through university-level study.



“It is through language that we are able to enter more fully into the texture of life and thoughts of fellow human beings as we interact with one another in numerous contexts locally, continentally and globally. For South Africans, our ability to find one another through our languages will be one of the greatest formative experiences of citizenship in our new democracy; even more so if we are able to undertake this journey of mutual discovery through science and mathematics in their capacity to deepen our conceptual imaginations.”

Professor Njabulo S Ndebele, Vice Chancellor of the University of Cape Town

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