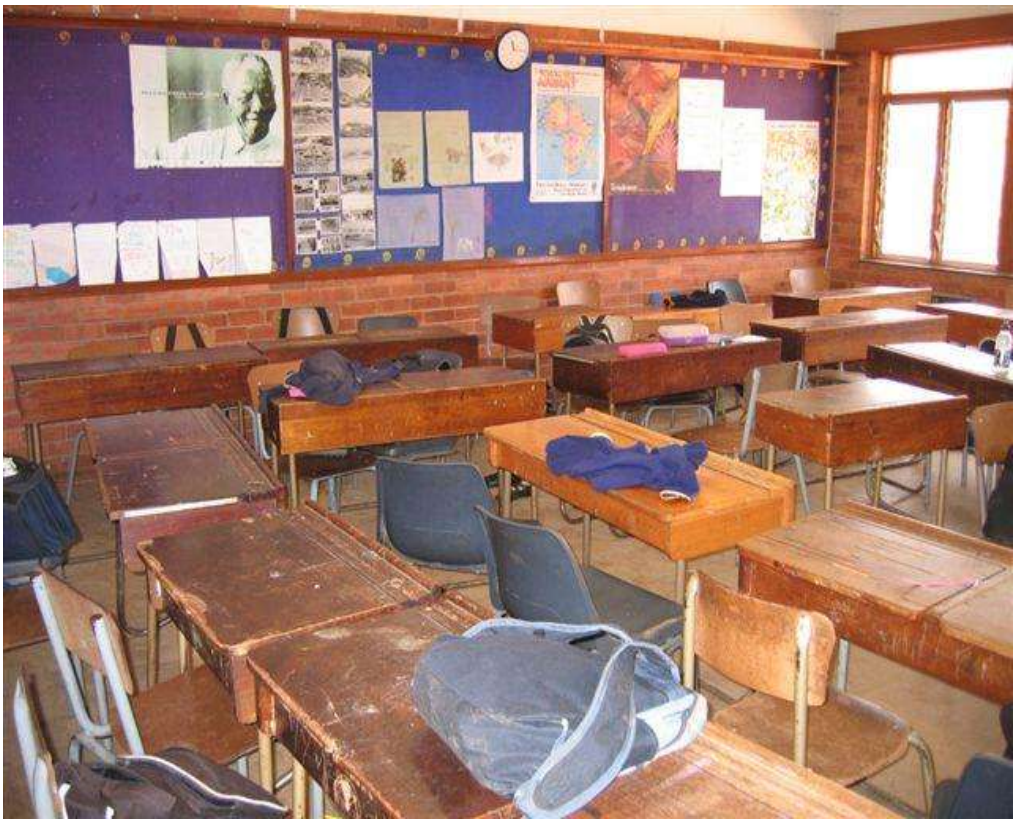
Quality and Relevance in South African Schooling



Implications for Human Capital Development in the Environmental Sector

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Contents Pages

Executive Summary

Much has been said about the poor performance of the South African schools system. This report summarises key issues, with details in Appendix 1. It provides an analysis of the underlying factors, drawing on the extensive literature available, and on 12 interviews with teachers and departmental officials in the Eastern Cape and Western Cape.

It is important to consider the *systemic* nature of the factors underpinning the crisis in schooling, when planning investments in human capital development. Most analysts describe multiple causes to the problems, even though the media and others have tended to focus on one factor, being the outcomes-based curriculum.

Socio-economic conditions

High unemployment, poverty and inequality affect the majority of communities where poor performing schools are situated, and have a knock-on effect on other schools. These conditions affect children's readiness to learn in multiple ways: through poor nutrition, low self esteem, few good role models, limited access to learning resources including educated adults, and too few opportunities to develop the conceptual building blocks on which further learning depends. Investment in social welfare and development will improve the chances for learning. Teachers also call for additional human resources in the form of remedial and learning support teachers. These are available, in limited numbers, in urban areas in the better resourced province. They are absent in the poorer resourced province. Teachers also greatly value being able to address socio-economic conditions through Eco-Schools (food gardens, beautifying the school, involving the community, building pride).

Quality of teachers and teacher training

Countries with excellent education systems invest strongly in the quality of their teachers. In South Africa the teaching corps was reduced to cut down on public expenditure, with no effort to ensure that the best teachers remain in the system. Remnants of Bantu Education logic remains in a view that teachers are merely technical implementers at the bottom of a hierarchy, hence the emphasis on developing and handing down a policy. Today many teachers cannot pass tests on the knowledge they are meant to teach; teachers in our sample admitted to not teaching key components of the curriculum because "I am not good at it". There has been inadequate attention to a concerted teacher development programme, and teacher training efforts from providers have, with some notable exceptions including programmes in environmental education, been found wanting, inappropriate (e.g. an advocacy orientation) and ineffective (e.g. without clear practical application).

Quality of leadership and management at all levels

Research identifies the quality of school management as a more important factor in learner performance than socio-economic conditions. Teachers in Eco-Schools report that a supportive principal enables them to go the extra mile. With good management staff are motivated, on time, teaching when they are meant to teach, and following a structured, planned curriculum. South African is unique in the extent to which these factors are absent in the schools and learning is affected dramatically. A teacher 'defiance' campaign is still operative in some provinces. But *management failures feature throughout the system*. Available funds are not deployed effectively and text books and other resources often fail to reach schools on time, or at all. While there are differences between and within provinces, and often highly committed and hard-working staff, most district offices are operating ineffectively. Departmental staff are squeezed between the huge demands in the schools and poor support from higher up. In some provinces senior appointments are not made on merit and this hinders the success of national level interventions. Subject advisors who have interacted with environmental education partners outside the system value the resources and information to which this gives them access, as they can in turn pass this on to teachers. *There is very little or no support for environmental education at higher levels in the education departments*.

Funding and resources

Government allocates a significant portion of the national budget to schooling, but the system is still unable to use and distribute the available funds, effectively. There has also been reluctance to spend money on teaching staff, although research and international practice suggest that investing in the human resource base, through more appointments, better selections, conditions and training, would be one of the most effective and lasting investments that can be made. Quick-fix solutions are tempting, and funding infrastructure and workbooks are easier to fit into short term performance systems, and may even bring about an improvement in benchmark test results. However, *there is little research to show that they will have a significant and lasting impact on fundamental learning, unless other factors are also addressed*.

Curriculum, curriculum guidelines and other policies

Much attention has been given to the radical nature of the outcomes based education framework which was adopted to overcome the legacy of Apartheid education. Some commentators including academics draw a direct line from the new curriculum, to the poor results now evident in matric and university tests. However, *poor learning outcomes including limited literacy and numeracy among the majority of young people have been the outcome of South African education for decades*. One of many significant differences between then and now is that *in the past, few of these learners would have progressed to university or even matric*.

While it is evident that, since their introduction at the start of this decade, the new National Curriculum Statements have not eradicated educational inequities, and that they have some problems which need to be ironed out, it is also prudent to note that they have not yet been adequately implemented; many teachers and officials report that they have not been adequately trained in this curriculum, and some are actually still implementing the original version of Curriculum 2005. To scrap and replace the already revised curriculum would mean another delay in attending more effectively to other issues such as the quality of teaching and better management of the curriculum implementation, the schools and the system. A plethora of attendant policies and a problematic assessment framework have been developed at national and provincial levels; a recent report to the Minister confirms that these have added little clarity but instead sowed confusion and overloaded teachers with administration which further compromise the quality of teaching and learning. This does indeed need urgent and radical action, so as to streamline and strengthen the *implementation* of the curriculum. In response to the report, the Department of Education has decided to develop syllabi for certain subjects and scrap others.

Environmental education

General

Our study shows that environmental education is happening haphazardly in South African schools, where teachers have been exposed to it by non-departmental programmes and providers. The National Curriculum Statements provide considerable opportunity for environmental education and teachers with enough exposure, interest, knowledge and assistance manage curriculum-related environmental education very well; this tends to happen particularly in the Intermediate Phase of schooling, but also elsewhere including high schools. Because support is not systemic, however (i.e. not imbedded in the formal system of teacher training and professional development, as well as departmental guidance) the work teachers do tend to be shaped significantly by what the environmental partners offer, and by the quality of their own general training, i.e. their general competence as teachers. Teachers whose exposure to and knowledge of environmental education has been limited, do nothing, and ignore the environmental learning outcomes in the National Curriculum Statements. Teachers whose initial training has been inadequate, struggle to make coherent sense of environmental education in the curriculum even after exposure. This is not unique to environmental learning outcomes; it may also happen to Mathematics in Foundation Phase, or Science in the Senior Phase.

Science and Environmental Learning Across the Grades

In an interview with a curriculum advisor for the sciences, the following summary was provided: In the Foundation Phase, ‘science is not happening’; in the Intermediate Phase, it is ‘a challenge’, in the Senior Phase, ‘it depends on the teachers we have’, and in Grades 10-12, science learning is weakened

Environmental learning is associated with the Sciences and the rest of the National Curriculum Statements. In the Foundation Phase, both science and environmental learning must be addressed through the Life Skills Learning Programme, which must be integrated with the two other Learning Programmes, Literacy and Numeracy. This happens in some schools, where teachers for example draw on school gardens to introduce basic science and environmental concepts. In other schools, however, very little attention is given to the Life Skills learning programme, by either teachers or departmental officials.

Many environmental partners focus their attention on intermediate phase grades (4-6) and there is much environmental education activity at those schools that have such partnerships, but it is confined to the work of teachers who have been informed and inspired through workshops and courses from a range of providers, or visits to environmental education centres of various kinds. Teachers are able to varying degrees to link their activities to environmental education based on the curriculum, but many think of it as 'bringing environmental education in' and most report that they need more help to know how to do curriculum-based environmental education. Teachers who have had no exposure to environmental education or to science, simply do not attend to it. Support from departmental officials also depends on the personal interest and exposure of the curriculum advisor, rather than on policy.

Two schools show the spectrum of environmental education in the Senior Phase (Grades 7-9), based on very different ways of implementing the National Curriculum Statements. At school servicing unemployed and working class families in Cape Town, a Senior Phase teacher estimated the environmental content of the curriculum she teaches as follows:

- Natural Sciences 100%
- Arts and Culture 70-90%
- Mathematics 50-70%

At a comparable school in the Eastern Cape, the Senior Phase teacher's awareness of environmental education was much more limited and she estimated:

- Natural Sciences 40% (fossil fuels and where they come from, 'things about nature')
- Mathematics 40% (exposure through workshops on the weather by SAIAB).

Grades 10-12

In the Further Education and Training (FET) band the pattern is similar, with those teachers who have had exposure to environmental education through their own training or interests, using the curriculum for environmental education. Programmes from environmental partners and support from departmental officials are important; where these are available, vibrant environmental education activities take place; where they are absent, so is environmental education. In schools which emphasise

ecological footprints, inequality and the need to reduce our impact on the earth, students are starting to lose interest (particularly associated with the social component of Geography). Where the emphasis is on positive actions to address local issues in particular, the response is positive and there is pride and enthusiasm from all concerned.

Teaching and learning in the high school is significantly constrained by the poor quality of basic academic skills and concepts coming through the earlier phases. Teachers' content knowledge is a significant constraining factor, and a subject like Physics is at risk of 'dying out' due to too few knowledgeable and inspiring educators.

Career Guidance

More can be done by environmental partners and universities to support career and study guidance in schools. However, it would be futile to attempt to 'load' additional content or materials into the Life Orientation curriculum area, where study and career guidance is addressed, as this area is both over-full and marginalised in most schools. Opportunities include better design of career fairs and expo's, school visits, offering venues for job shadow programmes, and inclusion in a careers package endorsed by the Department, the PACE programme (see Rosenberg et al, 2009).

Recommendations

- Engage with the new Minister of Education to ensure environmental education expertise in the committees who will be drawing up syllabi, following the recent report on the implementation of the National Curriculum Statements.
- Strength the environmental content of initial and in-service teacher training courses to improve teachers' content knowledge.
- Provide guidelines to textbooks publishers to ensure that textbooks contain high quality up-to-date information on the environment.
- Improve the supply of appropriate educational materials to schools and the training of teachers in their use; the development of these materials should draw on appropriate educational expertise to ensure that they can be used to strengthen literacy and numeracy at all levels of schooling.
- Increase and strengthen opportunities for curriculum support staff at provincial and district levels in how to interpret the official environmental learning policy into learning programmes, lesson plans, classroom activities and assessment practices that promote systematic environmental learning.
- Monitor teachers' work to ensure that the environmental content is 'skipped' and is taught properly.

1. Introduction

Are Schools Important for Human Capital Development?

If the immediate need is to produce mathematical models to predict the movement of species for commercial sea fisheries, or to fill senior scientific and middle management positions, or provide the innovation, social insights and technical skills with which to respond to climate change, then schools may not seem a priority site for intervention.

And indeed, schools are but a part of a multi-facetted system of human capital development, and all facets of this system need attention. But they are important:

- Environmental leaders, managers and scientists start somewhere – and along with the home and wider experiences, schools play a role in shaping both values and intellectual skills.

- The foundations of learning are critical in determining success in further and higher education. When interviewed about the level of readiness among their students, staff in high schools, FET colleges and universities reported that they could clearly distinguish between learners from different schools; some are ready for further learning, and others are hamstrung by inferior quality schooling.

- Innovation is by its very nature unpredictable; it cannot be forced and it is not the inevitable result of education. But we can prepare fertile ground for innovation. The conditions which led to the flush of innovations that characterised Silicon Valley, included wide investment in all levels of education including schooling.

- Schools and environmental learning are also important for the general population and for those in the environmental sector who will not take up senior positions. Environmental managers and researchers need a strong support base in the workplace and in broader society; little can be achieved by such leaders if the rest of the population is ill-informed and apathetic, or if support staff have limited competence to help implement policies. Innovative sustainability practices also need to come from among communities outside formal institutions and government.

Data Sources

This report has been prepared as part of a study into the quality of provision of environmental learning across all levels of education and training, to inform the development of human capital development strategies for the environmental sector. Two other reports focus respectively on Vocational and Further Education and Training (Rosenberg & Burt, 2009) and Higher Education (in preparation), while a third focuses on Career Guidance (Rosenberg et al, 2009).

Data sources for this report on schooling include:

1. Desk top review by Yvonne Nsubuga (2009)

2. Further review of the literature by Eureta Rosenberg

3. Interviews by Jane Burt at nine primary and high schools in the Eastern and Western Cape and with two provincial education department officials (subject advisors). Schools were sampled across the historical and socio-economic spectrum. Because we were interested in general quality issues as well as the quality and extent of environmental education and learning, we approached schools where we expected a bigger chance of some environmental education taking place, in the form of schools which had been involved in Eco-Schools or other environmental education initiatives. This approach also facilitated access to schools, as we were able to contact individual teachers, known to our partners through their involvement in environmental education. Thus we have to some extent a 'best case scenario' sample across the spectrum of schools in the two provinces. The provinces were chosen through convenience sampling, as they are where the research team members are based, and they present the extremes of South African socio-economic conditions, from among the best resourced and performing (educationally) to among the least resourced and the worst performing.

4. To consider a few examples of what has already been done, we conducted a tenth interview at a LEAP school, which is a school outside the government framework, that aims to improve mathematics and science education among talented children in townships. We also drew on an evaluation of the Eco-Schools programme (Rosenberg, 2008), and on a review of the Department of Science and Technology's *Youth into Science* Programme (Reddy et al. quoted in Vass et al. 2009.)

2. Environmental Learning in the Curriculum

When the ANC and partners produced a *White Paper on Education and Training* (published in 1995) the document stated that environmental education and training was necessary for all levels and sectors of society. Fifteen years later, education policies continue to articulate well with environmental policies such as the National Environmental Management Act. This is the result of a considerable history of state environmental and education departments working with civil society and international donor partners to ensure that environmental learning is articulated in the national school curriculum.

These stakeholders have deliberated the best forms in which to include environmental education in the curriculum, informed by international best practice and principles. It was concluded that environmental learning needs to be integrated across all subjects and learning areas, rather than be a separate subject.

When Curriculum 2005 was developed as the first unified curriculum for all South Africans, it featured environmental learning as one of six themes ('phase organisers') to be used by teachers across all learning areas.

Curriculum 2005 had some problems; it was over-elaborate in some respects and low on content. On the request of the then Minister of Education, Kader Asmal, Curriculum 2005 was reviewed and academically strengthened in 2000. Asmal also ensured that environmental education featured. The working groups for each learning area for GET (General Education and Training) were tasked to include environmental education in the design of the learning area, across the band from Grade R to Grade 9.

This was then picked up when the Further Education and Training (FET) subjects for academic schools (Grades 10-12) were revised. Thus we find opportunities for environmental learning in a number of formats, across the (revised) National Curriculum Statements (NCS). These opportunities are illustrated in Table 1[1].

[1] For further insight, view the National Curriculum Statements on www.education.gov.za. C.A.P.E. has produced a number of publications that explain how educators can work with the curriculum opportunities to strengthen environmental learning. These include Raven (2007), Raven and Rosenberg (2008) and Rosenberg (2009).

Table 1: Opportunities for Environmental Learning in the National Curriculum Statements

Foundation Phase (Grades R-3)
Principles across the curriculum: Healthy Environment, Human Rights
Life Skills Learning Programme (Combining Natural Sciences, Social Sciences, Life Orientation and other subjects) and integrating with Literacy and Numeracy Learning Programmes: The NCS points to learners exploring their local world including nature; links between a healthy environment, healthy me and healthy community; Wise use of resources.
Examples: Steps to ensure hygiene; we need clean water and fresh food. Suggest and explore actions to make the home and school environment healthier. Participate in recycling and explain how it contributes to environmental health. The existence of a large variety of plants and animals with interesting similarities and differences. We depend on plants and animals. The weather. Objects in the sky including planets. Materials have different properties and we can use them to make things.
Intermediate Phase (Grades 4-6) and Senior Phase (Grades 7-9)
Specified environmental learning outcomes and content; cross-curricular principles as above, informing all the learning areas, for example:
Mathematics: Teach math concepts and skills using examples that demonstrate environmental, social and human rights issues.
Languages: Develop confident bilingual speakers who have the critical tools to read their world and the texts spoken and written about it; analyse these texts and rewrite them in ways that expand possibilities for human rights and environmental justice. Example: Read different kinds of stories and factual texts.
Natural Sciences: Three intended learning outcomes address (i) scientific enquiry skills and values; (iii) scientific concepts and content; and (iiii) the links between science, technology, environment and society. Concepts and content include: How plants grow; adaptations; ecosystems; food webs; reproduction; natural selection. Energy sources and environmental impacts. Biodiversity and threats to biodiversity; classification; the cell.
Social Sciences: Intended learning outcomes include social science enquiry skills, knowledge and understanding. Content and concepts include: Links between society and environment; the effects of unequal access to resources and services; sustainable use of resources; positive case studies of sustainable development; mapwork; the climate, landscapes and population of South Africa; climate and vegetation regions of the world; environmental issues like loss of biodiversity, wetland loss, erosion.
Life Orientation: The first of 5 learning outcomes explores the link between environmental, personal and community health. Assessment standards include planning, participating and evaluating projects to address issues affecting community well-being, with knowledge of laws and policies provided to protect human and environmental health and safety.
Arts and Culture: Explore cultural heritage and why to conserve it; express ideas and values about environmental issues through the medium of art.

Further Education and Training (Grades 10-12) Academic Schools[2]
Principles to apply across all subjects: Human rights, social and environmental justice
Geography: Enquiry skills include map work, fieldwork and using Global Information Systems (GIS); Content and concepts related to the atmosphere (including global warming); time perspective within geomorphology; spatial distribution patterns and key human-enviornmentl interactions including inequality, unemployment, refugees; the significance of water masses and water as a critical resource in SA; ecosystems; resource and energy use and management; climate, weather and climate hazards; positive case studies of sustainable development, Agenda 21.
Agricultural Science: Sustainable agriculture. E.g. Interpret legislation for the use of agricultural resources in order to sustain agriculture in a responsible manner; investigate and explain sustainable use of agricultural resources to obtain optimum production in different systems.
Life Sciences: Scientific enquiry skills; construction and application of scientific concepts and content, including management and maintenance of natural resources; human influences on the environment and sustainability; biodiversity in ecosystem function and human survival, threats; extinction; conservation; bio-technology including genetically modified organisms; climate change; ozone depletion.
Physical Sciences: Matter and materials; disposal and pollution problems of various materials and substances; environmental impacts of mining and different forms of energy production; dependence of fossil fuels; ozone depletion; the relative scale of our galaxy and universe.
Life Orientation: Citizenship – identify environmental issues, participate in addressing an issue, evaluate own contribution and services offered by community projects; the principles of the Constitution and participating in a democracy; career opportunities and requirements; requirements for admission to additional and higher education.

The National Curriculum Statements have imperfections, even on paper. But in comparison to Curriculum 2005, the NCS has stronger content and cognitive requirements. Environmental departments and lobby groups are generally satisfied that the opportunities exist to develop an informed, environmentally literate and caring citizenry through the specified learning outcomes and content.
However, taught curricula differ from intended/paper curricula. This is a universal phenomenon, but in South Africa the differences are perhaps particularly pronounced. The reasons are explored in section 4, but include:

- A lack of knowledge of intended content and concepts among teachers and departmental officials with a teacher support role. This follows on the back of decades of poor teacher training in DET colleges, and the inadequacy of more recent training of teaching and departmental staff in the new learning areas and subjects.

[2] For a review of the content of the new curriculum for the National Certificate (Vocational) in FET colleges, see Rosenberg and Burt (2009).

- Policy confusion and overload - many teachers are inadvertently still trying to implement C2005; officials at all levels may have a limited grasp of the NCS or underlying principles, and many of the implementation guidelines produced have added more confusion than clarity, as well as a plethora of associated bureaucratic tasks.

Under these circumstances, it might be prudent to consider that with some exceptions, the National Curriculum Statements have not yet been adequately tried and tested.

The recent decision of the Department of Education to introduce syllabi for some subjects and do away with Economics and Management Sciences, and Technology, as separate Learning Areas in the primary schools, may help to focus attention on foundational learning, reduce overload, and assist with curriculum pacing and progression. However, there is danger than in the process of specifying what should be taught, when and how, and perhaps reducing the curriculum to what teachers tend to know, that environmental content and learning outcomes will be removed. It is vital that environmental education experts join the groups involved in drawing up these syllabi, and help them to interpret and retain relevant environmental aspects of the National Curriculum Statements.

Section 5 considers the extent to which the opportunities for environmental learning in the National Curriculum Statements are currently being used by teachers.

3. Quality Issues – An Overview

Much has been said and written about the performance of the school system since the unification of three separate and unequal departments. A useful summary of the key issues had been prepared for the Office of the President by Taylor, Fleisch and Shindler, 2007), while former Director of the Joint Education Trust, Nick Taylor, also provides some useful overviews in other papers. These and other sources informed the following review of quality issues in South African schools:

Access for all

Despite the impact of HIV and AIDS and poverty generally, the overwhelming majority of children are enrolled in primary schools, and compared to countries with similar levels of development, a high proportion of young people go on to secondary education, and there has been a steady increase in the number of learners who write the Senior Certificate examination. The National Gross Enrolment Ratio stood at 99% in 2007 and 98% in 2008 (DoE, 2009a). Some children still have to travel a long time to reach school, though, not only in rural areas, but also in urban areas where parents send children to ‘better’ schools on public transport. In recent national assessments (DoE, 2009a, b) 30% of Grade 3 learners said it took them up to an hour to reach school.

Significant and increasingly equalised spending

At 5,4% of GDP, South African spending on education is high by comparable standard. Government has also made progress in equalizing government spending within and across provinces.

An inefficient system

However, as Taylor (2007) observes, "*South Africa is not getting value from money from its public school system. Although school is accessible to the majority of children, the skills produced are expensive and their quality low*". In 2000 the Southern and Eastern African Consortium for Monitoring Educational Quality (SACMEQ) tested Grade 6 learners in 14 countries (www.sacmeq.org). South Africa placed ninth, behind several neighbouring countries including Mozambique (Gustafsson, 2005). In the same year, South Africa's Grade 4 learners' scores on life skills put them second last among 12 African countries participating in Unesco-Unicef's Monitoring Learning Achievement Project (DoE, 2000). Mean scores on the Trends in Mathematics and Science Study (TIMSS) placed South African Grade 8 learners at the very bottom of 50 participating countries (Taylor, 2007). Similar trends were evident in the International Reading Literacy Study (PIRLS) which tested children's ability to read in their mother tongue as well as the language of instruction (Van Staden, 2006).

The foundations of learning are not being laid

Benchmark tests show that already at Grade 3, the majority of South African learners are behind their international compatriots. By Grade 6, 72% of all learners failed a national literacy test. In Mathematics the figure was higher, with 88% of all Grade 6'ers failing to achieve the curriculum standard (Taylor et al, 2007). Benchmark tests might have several flaws, but their findings are corroborated by the experience of classroom teachers. Shirley Michaels, a Grade 7 teacher, observed: "*We have a big problem with reading. All of a sudden, things are falling apart*". Given the centrality of reading, writing and arithmetic to all further learning (and functioning in society, as well as employment) "*the poor performance of South Africa's primary schools in providing basic education must constitute one of the country's most urgent problems*" (Taylor et al, 2007, p.2).

Inequality persists

Not all South African learners are behind the rest of the world; some are on par. The distribution of scores on international tests are skewed, as Figure 1, a graph based on the SACMEQ study quoted above, shows:

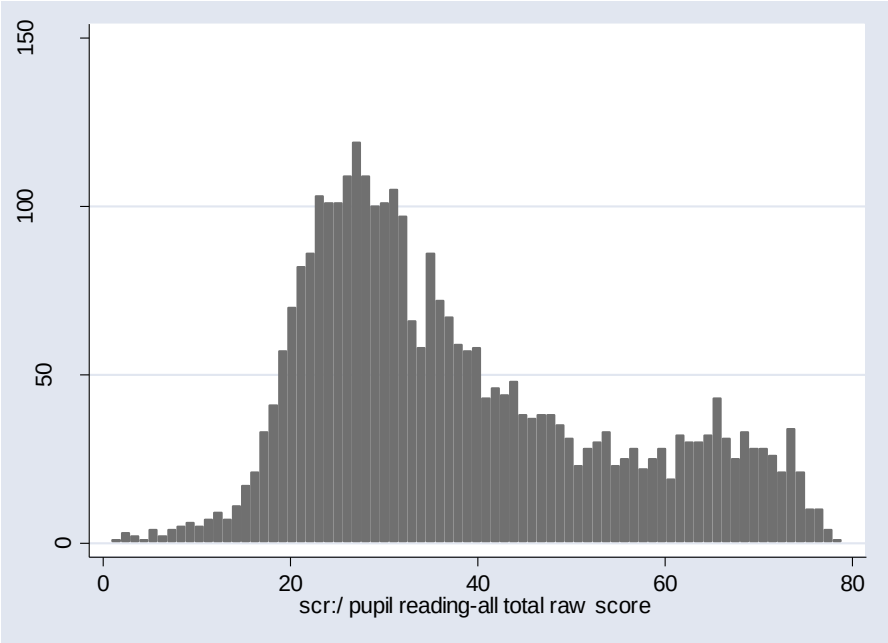

Figure 1: South African Grade 6 learners' reading scores in 2000 SACMEQ study (Gustafsson, 2005)

Despite impassioned efforts to wipe out inequality in the education system, South Africa's inequality is the highest by a large margin among countries participating in cross-country tests. The point is illustrated by results from tests administered in Western Cape schools. Here, if one wanted to find four children who can read at the level prescribed by the Department, one would test five children in a former Model C school, and nine children in a former House of Representatives school. In a former Department of Training (DET) school, one would have to test 100 children, before finding four who can read at the prescribed level (Taylor et al, 2007).

Low output in Mathematics and Sciences

Of the total population of 18 year olds (about 980,000) fewer than 140,000 pass Grade 12 Mathematics, and only 20,000 to 25,000 (2,5%) pass Mathematics at higher grade. In 2008, the number of learners who wrote the Mathematics examination was the highest ever at 298,621. 63,000 learners passed the examination – 45% of the learners who wrote the examination (DoE EMIS data). However, the general quality of the passes was poor. The majority of the passes (165,128) were in a 'less than 30%' category. Only 26,754 learners obtained 40% or more.

The number of learners who pass Physical Science (and Mathematics, which is a prerequisite) is also a fraction of those who write the Senior Certificate examination (Table 2). At the high school in Khayalitsha we visited, only 5-8% of students choose Physical Sciences, because it is perceived as "too difficult" and requires Mathematics. Nationally passes in Physical Sciences were mostly at the lower end of the scale. Only 1,2% of the candidates who wrote Physical Sciences scored 80% and above.

Table 2: Learners passing Mathematics and Physical Science, 2001-2007

Year	Number who passed Matric	No. passed Maths HG	No. passed Maths SG	Total number passed Maths	No. passed Science HG	No. passed Science SG	Total number passed Science
2001	277 206	19,504	72,301	91,805	24,280	45,314	69,594
2002	305,774	20,528	101,289	121,817	24,888	70,763	95,651
20003	322,492	23,412	104,707	128,119	26,067	75,693	101,760
2004	330,717	24,143	109,664	133,807	26,975	73,943	100,918
2005	347,184	26,383	112,279	138,662	29,965	73,667	103,632
2006	351,217	25,217	110,452	135,669	29,781	81,151	110,932
2007	368,217	25,415	123,813	123,813	28,122	87,485	115,607

Although between 2000 and 2005 there was a 3% increase in the proportion of learners passing with a university endorsement, the percentage of learners with pass rates in Mathematics HG and Physical Sciences remained more or less the same (Crouch and Vinjevold, 2006).

On the positive side, more students take Biology/Life Sciences, and matric performances are also better (Table 3). Learners taking Life Sciences in 2008 outnumber those taking most other matric subjects (Table 4); the reason for this is the way in which subject choices are structured; most 'packages' include Life Sciences. At the Khayalitsha school in our sample, 80% of the students take Life Sciences, and the teacher believes this is not necessarily due to an interest in the subject.

Table 3: Numbers of learners passing Biology/Life Sciences, 2006-2008

Year	Biology HG	Biology SG	Life Sciences
2006	120 259 (69.3%)	228 878 (67.4%)	-
2007	121 135 (72.0%)	249 487 (65.4%)	
2008	-	-	297 417 (70.5%)

Table 4 shows the 2008 results for other subjects, including Geography. Teachers report a decrease in interest in taking Geography.

Table 4: Learners passing other Senior Certificate subjects in 2008

Subject	Wrote	Achieved 30%	Achieved 40%	Did not Achieve
English First Additional Language	464 179	438 822	327 335	24 998
Life Sciences	297 417	209 707	117 787	87 583
Geography	213 369	171 338	87 308	41 864
Accounting	176 078	108 099	55 164	67 848
History	93 666	64 355	35 290	29 263
Business Studies	204 7994.	151 777	87 553	53 002
Economics	218 156	119 823	62 530	98 060

Matric results and throughput

Matric results are a limited measure of the quality of schooling. But an inability to pass matric (Grade 12) does indicate some level of failure in mastering the learning outcomes which had been specified for the country's children. In 2007, 35% of learners who attempted the General Certificate in Education, were failed. This excludes those who had already decided to leave school on the way to matric. Whereas there is over-enrolment (relative to the number of children of the appropriate age in the population) in Grades 1, 3, 4 and 10, numbers generally drop through the grades and by the time one reaches Grades 11 and 12, there is under-enrolment. In 2007, more than 1 million teenagers were of an appropriate age to be in Grade 12. Of these, only 625,809 were in fact in Grade 12 in general schools. Others would have been in FET (Further Education and Training or technical) institutions, but many others had left school entirely and would be either looking for a job, or 'watching TV'. They would be joined by many who do obtain a matric certificate; around half of all young people who spend some time in secondary school or equivalent, fail to find employment (Taylor et al, 2007).

The quality of skills observed in the workplace

Human resource development for environmental management, research and sustainable development does not require everyone to go to university or to pass Mathematics in matric. But most employment opportunities in the environmental sector require some general, basic skills. Among the school leavers who do find a job with a matric certificate, many have difficulties with generic skills in the workplace. This is the verdict from environmental agencies such as Capfish c.c., where it is reported that 90% of the matriculants the organisation trains as sea fisheries monitors, lack numeracy, writing and communication skills at the expected level.

Poor results in Higher Education

Under-graduate enrolment at South African higher education institutions is growing by 5% per annum, and the ratio of Black students had increased to 63%. However, half of all students admitted to primary universities and universities of technology drop out without receiving a tertiary qualification, and two thirds take more than five years to obtain their first degree. The throughput rate in minimal time in Engineering is around 35% at the best institutions and between 5-10% at the others. The comparable throughput rates in East African, Indian and United States institutions are 80-90%.

The quality of schooling seems to have a direct influence. In 2009 the Wits University School of Mathematics reported that the pass rate among first year students in Engineering on mid-year tests had dropped from 71% to 35%; this was ascribed to a third matric Mathematics paper being made voluntary rather than compulsory in 2008.

University staff also observed that concepts that were necessary for university Mathematics were not being taught in school, and that concepts which had been

taught were “shallow” (*The Star*, June 26 2009). This resonates with the observation of a high school Geography teacher at an independent high school in Cape Town; by the time students arrive in her Grade 10 class, they “knew little about a lot”, and their conceptual development was more superficial than what had been the case in previous years, before the introduction of the new curriculum.

4. Causes of Low Quality

Is it OBE?

Analyses of the causes of poor learner achievement show that multiple factors are involved. Perhaps because of the manner in which ‘OBE’ was interpreted and communicated, the media, parents, many teachers and even academic who might be expected to take a more considered approach, tend to focus almost exclusively on the role of the curriculum and/or OBE framework. It would be unfortunate however, if another curriculum review process left other fundamental issues unattended.

But what is the role of OBE?

The introduction of outcomes-based education has indeed been problematic. It has left many teachers resource-less and often clueless as to what to teach. However, it was also underpinned by some sound principles and intentions, including the intention to achieve meaningful learning outcomes by moving away from mindless rote learning (‘content regurgitation’); the importance of the relevance of the content to learners’ lives, and the value of active learning and a greater variety of interactive teaching styles. Unfortunately, in the advocacy campaigns and subsequent teacher workshops, these principles were presented in an ‘out with the old and in with the new’ fashion, and taken up in a crude manner. The results were an unnecessary shift away from solidly taught lessons, text books, and the vital importance of teacher knowledge. This manifested in the classroom as disjointed learner activities (group discussions, poster making and picture pasting) during which little or no coherent new knowledge is shared. Misconceptions abound and progression from grade to grade became a problem. At the same time elaborate curriculum management - and assessment frameworks (including learner portfolios) were introduced. These proved unworkable, and there were soon calls for action.

Under the direction of Dr Linda Chisholm the ‘empty’ and at the same time overfull version of Curriculum 2005 was replaced with the National Curriculum Statements. The learning areas and subjects which were crafted were still informed by the principles of outcomes based education, but there was more emphasis on the content and concepts, and these were specified for all learning areas, particularly the sciences. The aim was to provide learners with opportunities to achieve meaningful learning outcomes through a combination of conceptual and contextual explorations and application.

During roll out, however, the implementation of the NCS has been characterised by a number of problems. Some of these are related to remaining problems with individual learning areas and subjects, cross-curricular issues such as progression; an overload in some phases and subjects; and inadequate guidance on how to build the building blocks for reading, writing and mathematics. Following a report on the implementation of the National Curriculum Statements (DoE, 2009c) the Department of Education recently decided to reduce the number of learning areas for the primary schools (by incorporating elements of Technology and Economics and Management Sciences in other learning areas) and introducing syllabi which will specify exactly what is to be taught in what grade, and how. This *may* help to focus attention on foundational learning, reduce overload, and assist with curriculum pacing and progression. However, there is also a significant danger than in the process to streamline and specify, that environmental content and learning outcomes will be removed. It is therefore vital that environmental education expertise join the groups involved in drawing up these syllabi, and help them to interpret and retain relevant environmental aspects of the National Curriculum Statements.

However, continuous adjustments to the formal curriculum can detract attention from the large number of quality issues which are not specifically attributable to the National Curriculum Statements themselves, and which would remain to derail the implementation of any curriculum, should they not be effectively attended to.

Inadequate attention to human resources

Numerous studies have identified the quality of teachers' training as a key variable explaining South African children's poor results (see e.g. Carnoy, Chisholm and Baloyi, 2008; Gustafsson, 2005). In his analysis of the 2000 SACMEQ results, Gustafsson reports that 28% of the teachers who were associated with below average learner scores, had not received any in-service training during the preceding years. Exposure to training is no guarantee of learning, either. Only 20% of the teachers in the SACMEQ study described the training that they had received as "very effective".

The development of policy, policy guidelines and procedures have taken precedence over effective attention to the human resource base. When Prof Asmal led the 'rationalisation' of teachers' jobs in the late 1990s, there was no discernable effort to retain the most suitable teachers (better qualified, better aptitude, high standards of excellence) in the system. This, despite the mammoth task awaiting those teachers who remained behind when others took severance packages: With the aide of a few short workshops and a set of policy guidelines, to undo the legacy of decades of Apartheid Education.

The national capacity assessments (DoE, 2009) indicated that 68% of teachers had attended in-service training programmes, but that 62% did not feel confident to implement outcomes-based education. A Foundation Phase teacher we interviewed in the Eastern Cape admitted that she was "not good in Maths" and that she therefore did not focus on numeracy in her classes. It is important to bear in mind that between

80-90% of teachers currently in classrooms, received their basic training during the Apartheid era. Reports on the quality of new teachers entering the system are also not positive (see below).

Departmental officials have a role to provide teacher support (although there are indications that these roles are unclear and vary among the provinces). However, in perhaps a majority of cases, subject advisors have also had limited training. During the Eco-Schools evaluation (Rosenberg, 2008), during which principals reported that curriculum workshops run as part of Eco-Schools were in some instances superior to those offered by the provincial department. The Eco-Schools programme, while informed by the Environmental Education and Sustainability Unit at Rhodes and training centres like Delta Education Centre, is by and large staffed by individuals with no formal training in the new curriculum.

Contrast this with the approach in those education systems which do excel. Comparative studies have found that countries with the best schooling results in the world, such as Finland, invest heavily in their teachers. The best students in school are encouraged to study further in education; among the education students, in turn, the strongest candidates are asked to specialise in primary school education.

It is important to note that there is a diversity of teachers in the South African system, including many who are very committed to education, and many who are very competent. On the Eco-Schools programme we met teachers who ably work with the National Curriculum Statements and improve learner' outcomes over the course of a year. But these teachers seemed to be exceptions. Many teachers and subject advisors lack subject knowledge, and routinely fail the tests for which they have to prepare learners. Many also report that they have a limited grasp of the environmental content and concepts in the curriculum.

Efforts to train teachers are being made, so much so that the departure of teachers to attend workshops puts pressures on those remaining behind to take up the teaching load. On average, South African Mathematics and Science teachers engage in in-service activities at a higher rate than the international average (Reddy, 2006). However, training is, as noted above, often ineffective. A number of reasons are being put forward; training is too superficial, too general, too short, or poorly conceptualised, often with a weak interpretation of outcomes-based education guiding the design. In one experience of national 'training of trainers' for departmental officials, we found that training was poorly conceptualised by the departmental clients and the contracted consultants, consisting mostly of a variety of activities without a clear purpose within a coherent framework. Perhaps it is not possible to compensate for poor or inadequate pre-service training, through short term sessions that are not designed for that role.

Primary school teachers interviewed for this study find training that has clear practical application and guidelines of what to teach learners at what stage of learners' development, most useful. These teachers did however have a sound pre-service educational foundation. They observed that teacher preparation at university was/had

become too theoretical and that practical-conceptual pedagogical knowledge was being lost in the system. Where there was some level of capacity among the teaching corps, workshops were often most useful because they brought teachers together who were in similar situations and could learn from each other.

The teacher hearings and submissions that informed the 2009 report to the new Minister of Education, Ms Angie Motshekga, were unanimous in suggesting that current teacher development policies to support the curriculum were too generic and superficial and did not provide the necessary support. The report recommends subject specific teacher training, and training for support staff such as school management, subject advisors and district staff, on the curriculum and assessment policy.

At the same time, staff training cannot be seen as a panacea for all ills in the system, particularly not if it were to be conceptualised only as imparting subject or policy knowledge. In addition to understanding the purpose and intended learning outcomes, concepts and content of the subjects they would then be qualified to teach, teachers also need pedagogic knowledge. We observed that some teachers have a very limited range of teaching strategies on which to draw. A teacher we interviewed grouped stronger and weaker students together to develop Maths skills, but resorted to punishment as a means of motivating them: she asked the weakest member of the group for the answer to a Maths question and if the answer was incorrect, the group would have to sweep the classroom! Studies show that teachers' ability to *pace* their teaching with their students can improve results. This of course becomes more challenging if the class is very large, with learners at greatly varying levels, if the teacher has numerous tasks in addition to teaching, and if basic resources (such as books) are lacking, it must be well nigh impossible.

Intermediate Phase teachers from a working class area in the Western Cape, subject to ongoing social violence, suggested that there was too much emphasis on training and not enough on structural and social problems affecting their ability to teach. In their experience, workshops run by the department mostly served the purpose of giving them an opportunity to explain the conditions of teaching to their officials, who seemed nonetheless powerless to address them.

Ineffective bureaucracy

Taylor et al (2007) note that the implementation of policy with respect to school is heavily dependent on the effectiveness of provincial departments of education. They note that there is considerable variation across and within provinces in this regard, but also that "*it is fair to say that most parts of the system exhibit low levels of functionality, while significant parts are dysfunctional*". The then Minister of Education, Naledi Pandor, admitted in 2007 that the full Treasury allocation for the QIDS UP programme (aimed at the poorest schools) had not been used for this purpose in the provinces. Similarly, poor procurement and distribution of books and desks to schools – rather than national budget constraints - leave many schools undersupplied with basic education resources.

Is it a matter of race?

Case Story: Siyabulela Xuza
grew up in one of the poorest provinces in the country. Even as a young boy he had a fascination for planes and rockets. When his academic talents were recognised, he was awarded a scholarship and in Grade 8 he left his home town of Umtata to attend St John's College in Johannesburg. He attended one of the President's Award programmes for the youth, and built a rocket which broke the SA Amateur Altitude Record. He was invited to International Youth Fair in Sweden and then entered the International Science and Engineering Fair in the USA. Among 1,500 students from 52 countries Siyabulela won First Prize in the Energy and Transport section. He now studies Chemical Engineering at Harvard University, takes classes in Mandarin at night … and hopes to start a 'green energy' company in South Africa one day.
(Adapted from Meiring, 2009)

The case story raises a number of questions. Would this gifted individual have reached the same heights if he completed his schooling in one of the 'average' schools in Umtata? What exactly does the resources of a St John's College buy, that government funds have been unable to provide other children in the country? How many similarly talented youngsters travel unsupported through the system, never to shine as brightly?

The story also illustrates a point that should be unnecessary to make, and that is that race is not the deciding variable that explains why some children succeed in school, while others do poorly. Refer back to Figure 1, which plots Grade 6 learners' reading scores. The author of this graph, Martin Gustafsson (2005), explains that 14% of the learners who scored satisfactorily on the reading tests (the small peak between 60 and 80 on the graph) would have been African, Indian or Coloured, given that only 6% of the overall population of Grade 6 students in 2000 were White. The great majority of children in the low-scoring peak around 30, would be African. This indicates that the persistent inequalities in the system are linked to other factors – variables which tend to co-exist with a classification as Black. Some of these factors are noted next.

The role of language

If one has to learn to read, write and grasp new concepts and at the same time learn the language of instruction, one would understandably be greatly challenged. The matter is much worse if one's teachers are not proficient in that language either, and if the adults at home are unable to help with homework if they don't speak the language. Many South African children are being taught in a language they seldom hear at home, by teachers who do not know that language well either. For example, children who grow up speaking Xhosa might first encounter English on their first day at school, where they might be taught by teachers who have no Xhosa themselves, and whose own first language might be Afrikaans. Although there is a policy to encourage the home language to be the medium of instruction during the first years of schooling, and 76% of Foundation Phase learners are taught in their home language, one quarter are

not. There is a reported shortage of African language teachers in the Foundation Phase, and parents who have a choice tend to send their children to schools where the medium of instruction is English. The Foundation Phase we interviewed in the Eastern Cape, a Xhosa speaker, noted that teaching in English makes it harder for the learners; “if taught in Xhosa it is easier for them to learn to count”.

In 2003, 61% of South African children could not read at the expected level for their age. Teachers interviewed for this study believe that low reading skills have a knock-on effect on the development of mathematics (understanding written questions, story sums) and other curriculum areas, right up to high school.

The PIRLS study results (Van Staden, 2006) suggest that children also struggle to read and write even in their home language, and teachers interviewed noted that African language literacy is being lost. It is reported that teachers are seldom taught explicitly how to teach reading and writing skills; this may be associated with the introduction of outcomes-based education, but it may also be a historical factor associated with Bantu Education. Furthermore, the standard of the English Second Language subject is said to be low, so those who start with a disadvantage because English is not their first language, will struggle to catch up. Analysts warn that teachers’ proficiency in teaching Reading and Writing in the language of instruction is vitally important (Taylor and Prinsloo, 2005).

Resources and School Management

Poverty affects learning in multiple ways. Firstly, it affects the resources at the school, of which the number of teachers is perhaps the most significant. Although the Department of Education spends more on poorer schools, its expenditure is either inadequate or poorly administered (as when departmental administrations fail to pay schools’ water or electricity bills, or to distribute books which had already been bought). Schools with a parent body who can afford higher school fees, or access to other sources of external funding, can appoint additional staff to keep class sizes smaller and provide administrative and remedial support.

Differences in resources between schools remain a highly poltical matter and government deliberations on how to improve education almost invariably turn to the modernisation project: building classrooms so that children would no longer have to learn under trees or in huts. However, better resources does not always translate into better teaching and learning and with some exceptions, investments in infrastructure may be the least important priority, if research findings into quality issues are considered. Quality learning can take place in a hut if that hut is well equipped with basic teaching resources and a skilled, knowledgeable teacher; conversely, if a spacious classroom lacks discipline, an educational focus, books and a capable teacher, then the investment will not yield results.

Research has confirmed a significant variable distinguishing between poorly resourced schools whose learners perform better and those whose learners who

perform poorly, to be the quality of management at the school. Management which results in teachers and learners being on time, on task and following a planned curriculum, yields better results, *regardless of the school's physical resource base*. In his analysis of the 2000 SACMEQ results Gustaffsen (2005) found the school's time management to be a significant variable associated with poor learner performance – a variable that did not feature in other countries in the SACMEQ study. Many South African teachers do not actually teach when they should be doing so. Poorly performing schools are characterised by a lack of discipline and strife among the staff, low motivation and morale, poor management and poor leadership from the principal. In schools classified as Type 1 (dysfunctional) only radical interventions in staffing and management will improve quality of teaching and learning. Punitive measures to keep teachers on task are unlikely to improve morale and may achieve little more than adding to the burden of the committed teachers.

Poverty and Epistemological Access

Poverty also affects learning through its effects at home. One consideration often noted by teachers is poor nutrition. In 2003, when South Africa's poor schooling results made headlines, the Department of Education conducted a Systemic Evaluation and found that more than 25% of Grade 3 learners only have one meal a day. A poor breakfast and a long journey means that many learners arrive at school too tired to learn; teachers resort to 'brain gym' or some rousing songs before teaching can start. Adequate protein content and micro-nutrients are essential for keeping children mentally alert and settled enough to engage in challenging work. Government invests in feeding schemes; Gustafsson calculates that these can make an improvement in learner performance. However, his and other studies suggest that investments need to take place at multiple levels in the system.

Poverty does not always translate into misery at home, but it is often associated with social issues such as alcoholism, various forms of violence, single parent families, absent parents and poor role models. All of these influence the situation in the classroom in schools where feeder communities are impoverished. In some communities there is, despite social ills and poverty, some sense of community and of the school as a 'haven' or resource centre in the midst of hardship. Here ex-learners would, for example, return to their primary school to run a computer lab and "encourage better morals", or a parent would run a soup kitchen or beading project at the school. But a teacher reports that "even the parents are at a loss" about how to do deal with problems like drug abuse and violence in their midst.

Another effect of poverty in the home environment is limited access to learning resources and support. When the introduction to OBE was accompanied by calls to replace textbooks with a variety of contextually relevant resources, the outcome has unfortunately been in many schools to expect children to look for resources outside the classroom and in the absence of libraries and resource centres, this has meant the home. The Department of Education's National Systemic Evaluation (DoE, 2003) showed that access to TV and radio was relatively high, but 53% of Grade 3 student's

parents have fewer than 10 books. Perhaps more importantly, many children have, for a variety of historical and contemporary reasons, no literate adults and role models for learning at home. The education level of more than 25% of responding parents was lower than Grade 7. Such factors have a knock-on effect on the school: Teachers we interviewed said "*We have to make up for the parents*".

A third, related effect of impoverished home circumstances links to what the late Prof Wally Morrow (see Sisitka, 2009) has called epistemological access: children's ability to 'get into' academic knowledge. The inter-generational effects of poverty, which cause working class children to enter school without the same capital of concepts that generally make middle class children 'ready to learn', have been well described in the literature (for example, in the UK and USA, Apple and Giroux). Where there are few books, few reading adults, few opportunities for gross motor play outside, children are unlikely to 'get ready to learn' and when they enter Grade R or Grade 1 at the age of 6 or 7, the conceptual foundations which might be *assumed to be in place*, are not.

Prof Heila Lotz-Sisitka (2009) has noted that the application of outcomes-based education is leaving many children without epistemological access, through unrealistic tasks and assumptions of access to resources at home, as well as 'under-teaching' which fail to provide children with new knowledge. Our review also indicated that early learning educators and Foundation Phase teachers are not guided on how to prepare young learners with the building blocks for reading, writing and arithmetic.

Teachers we interviewed, all the way up the system, lamented that the absence of 'the basics' was a huge factor in the difficulties they experience in teaching the academic content of subjects; children could not read, or do the basic calculations, for other learning to proceed. While their listening comprehension was reasonable, their reading comprehension was very low (DoE). Writing full sentences was a challenge for many.

Teachers also noted that colleagues lower down in the system would simply pass learners because the paper work involved in motivating for a learner to be held back, was onerous. Studies also show that holding children back was not necessarily effective; in the absence of alternative strategies or additional help to teach them, they simply ended up disrupting the classroom.

Thus teachers were teaching the content from lower grades, in the higher grades, to 'catch up'. They report that 'because we have to keep going back to basics, we get nowhere'. Many Foundation Phase teachers, in turn, referred us back to the socio-economic circumstances in their feeder communities, noting that to deal with the ramifications of poverty, much additional support in the form of learning support teachers, 'remedial' teachers or occupational therapists were required to provide basic academic support and set children on a path to learning. Teachers report that where additional 'remedial' or learning support teachers were available, particularly at the early grades, it was possible to make a difference, but there were too few of them. They were being shared between schools, and only up to Grade 5, in the Western

Cape; in the Eastern Cape there were none, and volunteers in the community, or university students, come to help teach reading, for example.

Other teachers would not accept poverty at home as the cause for poor literacy development, noting that the schools where learners received their Foundation Phase education, made a significant difference: 'The difference in their ability to read depends on the school which they come from'. It seems that those countries who invest heavily in their foundational teachers, had done their homework! Teachers interviewed for our study recommended that sound teacher training would yield results (better literacy levels) in 4-5 years' time, but that smaller class sizes would have an immediate impact for the better.

Interestingly, children's ability to develop good literacy and numeracy concepts were a cause of concern in schools across the socio-economic spectrum including some of the independent schools we accidentally included in our sample. In the view of the latter teachers, even children growing up in well-resourced homes are starting to experience problems with the basics. A range of factors were blamed, from TV to Grade R being taught as 'a watered-down version of Grade 1', rather than being a specialised preparatory year.

5. Coverage of Environmental Content

There was some form of environmental activity in all the schools where we conducted interviews, which may have been the result of our sampling strategy. Most schools had some practical environmental projects and some efforts, of varying extent, of supporting environmental learning through the curriculum. The one school where there was no evidence of environmental education, was not an Eco-School.

Our studied shows that teachers with enough exposure, interest, knowledge and assistance manage curriculum-related environmental education very well; this tends to happen particularly in the Intermediate Phase of schooling. Because support is not systemic, however (i.e. not imbedded in the formal system of teacher training and professional development, as well as departmental guidance) the work teachers do tend to be shaped quite significantly by what the environmental partners offer. Teachers whose exposure to and knowledge of environmental education has been limited, do nothing, and ignore the environmental learning outcomes in the National Curriculum Statements. This is not unique to environmental learning outcomes; it may also happen to Mathematics in Foundation Phase, or Science in the Senior Phase.

Schools across the socio-economic spectrum tend to take different approaches to environmental education. Some put more emphasis on human impacts and the need to reduce our footprint (former Model C schools); others more emphasis on appreciating nature (former House of Representatives schools) or more emphasis on improving in livelihoods and cleanliness (former DET schools). In some schools there is some attention to the knowledge content of environmental education, but in the

DET schools in our sample there was a greater emphasis on do's and don'ts and less emphasis on knowledge, even at high school level. There is generally more attention to environmental activities, special days and school improvements (e.g. in the Eco-Schools programme) than on (associated) classroom learning and curriculum content. High school Life Sciences (formerly Biology) and Geography were to some extent exceptions, as the environmental content in the curriculum is explicit.

The more resourced schools tended to focus on activities to reduce their footprint (e.g. recycling) while the less resourced schools were most successful with activities that address livelihoods, such as food gardens and health. At the townships schools there were also an emphasis on cleanliness and reducing litter. Here the focus was often localised, and teachers' view was that learners could not consider more global-scale or indirect environmental issues (such as climate change) given that the issues in their local environments are so dire. In one of the independent schools (which we accidentally included in our sample) the Geography teacher puts considerable emphasis on environmental education in her subject, through project work. She reports that students have started to 'switch off' when she introduces topics; that they enjoy Physical Geography, but that they get 'bored' with the socio-economic and development issues address in Social Geography. This may relate the teenagers not wanting to be weighed down by the weight of guilt that comes with learning that they are more privileged than others, and have a greater ecological footprint.

Teachers interviewed have had no support for or training in environmental education from the Department of Education, but all those who were particularly active in environmental education, have had some training from NGOs, environmental agencies like SANBI or universities, or have come across an institution involved in environmental education which had impressed them. Training definitely seems to increase interest, and can spark interest in environmental matters where there had been none before (in two of the teachers we interviewed).

"I did an ACE [Advanced Certificate in Education] at Rhodes. I didn't know anything about EE before so it introduced it to me and won my interest". "I developed an environmental interest through teaching Grade 5 Science in Pietermaritzburg. Once a week they would go to the local nature reserve. They were so clued up".

Hands-on interactions and learning seem to leave lasting impressions, as does practical actions and resources to improve environmental issues, as in the case of the City of Cape Town, mentioned by one township school. The schools all rely on outside agencies for environmental education resources; in Cape Town where numerous NGOs, education centres and the local government are active in environmental education, this happens through networking including the Eco-Schools programme. Some teachers seem to be better networkers than others. In the Eastern Cape schools we interviewed, environmental education resources are accessed exclusively through the Eco-Schools programme and the partner they accessed through it, Rhodes University. They find the educational resources good, practical and relevant.

They highly value access to a photocopier. Better resourced teachers also buy resources, e.g. from CNA.

Foundation Phase

"Science is not happening in the Foundation Phase" (Curriculum advisor for Life Sciences, Western Cape)

The Eastern Cape department gives support for Literacy and Numeracy, but not for the environmental content of the Foundation Phase. In general the focus in the Foundation Phase is on Literacy and Numeracy and not on Life Skills; and teachers associated environmental education with Life Skills only, although they do make attempts to integrate. Examples of a Literacy activity integrated with Life Skills: Draw your favourite animal and present; Draw fish and sea and label. Teachers 'look for moments to strengthen environmental learning' within Life Skills. The Life Orientation subject advisor in the Eastern Cape estimated that 15 days in the year are spent on environmental learning – these being the estimated number of Life Skills in the year. She regards all Life Skills learning outcomes as environmental learning.

It is not easy to assess what exactly is happening in classrooms with regards to environmental education, without actual observations and review of learner work, which we were not able to do in this study. However, from the interviews (and Eco-School portfolios reviewed over a number of years) it would seem that the teachers in the former model C schools give a greater focus to knowledge in their environmental education, while the former DET schools there is less emphasis on knowledge, and more on 'what we should and shouldn't do'.

Intermediate Phase

Science can be a challenge in the Intermediate Phase, because the teacher teaches all the learning areas, and therefore needs a background in all aspects of the physical and natural sciences as well as history and the social sciences. Yet, of the teachers interviewed, the three Intermediate Phase teachers seemed to have best grasped the concept of working with environmental themes in the curriculum. None of them had any formal training in environmental education but they had all been involved in the Eco-Schools programme and had attended workshops. They did however call for more workshops that shows one how to 'put environmental learning into the curriculum successfully' – noting that they feel as if they 'hit and miss at the moment'.

All teachers we interviewed had good basic knowledge of environmental concepts and issues and perhaps as a result, they were able to address environmental learning across all learning areas; they also seemed to have a good pedagogical competence and were resourceful, using opportunities such as a snake found in the classroom, a new food kitchen, their Eco-Schools garden … or various local and human resources, for teaching. Our interviewer noted: 'It seemed to come naturally to them'.

In the Eastern Cape, the teacher described how she used a visit to a local nature reserve for developing reading and writing skills – through thank you letters, and stories about the animals observed.

The 'whole school' approach to school and curriculum management which is promoted by Eco-Schools and other environmental education programmes, is most likely to succeed in the Intermediate Phase. With a supportive principal and motivated, tireless teachers, integration across projects and lesson planning works on occasion in several working class schools on the Cape Flats. At some of these schools, there is 'continuity throughout the school' which means that the whole school can be involved in certain projects and activities; teachers support each other in developing lesson plans around themes, and they take each other's classes when one teacher is particularly knowledgeable on a particular topic. Progression is attended to, so that children in different grades do different things to learn different skills, associated with the same school-wide project.

Careful management is however essential. In one example, the school conducts a whole school evaluation to see how the whole school approach pans out; the principal and head of departments each take three themes each and assess them according the assessment criteria provided by the department. The teachers are divided in groups according to different themes, and then plan lesson plans. It is noticeable that teachers have re-introduced theme-based teaching, which the National Department had vehemently opposed at one point, and which was also evident in Curriculum 2005, in the 'phase organisers'.

Senior Phase

At this level there may be more of a specialisation and more science background among teachers, but note the point about teacher qualifications below. One Senior Phase teacher had no training in teaching science, as it was not offered when she qualified, at the start of the decade.

Two schools we visited showed the spectrum of environmental education in South African schools, based on vastly different ways of implementing the National Curriculum Statements. At school for unemployed and working class families in Cape Town, the teacher estimated the environmental content of the curriculum she teaches as follows:

- Natural Sciences 100%
- Arts and Culture 70-90%
- Mathematics 50-70%

At a comparable school in the Eastern Cape, the Senior Phase teacher's awareness of environmental education was much more limited and she estimated:

- Natural Sciences 40% (fossil fuels and where they come from, ‘things about nature’)
- Mathematics 40% (exposure through workshops on the weather by SAIAB).

In the Senior Phase, so important for learners to make study choices, some schools reported very little involvement from environmental partners to help with career and study guidance. Students have to do a job shadow and one teacher reported that it was very difficult to find environmental partners who can facilitate this. She reports that most students (in this independent school) think of environmental careers as eco-tourism (in which they are not particularly interested) and do not, for example, equate engineering with an environmental career. She also thought the MTN Science Expo and ‘enrichment weeks’ would be ideal opportunities for environmental partners to engage with schools and senior phase teachers.

Grades 10-12

Significant here is that many teachers lack the necessary Mathematics and Science content background. Between 80% and 90% of teachers currently in schools, have been trained before 1994. In the Apartheid period, Black student teachers were apparently not allowed to specialise in Mathematics and Physics. The legacy of this situation is undoubtedly casting a long shadow. Good Mathematics and Science teachers are drawn to the better schools. The future is also not secure; it is difficult to attract people with a good science background into teaching, as they have so many other career options, and teaching in South Africa has a poor reputation at the moment. As a result, a curriculum advisor for science reports that in some schools, ‘the subject is dying’; it is easier for students to choose business studies. However, where there are passionate, informed teachers, the numbers of students in the sciences stay the same. The content knowledge of the teachers, and their practical ability to teach effectively in anything other than a transmission mode, is a key concern for this official.

Teachers in former DET schools report that they struggle to get environmental concepts across because of their students’ low literacy and numeracy levels. In a school in Khayalitsha a reading test was done with Grade 8 students. Most of them performed at a Grade 4 level. Low literacy also affects Mathematics – students do not interpret questions correctly. At this school 5% of students choose Mathematics; the rest take Mathematical Literacy. Master Maths is made available free of charge and students enjoy the visual aspects of it. Both low literacy and low numeracy skills affect the teaching of Science: They are not at the level where they should be; we have to keep going back to basics so we get nowhere”. For example, students do not follow interpretive questions in Life Science.

Two teachers report that Geography is losing popularity among learners because most of the ‘natural’ aspects have moved to Life Sciences, leaving mainly the ‘social’ aspects in Geography (becoming ‘boring’). There is now a strong emphasis on development in Geography. Students at an independent school do not like this

component; it seems “overdone, like HIV”. How does one encourage students, rather than put them off with feelings of guilt? “They are tired of hearing about hungry children and fights over water. Children of 16 don’t want to worry about saving the planet, they want to worry about who they take to the matric dance”. Dr Jim Taylor makes the point that those with an environmental concern tend to feel better once they have passed this on to children; perhaps adults are overdoing this?

Other curriculum changes have led to learning difficulties, e.g. Climatology was taken out of Grade 11 and now there is such a gap between Grade 10 and Grade 12 that the matrics struggle with the abstract concepts. Generally, learners seem to know a little about a lot; concept development is more superficial. In other cases, however, there is overlap between subjects and this frustrates students. (!)

Another significant observation is how high school teachers with a good grasp of and strong interest in environmental issues struggle to teach about environmental matters in positive ways. For example, one teacher teaches about environmental impact assessments but wonders how to do this “realistically” as “we know they are not going to be adhered to anyway”. The focus on the global, and on seeking solutions to problems, seems to create significant challenges for Geography teachers. There is an information overload, which students tend to compartmentalise, in not too much depth, and they ‘get frustrated when they have to come up with solutions for environmental issues, when not even world leaders can do this’. Positive hand-prints, ‘what we can do’ stories and case studies of sustainable development will make valuable teaching resources in this context.

Teachers also report that their colleagues at school have a limited grasp of the scope of environmental education in the curriculum: “Most teachers think environment is about pollution and littering”. At high school level, attempts to plan across the curriculum for environmental education are met with some but often limited success. Many teachers consider environmental education to be the reserve of the sciences. The full curriculum also mitigates against an enquiry approach. Some teachers ‘sidestep’ their responsibility for environmental education by leaving it with the students as project work, ‘so that they don’t have to teach it’. Many teachers, in other studies, report that they are not confident about the environmental content of the curriculum. School management does not seem to take a hand in curriculum planning, but at more than one school the principal had great pride in showing environmental projects (such as gardens) at their school to the visiting researcher.

General

Teachers’ own environmental interest and values remain one of the most important factors in determining whether they attend to the environmental content in the curriculum or not. The good news is that exposure to well organised and well resourced partners and courses can ‘turn on’ a teacher who previously had little interest in or knowledge of environmental education, and often do. Inspiring courses, workshops and individuals, all played a role. Also noticeable is that teachers with an

environmental interest are often more active and dynamic than colleagues; they form partnerships, mobilise resources where none seemed to be available, and 'get things done'. They are often incredibly motivated and hard-working and deserve far greater recognition within the system itself.

All teachers talk about 'including it [environmental education] in the curriculum" – treating it as a matter of choice, as to whether it is taught or not. It is often described as 'extra work'. A departmental official who was involved in drawing up the Natural Sciences and Life Sciences curriculum statements describe environmental education as 'already included' – it is integrated, so you won't see it if you don't know what to look for'.

The teachers in our sample do not feel well supported in environmental education by senior officials in the department, some of whom have not been educators, and many of whom have no environmental knowledge. "The director of environmental affairs came to the school and killed a snake". There is a sense that senior officials are sometimes appointed for political reasons rather than on merit. Among subject advisors, too, the level of support provided for environmental education seems to depend on the interest of the individual: One curriculum advisor indicated "I don't like environmental education" and that was that. There does not seem to a commitment to the environmental content of the curriculum. Some advisors are however good at other aspects of the job (e.g. introducing and interpreting departmental requirements), and as with teachers, there are different levels of competence and commitment among them.

There are no environmental education resources from the education departments. Yet all teachers, in both provinces, indicated that they had enough resource materials and that this could not be an excuse for not doing environmental education. Partners provide a myriad of resources, but these are often not useful (with some exceptions; see e.g. Two Oceans Aquarium, above). This is when they have too much information, 'too busy', 'too dense', or too complex for students to use. From the Western Cape Education Department, a Maths, Science and Technology kit was found to be very useful. Text books from the Department are 'not specifically environmental, but can be adapted' by knowledgeable teachers.

Much of the environmental activity and associated learner work happens outside the classroom, e.g. in environmental clubs.

In response to the Department of Education's call for comments about the implementation of the National Curriculum Statement, Lotz-Sisitka, Rosenberg, Nsubuga and Schudel (2009) made a number of observations which throw light on the status of environmental teaching and learning. They were that:

- Although there is a focus on environmental learning in the national NSC documents, there is inadequate support to curriculum support staff and teachers

to ensure that it is interpreted into appropriate guidelines, learning programmes, classroom activities and assessment practices.

- Environmental learning is still regarded by many teachers as being outside the formal school curriculum.
- Many teachers have inadequate knowledge of environmental concepts and issues. They tend to 'skip' the environmental content of the curriculum or to teach it in a superficial disjointed manner. There is often repetition and lack of progression in what is taught.
- Many of the textbooks and other educational materials in use at schools have inadequate environmental content.
- The environmental learning agenda at many schools seems to overly rely on the educational materials that are supplied by external agencies. Many teachers are unsure of how to make use these materials.

Career Guidance

Teachers in the Khayalitsha high school we visited report that when it comes to students' study choices, there is "No coherence between their dreams and their subject choices". For example, students want to pursue a career requiring Physical Sciences but did not take the subject. Career and study guidance is provided for in National Curriculum Statements in the Life Orientation learning area (Grades 7-9) and the Life Orientation subject (Grades 10-12). But as we report elsewhere (Rosenberg et al, 2009), there are significant problems with career and study guidance in Life Orientation and in this particular school, "it does not seem to make a difference". Children may be advised to take certain subjects (e.g. Mathematics Literacy instead of Mathematics) in an effort to improve the school's overall performance, and the availability of subject teachers is a significant factor in providing students with subject choices, and the presence or absence of inspiring teachers also motivate them in their choices. These choices in turn shape their career options.

In a number of schools career guidance is based on the PACE Career Guidance dvd (see Rosenberg et al, 2009). Where students from township backgrounds do get a chance to further develop their Mathematics and Science skills, such as at the Cape Academy of Maths, Science and Technology, even those who choose to study in the sciences, tend to opt for other careers, which are perceived to be more lucrative. Most of the students at this school go into business studies. The quality of science teachers at schools seem to be a significant factor influencing choices.

In one independent school we visited, there is an emphasis on career guidance for Grade 9 learners (who must choose subjects for the last three years of schooling). The Geography teacher we interviewed thought that there was a high enough level of environmental awareness. She quoted a student who turned down an Oxford Scholarship to study environmental engineering. Another school reported the exact opposite! The teacher's own knowledge and links with environmental partners seem once again to be highly significant variables in what is eventually offered to students.

As far as choosing to study further in Geography is concerned, however, there is considerable confusion, as the universities seem unclear as to whether the new Geography subject at school can be regarded as a science, or not.

6. What has Worked, and Not Worked?

What Works: Investing Wisely in Human Resources

Comparative studies show that countries with the best performing education systems invest heavily in schooling. In Finland, for example, the best students are encouraged to take up a teaching career; in turn the best student teachers are encouraged to specialise in primary education.

What Is Unlikely to Work: Isolated short-term interventions

A departmental official notes that “having [science] equipment does not necessarily lead to better teaching. It helps to get learners excited about learning”. Studies (see e.g. Gustaffson, 2005) confirm that beyond the basic physical resources (such as a building, books, stationary) a further investment in infrastructure and physical resources does not lead to a significant improvement in learner performance, without other investments (such as teacher competence).

What Has Not Worked: Investing in dysfunctional schools

A number of studies have shown that some schools are completely dysfunctional and that investment to improve the quality of teaching and learning at those schools, do not yield results. These schools have been described as Type I schools (REF) and the conclusion has been that only radical intervention in the management of these schools will achieve an improvement in the situation.

What Has Not Worked: Setting performance targets

The National Strategy for Mathematics, Science and Technology education (NSMSTE) was one of government’s initiatives to improve the level of participation and performance in Mathematics and Sciences (and English). NSMSTE had eight key aims:

- To set performance targets for all schools,
- To provide schools with qualified and competent teachers,
- To improve the teaching of the language of instruction,
- To identify and nurture talented learners,
- To form partnerships between DoE, and other key stakeholders such as the Department of Science and Technology for the provision of resources and technical support,

- To evaluate and monitor the teaching and learning of Mathematics, Science and technology in all provinces, and
- To introduce Information and Computer Technology into schools.

Crouch & Vinjevold (2006) noted that one effect of the NSMSTE initiative was a drop in the number of learners who wrote the Senior Certificate examination, from 2001, as provincial education departments held back learners to improve overall pass rates. Another unintended effect was the decrease in the number of learners who took Mathematics and Science at Higher Grade level, as learners opted for the easier Standard Grade option.

What Has Partially Worked: Dinaledi Schools

The Dinaledi Schools project and the Adopt-a- school project are part of the NSMSTE. The number of Dinaledi schools has gradually increased and currently stands at 500. Dinaledi schools have received the following from the Department of Education (Engineering News, 2009):

- 251 000 copies of English, Mathematics, Physical Science and Life Orientation textbooks,
- 500 000 copies of Mathematics Workbooks for Grade 11 and 12,
- 235 000 calculators for Grade 11 & 12, and
- 20 000 Mathematics and Science exemplar papers.

In addition 24 000 Mathematics and Sciences teachers have received professional development training to improve their content knowledge in Mathematics and Science. Dinaledi schools have been adopted by different business, NGOs and higher education institutions.

The Dinaledi Schools initiative has resulted in increased participation of learners in Mathematics and Sciences. In 2008, 53 469 learners from Dinaledi Schools wrote the Mathematics examination, 30 786 (57.5%) of whom passed. A total of 15,500 learners from Dinaledi schools obtained 50% or higher in the Mathematics examination. They accounted for 24% of the national total number of learners who achieved at that level. A total of 40 790 learners from Dinaledi schools wrote the Physical Science examination, of whom 27 590 (68%) passed. They formed 29% of the learners nationwide who managed to score above 50% for the Physical Science examination.

Two shortcoming in the performance of the Dinaledi schools is that they were unable to meet the target of 10 000 passes in Physical Science that was set for them for 2008. Large numbers of learners from Dinaledi schools still under-performed in Mathematics and Sciences, despite the resources and other forms of support which were provided to them. For example, only 8 289 Dinaledi learners managed to score above 50% in the 2008 Physical Sciences examination.

Crouch and Vinjevold (2006) note that in the first phase of the Dinaledi Schools project, there were no set criteria by which schools were not selected, nor were performance targets set for them, or a system of monitoring and evaluation put in place. In the second phase of the project, schools which wished to join this project had to first show that they have the potential to produce Higher Grade passes in Mathematics and Science.

What is Working at a Small Scale: LEAP Schools

The LEAP initiative is a small-scale initiative aimed at improving the Mathematics and Science ability of high school students from a disadvantaged background. LEAP has programmes in Mathematics and Science at government schools situated in townships, where children with potential and interest are identified. They are then offered a place at a LEAP school (of which there are two in the country). At these schools a double dose of the Mathematics, Sciences and English is taught, and there is ample time for learners to address social and personal issues in extended Life Orientation periods. The teaching is done not by teachers who have come through formal training, but by retired engineers and scientists, and by qualified social workers (Life Orientation). The schools report an excellent morale among students, above average pass rates, and above average entry into higher education. The LEAP schools draw their resources from multiple partnerships including business and the schools have several local partnerships at local level.

What Has Potential: Partnerships with Science and Environment Partners

Environmental agencies in government, NGOs and businesses support environmental education initiatives in schools. Examples include the following (among many others):

- *2020 Vision for Water, Sanitation and Forestry Programme*. Launched in 1996 and run by Department of Water Affairs in partnership with the Department of Education. Provides resource packs to schools for use in investigating water and sanitation issues at schools and in communities. However, teachers report that support is inadequate, when 80% of budgets are spent on competitions; more should be used for teacher training.

- *Greening the Nation Programme*. Run by the South African National Biodiversity Institute and the Department of Environment Affairs. Launched in 2004. Involves establishing school gardens of indigenous plants, vegetables and fruit trees for nutrition and as an educational resource. Contributed to job creation and skills development in the community; SANBI also supported a teacher development programme in partnership with the Environmental Education and Sustainability Unit at Rhodes University.

- *Share-Net*. Supports environmental education in southern Africa by developing and supplying copyright free educational materials.

- *WESSA* and partners offer professional development courses to teachers and curriculum support staff, as well as courses in environmental education.

- *Cape Action for People and the Environment* (C.A.P.E.). This programme produced a number of resources to help teachers (and their environmental partners) to interpret and work with the environmental learning outcomes in the curriculum (Raven, 2007; Raven and Rosenberg, 2008 and Rosenberg, 2009). The programme also produced a conceptual framework for teaching and learning processes which meet the purpose of curriculum areas (such as enquiry) through explorations of environmentally related matters.

- *South African Environmental Observation Network (SAEON).* Is an information management network involved with long term research and monitoring of ecosystem change. Also runs an education outreach programme in which learners and educators are provided with hands-on inquiry based learning experiences (Environmental Science Education).

- *The South African Institute for Aquatic Biodiversity (SAIAB*). In addition to its general environmental education programme SAIAB also runs the Bright Sparks Programme which identifies and nurtures disadvantaged learners for future careers in Science and Technology.

- *Two Oceans Aquarium* is one of few partners that run workshops for high school teachers, as well as a Young Biologists programme. The programmes are very useful, the resources are good and the staff supportive, because they "are ex-teachers".

The Eco-Schools programme is currently the most extensive environmental education initiative targeting South Africa's schools. The programme:

1. Offers support to teachers in the implementation of the curriculum. Teachers in participating schools gain from visits by the project's staff and other partners.
2. Creates opportunities for learners to tackle local environmental issues such as poverty and waste management thus contributing to community upliftment.
3. Provides experiential learning opportunities to learners.
4. Improves teacher s' and learners' morale, and sense of pride through peers acknowledgement and the award of the Green Flag.
5. Contributes to better school management processes through better approaches to planning school activities (Rosenberg, 2008a, 2008b).

7. Recommendations

From the above review, a number of factors stand out:

- A systemic approach to improving the quality of teaching and learning in South Africa is necessary.
- The knowledge, teaching competence and resourcefulness of the teacher are vital components, as is the quality of the management and support elsewhere in the system.
- Teachers who are informed and interested, do environmental education based on practical projects and are able to connect this with better learning outcomes in the curriculum. In the absence of such teachers, no environmental education takes place Teachers gain their motivation, information and resources from partners such as universities, science and environmental agencies, both governmental and non-governmental. There is no support from departmental structures, except where individual officials are also well informed and interested, through similar exposure.

To strengthen science and environmental education in schools, one would need to:

- Link to and support efforts to support the foundations of teaching and learning, more generally, and
- Continue to place environmental education on the agenda of politicians, education department officials, teachers, teacher educators and text book writers, or it will not be attended to, despite the policies which state its importance.

The following specific actions are recommended:

- Engage with the new Minister of Education to ensure environmental education expertise in the committees who will be drawing up syllabi, following the recent report on the implementation of the National Curriculum Statements (DoE, 2009c).
- Strength the environmental content of initial and in-service teacher training courses to improve teachers' content knowledge.
- Provide guidelines to textbooks publishers to ensure that textbooks contain high quality up-to-date information on the environment.
- Improve the supply of appropriate educational materials to schools and the training of teachers in their use; the development of these materials should draw on appropriate educational expertise to ensure that they can be used to strengthen literacy and numeracy at all levels of schooling.
- Increase and strengthen opportunities for curriculum support staff at provincial and district levels in how to interpret the official environmental learning policy into learning programmes, lesson plans, classroom activities and assessment practices that promote systematic environmental learning.
- Monitor teachers' work to ensure that the environmental content is 'skipped' and is taught properly.

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