Science and technology education and the new South African school curriculum

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Synopsis

Manpower competencies in the mining, minerals processing and energy industries in South Africa into the next century will, to a large extent, derive from the nature and quality of the teaching which pupils receive at school. This paper provides an overview of the current developments towards a new National Curriculum in South African Schools and highlights areas in which the Minerals Industry might provide input into this process.

The National Qualifications Framework and Curriculum 2005

The South African National Qualifications Framework recognises that education and training should be regarded as a life-long process and that the present schools education system places too much emphasis on knowledge acquisition, to the detriment of training learners in life-skills. One of the results of this recognition has been the development of a radically different approach to schooling, Curriculum 2005, which was formally launched in April, 1997 by the Minister of Education.

At the core of Curriculum 2005 is the concept of Outcomes-based Education (OBE)—in contrast to the existing, knowledge-based and content-driven format, Curriculum 2005 is driven by the acquisition of skills. Content is seen as a tool whereby life-skills and competencies can be enhanced; in other words, learners will be taught *how* to think, rather than *what* to think. Obviously, such a situation will have considerable benefits for employers over the present system.

In order to achieve the desired results as soon as possible, Curriculum 2005 will be implemented over six years, commencing in 1998 in Grades 1 and 7. The curriculum has been structured into 8 Learning Areas, which replace the old Subjects. These Learning Areas

- Communication, Literacy and Language Learning
- Numeracy and Mathematics
- Human and Social Sciences
- Natural Sciences
- Arts and Culture
- Economic and Management Sciences
- Life Orientation; and Technology

—will be driven by Outcomes, i.e., skills, abilities and values which the learner will acquire, and will be expected to demonstrate, in each Learning Area. Assessment of the learner's progress will be in terms of these outcomes.

The school curriculum is divided into 2 main parts—the first 9 years of schooling, referred to as General Education and Training (GET), will be compulsory for all learners, whereas years 10 to 12, or Further Education and Training (FET), will be optional. It is important to recognise that all efforts thus far have been concentrated on establishing the framework for the GET band, which will provide the minimum level of learning for work-seekers.

Relevance to the mining, minerals processing and energy industries

From a national perspective, Curriculum 2005 aims to enhance levels of literacy and numeracy among school-leavers, commencing with those entering the workplace with the GET (present Standard 7) Certificate in 2001. By 2007, the first work-seekers educated solely within the OBE framework (the 1998 Grade 1 class) will be entering the workplace.

While industry will benefit from the emphasis on skills acquisition and problem-solving which underpins the new curriculum and from the greater prominence given to Technology, the mining, minerals processing and energy fields in particular will benefit due to the restructuring of the old subject areas into Learning Areas, specifically:

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 SA ISSN 0038–223X/3.00 + 0.00. Paper received Jun. 1997.

- The introduction of Technology as a Learning Area. Through this, learners will develop problem-solving skills, apply technological knowledge and skills and understand the effects and uses of technology in Society, the environment and the economy. The Technology Learning Area also aims to develop citizens who are innovative, critical, responsible and effective and who will have more positive attitudes, perceptions and aspirations towards technology-based careers.
- The formation of the Natural Sciences Learning Area, which will amalgamate the Earth, Life and Physical Sciences and Engineering. Traditionally, Earth Science (Geology, Geomorphology, Climatology) has been confined to the Geography subject area where it has occupied a somewhat smaller component of the course than Human Geography. The Physical Science syllabus, on the other hand, makes virtually no mention of the relevance of Physical Science and Chemistry to the study of the Earth and the management of its resources. Resource management is included in the Geography syllabus, but from the Human Sciences and Economic perspectives. This deficiency is aggravated by the fact that fewer than 10% of all Geography teachers have any Science training.

Four main themes

The Natural Sciences Learning Area has been structured to include four main themes:

- Earth and Beyond
- Life and Living
- Energy and Change; and
- Matter and Materials.

Together with the Technology Learning Area, this structure provides tremendous potential for increasing the profile of Science among learners and demonstrating its relevance. This should clearly benefit the mining, minerals processing and energy industries in terms of producing scientifically literate and numerate people entering the workplace at the bottom level; however, it is important to recognise that the changes which need to be made are occurring in an extremely unfavourable climate. The key problems with which we are faced include:

Teacher qualifications

It goes without saying that the fundamental shift in the philosophy underpinning education, and in the way in which learners will be assessed, requires comprehensive teacher retraining. In terms of the Natural Sciences, however, this retraining needs to be seen against a background of a profession in crisis. The recent EduSource Report on Mathematics and Science Teachers indicates the parlous state of Maths and Science education in this country. Apart from inadequate training of teachers (less than 42% of Science teachers (50% for Maths) have one or more years of specialised subject training), these subjects experience an inordinately high attrition rate (more than 15% versus a general average of 6% for other subjects). The report also notes that this depletion is not being matched by incoming teachers—only 1350 Maths and 1000 Science teachers qualified in 1996 with secondary school qualifications yet, if access to these subjects is to be increased, more than 3000 Maths and 5000 Science teachers are needed nationally. The high attrition rate is evidenced in the levels of experience—nearly half of all Science teachers, and about one-third of all Maths teachers, have less than 2 years' teaching experience. Equally alarming, the report notes '.. a lack of understanding on the part of teachers of the relevance of these subjects for their daily lives or for the environment'. If the new curriculum, which aims to make all learning relevant to life experiences, is to succeed, this problem will need to be urgently addressed.

'Ownership' of material

Against this backdrop, it is necessary to consider the nature of the changes being wrought on the school system. Whilst a subject like Maths will experience changes in terms of teaching and assessment methods and some content, the teachers of Maths will retain their own identity. In contrast, the Natural Sciences will be drawing on content from the old subjects of Physical Science, Biology and part of Geography, and Technology is an entirely new 'subject' for which no structure is yet in place. It is unclear how Geography teachers could retain 'ownership' of the old Physical Geography component of their subject as well as the Human Geography component which will fall within the Human and Social Sciences. Apart from the logistical problems of scheduling teaching time, and the danger of developing 'subject schizophrenia' due to too many teachers, the main concern is the appropriateness of predominantly Humanities-trained teachers retaining 'ownership' of the Earth Science material. Conversely, if they do not, significant re-training of Physical Science teachers is required to enable them to make the changes meaningful. Whilst many may regard the step from studying the properties of elements to recognising their usefulness to Society as small, sight should be not lost of the skills which Geographers bring to the subject, such as spatial conceptualization and map interpretation, and the ability to integrate the Human Factor into such things as environmental studies. As yet, no clear thoughts have emerged on the level of integration which will exist between the Earth, Life and Physical Sciences in the curriculum.

The matter of ownership also extends to the lack of 'champions' in teacher training institutions for the new structure. If South Africa is to produce Natural Sciences teachers in the near future, this aspect needs to be addressed urgently.

The timetable of implementation

Curriculum 2005 was formally launched in April, 1997, with implementation scheduled to start in 1998 in Grades 1 and 7. The timetable requires that pilot Learning Programmes be in place by July, 1997, and that teacher retraining takes place before January 1998. This agenda creates problems both in terms of the time available for development of materials and for teacher retraining. Of additional concern is that it does not leave time for the considered development of a coherent plan spanning the GET band within which the urgently-needed Grade 7 Learning Programmes can be developed. The danger has already been noted that, due to the time factor, choices made by the Provincial Education Departments concerning learning materials may not necessarily be based solely on merit. Choices based on expediency will undoubtedly create added problems in the long term.

A Wits perspective

The Curriculum 2005 plan stipulates that the responsibility for the development and implementation of Learning Materials and Teacher Training rests with the respective Provincial Education Departments. Specific allowance has been made for the Learning Programmes to reflect provincial interests and priorities. Thus, as an example, materials dealing with Economic Mineral Resource Extraction and Beneficiation might focus on gold in Gauteng, platinum or chrome in the Northern and Northwest Provinces, coal in Kwazulu-Natal and copper in the Northern Cape, allowing a close linkage to develop with local industry.

Currently, initiatives directed at developing Learning Programmes appear to be occurring on an *ad hoc* basis, with a variety of NGOs involved in the process. It is, however, not possible to give an overview of these initiatives as little central co-ordination appears to exist. In Gauteng Province, a group of initiatives is emerging in the Natural Sciences and Technology Learning Areas from the University of the Witwatersrand, which are described briefly here. These involve

- the School of Science Education in the Faculty of Science, and
- the Centre for Research and Development of Mathematics, Science and Technology Education (RADMASTE).

The School of Science Education focuses on the training of teachers through post-graduate studies, and on research into teaching methods. The School is unique in South Africa and is currently looking at ways of addressing the current crisis in Maths and Science education in schools. RADMASTE is involved in a wide range of donor-funded projects related to in-service training of teachers and College of Education lecturers and to the development of, and research into, learning materials. Personnel are employed on a contract basis. One of the projects of direct relevance to the Minerals Industry in which RADMASTE has been involved is the Phoenix Programme which developed secondary school learning packages on Coal, Gold, Chromium, Manganese, Copper and Separation Methods. This material incorporates much of the philosophy of Curriculum 2005 in being skills-oriented and applicable across a range of disciplines (Physical Science, Geology, Technology, Geography, Economics). A current project is the development of a college-level course in Technology.

The compact size of Gauteng and the strategic location within the province of no fewer than four of the country's leading Universities provide strong logistical factors which should facilitate the successful development of Learning Programmes, teacher training and the implementation of Curriculum 2005. At the University of the Witwatersrand, a strong core of expertise in research and development already exists in the School of Science Education and RADMASTE which can be harnessed to support the process. What is, however, currently lacking, is the necessary *co-ordinated* financial backing from Industry to support the necessary personnel and the creation of specific projects. As the ultimate beneficiaries of Curriculum 2005, it is hoped that Industry will seriously examine its role.

Conclusions

If implemented properly, Curriculum 2005 will meet the needs of South African Industry into the next century. There can be no doubt, however, that the future of South Africa's Science and Technology capability is fraught with potential dangers. Chief among these is that there has been no indication from National or Provincial Governments that they will be able to fund the vast amount of work that needs to be done to develop Learning Programmes and to comprehensively retrain teachers and teacher-trainers in the stipulated time-frame. It is our opinion that a necessary pre-requisite for success is the development of comprehensive Learning Materials which will assist teachers battling to come to terms with the new focus and methods of assessment which underpin Curriculum 2005. With its resources, the Minerals Industry, in partnership with Tertiary and other NGO groupings is ideally positioned to drive the process forward.

Acknowledgements

The views expressed in this paper have evolved over the past 12 months in large part due to workshops and meetings organised under the auspices of the Education Committees of the Geological Society of South Africa and the SAIMM, although they are the authors' personal opinions and not the views of these organisations. Should you require more information or wish to explore ways of becoming involved in the process, please contact one of the authors

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New alluvial project for Moonstone Diamond Corporation*

Australia's Moonstone Diamond Corporation is expanding its South African portfolio with an option to acquire an established alluvial diamond mining operation currently producing high quality stones averaging US$800 a carat.

Moonstone (Australian Stock Exchange code: MDI) has a three-month option over the Saxendrift and Annex Saxes Drift farms which encompass more than 300 hectares of alluvial gravels in the paleochannels of the Orange River.

The farms are located in the Northern Cape province in an area known for its exceptional diamonds, regularly producing large and fancy stones.

Alluvial gravels are currently being mined in the Saxendrift project area by a small miner, Northern Cape Diamond Mining and Exploration (NCDME), which has been recovering 250-300 carats a month over the past six months.

The top 30 cm of surface gravels in this area were mined up to the 1960s, producing stones of up to 130 carats. Earlier diggers were stymied by a hard layer of calcrete protecting the alluvial gravel beneath but NCDME has broken through the calcrete layer with heavy earth-moving equipment.

'In the past four months, NCDME has recovered 1459 carats and the mining operation has indicated ore reserves that will last well into the next century,' said Moonstone managing director, Alan Hopkins.

'This is one of the last sizeable tracts of highly prospective and mineable ground available and it is in a region which is currently attracting diggers from other South African diamond mining regions.

The Saxendrift project is an established mining operation producing high quality stones and it will be an important addition to our portfolio or projects," said Mr Hopkins.

Moonstone has a A$6.3 million (approx. US$4.6 million) option to acquire the mining rights and assets of NCMDE, including mining and processing plant.

Moonstone is listed on the Australian Stock Exchange but most of its mining and exploration projects are in South Africa. The company is successfully mining marine diamonds off South Africa's west coast through a joint venture with South African-listed company, Benguela Concessions. ◆

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