CHAPTER 8

The social, educational and curriculum landscape

Introduction

Chapters 3, 4, 5 and 6 considered the mathematics and science performance of Grade 8 learners within both national and international parameters. To provide an insight into the meaning of the achievement scores and postulate hypotheses for this performance, these scores need to be read against the social, educational and curriculum landscape of South Africa. This Chapter will first briefly describe some aspects of the social and educational landscape. This will be followed by a detailed description of the curriculum changes occurring since 1994. Information gathered on the curriculum from teacher questionnaires and the curriculum itself will then be presented.

Social landscape

Apartheid in South Africa came to end with the democratically held elections of 1994. South African society is, however, still characterised by high levels of poverty and enormous inequality – unwelcome legacies of the apartheid era. The latest UNDP report (2005) estimates that at least one-third of the population is living on less than $2 a day, with 11.1 per cent living on less than $1 a day. The Gini coefficient, which measures (among other things) national income distribution, was 0.6 in 2000.[1] This demonstrates that South Africa (along with Brazil) has one of the most unequal income distributions in the world (Statistics South Africa 2002). Africans, still struggling with the harsh consequences of apartheid rule, represent the poorest group. In the field of education, African schools endure crippling backlogs in the provision of basic infrastructure, learning materials and qualified teachers, all of which affect science and mathematics participation and achievement.

In the last ten years the government has attempted to improve the infrastructure and resources in schools previously designated for Africans. However, this is, 'unfolding at a much slower pace than envisaged' (Mbeki 2005). Twenty-five per cent of schools (mostly African) do not have access to running water and about 45 per cent do not have access to electricity (DoE 2001). African schools are still located in the areas designated for Africans to live in by the previous government, and these continue to be the poorest areas of the country.

South Africa has nine provinces and differences exist between them. Provincial performance on key socio-economic indicators is provided in Appendix 6, where information on indicators such as poverty rate, life expectancy, unemployment rate, and access to electricity, water and sanitation is given.

1 The Gini coefficient is a number between 0 and 1, where 0 equates to perfect equality (where everyone has the same income) and 1 corresponds with perfect inequality (where one person has all the income, and everyone else zero income). South Africa's 0.6 rating therefore represents, as noted, a markedly unequal national income distribution. Source: http://www.en.wikipedia.org/wiki/Gini_ coefficient.

Educational landscape

In 2002, the South African public school system consisted of 28 000 ordinary schools, 356 000 educators and 12 million learners. Since 1994, there have been many changes in South African education. According to the DoE (2005) the first phase of the post-apartheid change in the education and training system – 1994–1999 – was concerned with the system's reconstruction. This meant creating a single national system with nine provincial sub-systems, introducing nine year compulsory schooling, establishing school governing bodies, consolidating the teaching service, establishing a National Qualifications Framework, and introducing the outcomes-based Curriculum 2005.

This first phase involved systemic changes which resulted in the policy, legislation, protocols, structures and systems being put in place. The second phase, from 1999, has been characterised by a focus on implementation of policies. The debate in education shifted from issues of access and participation to focus on the quality of teaching and learning processes and inputs at the local level. Attention was directed towards sustaining learner participation through improving the quality of education in the institutions. Greater effort was made to improve opportunities for the poorest learners and communities in the system. Interventions during this period included upgrading and developing teachers' skills and implementing a revised curriculum for schooling.

Learners attend school for 12 years – in the General Education and Training (GET) section (Grades 1 to 9) and the Further Education and Training (FET) section (Grades 10 to 12). GET, which is compulsory, is organised into three phases: foundation (Grades 1 to 3), intermediate (Grades 4 to 6), and senior (Grades 7 to 9). South Africa's national Ministry of Education is responsible for the development of the policies and frameworks for education and the curriculum. The provincial ministries of education are responsible for the implementation and support of these policies.

Mathematics and science are two key areas where skills and competence are essential, not only for the development of the individual (that is, the learner), but also for the social and economic development of South Africa in a globalising world. Since 1994, the new democratic government has emphasised the centrality of mathematics and science to the human development strategy of South Africa (Mbeki 2001, 2005). The local government, business, academic and family sectors of the country have likewise acknowledged that South Africa's well-being cannot be developed without heavy investment in the scientific and mathematic disciplines. Recognition of the disadvantaged condition of the African population has also been apparent over the past decade; so too the need for programmes of redress to ensure better participation and performance in mathematics and science for the African community. Commitment to this has been outlined in various government gazettes and policy documents (DoE 1996; DoE & DoL 2000; DST 2002). These policies affirm that to build the mathematic, scienctific and technological capacity of South Africa requires intervention at the school level. This is the only way to meet the demands of the higher education and workplace environments and to ensure broader, more equitable participation in these sectors.

The DoE has developed a national strategy to improve participation and performance in mathematics and science education (DoE 2001). The flagship programme in the strategy was the Dinaledi project. This project centred on the identification and selection of schools in each of the country's provinces that exhibited the potential to perform well (and, therefore, to raise mathematics and science participation and performance).

The schools (102 in total) received additional facilities, equipment and support for the provision of effective mathematics and science teaching and learning. While the Dinaledi vision of investing in potentially successful schools appears sound, there have been problems in the selection of schools according to the pre-determined criteria; in addition, the implementation of the interventions in the schools has been uneven. The Dinaledi intervention has yet to be independently evaluated. Furthermore, the project has still to demonstrate the gains in participation and performance that were originally anticipated. In 2005, the Dinaledi initiative increased the number of schools in the programme to approximately 500.

South Africa has participated in a number of large-scale systemic studies assessing the performance of the country in science and mathematics (these having been conducted by international and national agencies).The DoE's systemic evaluation at the Grade 3 level revealed that the national average score for numeracy was 30 per cent (DoE 2002a). In the UNESCO-co-ordinated MLA studies for Grade 4 learners; the average numeracy score for South Africa was 30 per cent, compared to 59 per cent for Mauritius, 40 per cent for Senegal, and 43 per cent for Malawi (Chinapah et al. 2000). In 2004, the DoE's Grade 6 systemic study revealed the average mathematics score as 27 per cent and the average science score as 41 per cent.

While there has been noticeable commitment to mathematics and science education from various sectors, the achievements in these areas are still poor. The country is still grappling with how to improve the quality of school education and achieve higher learner performances.

Curriculum landscape

In the last decade there has been large-scale and radical curriculum reform in South Africa. In the old curriculum (NATED 550) all learners took general science and mathematics up to the end of Grade 9. In Grade 10, learners could choose to enrol for mathematics, physical science or biology. This curriculum was content-driven and the content to be taught was specified for teachers.

A new curriculum was prepared for the country. In 1998, C2005, based on an outcomes-based education (OBE) philosophy, was introduced by phases into schools. The intention was that by 2005 the whole schooling system would follow an OBE approach. The OBE curriculum necessitated a major shift in the approach to teaching, leading to a planned set of in-service activities for teachers, together with the development of learning materials. However, the process of implementation was hampered by lack of resources (financial, physical and human). The new curriculum was not well received by teachers and academics and there were widespread protests. Published research also commented on the difficulties of implementing this new curriculum.

The new curriculum was criticised for its under-specification of content and lack of structured resourced materials for teachers, brought about by the programme's departure from a traditional, content-based approach. In addition, it was perceived there was an overemphasis on the processes involved in science and mathematics and an underemphasis on basic knowledge and skills. During this period, because of the under-specification of content and lack of teaching materials, teachers then fell back on teaching the content that they had done previously (that is, under the NATED 550 curriculum). Chisholm et al. (2000, 2003) outlines the process, concerns, debates and critiques of

C2005. In 2000, the Minister of Education requested advice on the implementation of the new curriculum and set up a Review Committee to consider the feasability of its introduction and application. However, the establishment of the Review Committee served to cause confusion in the teaching community – teachers were uncertain whether OBE had been abandoned or not, and so fluctuated between using C2005 as a guide and following the previous curriculum.

The Review Committee submitted their findings to the Minister in May 2000 and recommended a revision of Curriculum 2005. This led to a process of streamlining and strengthening the curriculum and, in 2002; the Revised National Curriculum Statements (RNCS) were produced. The RNCS were to be implemented, in a phased manner, from 2004. The Revised National Curriculum Statements (DoE 2002b) provided a better structure for teachers to organise their classroom activities under. From 2002, especially at the higher grades, teachers used the three curriculum documents (NATED 550, Curriculum 2005 and the RNCS) and textbooks to decide what and how to teach in their classroom. Unfortunately, this resulted in a significant variation in what was taught in mathematics and science across the different classrooms in the country – making it difficult to isolate and define the intended curriculum.

The rapid and frequent restructuring of the education curriculum over a short period of time has caused uncertainty and anxiety among teachers, who are unsure about policy changes and which policy applies at a particular time. Teachers have attended many professional development activities (mostly during school time) to prepare them for the latest changes and this has led to losses in teaching time.[2] In the short term, the new curriculum may have negatively affected learners' knowledge, a situation caused by teachers struggling to understand the new outcomes-based approach and then teaching it using unfamiliar learning materials

TIMSS curriculum analysis

TIMSS administered a curriculum questionnaire that the national research co-ordinators were required to complete. One question regarded determining the proportion of Grade 8 learners who would have been taught the different curriculum topics by the end of the Grade 8 year. Because of the various curriculum changes occuring over the period in which TIMSS was conducted, it was difficult to 'pin down' the curriculum in the questionnaire. C2005 indicated that the content would not be prescribed and that teachers could choose what content to teach – it was more important to ensure that the learning outcome had been achieved.

Interviews with teachers, DoE officials and academics about the content selection for Grade 8 mathematics and science revealed the use of different sets of procedures in determining content areas. Some interviewees followed examples provided at in-service courses; others followed what was covered in the previous (pre-1994) curriculum; some followed the content in a textbook. Therefore, in the reporting that follows for the South African curriculum, it was decided to utilise what the teachers reported in the teacher questionnaires. In other countries, where official documents are more likely to be universally applied and followed, this strategy would not be needed.

2 For further details, refer to Chisholm 2005 which was commissioned by the Education Labour Relation Council.

Description of the South African science and mathematics curriculum

Science curriculum

In the new curriculum, at the General Education and Training (GET) phase (Grades 1 to 9), natural science is compulsory for all learners. Learners begin their science studies in Grade 4 and from Grades 4 to 6 follow a natural science and technology curriculum. From Grades 7 to 9 they take the subject natural science. This subject is compulsory for all learners up to Grade 9. natural science is offered for 12 per cent of the instructional time in the Grade 7 to 9 band (the senior phase).

Education systems use different ways to achieve the best match between the *intended* and the *implemented* curriculum. Internationally, the most widely used methods for supporting and monitoring curriculum implementation reported by education ministries were: provision of instructional or pedagogical guides (47 TIMSS participants); education ministry notes and directives (40 TIMSS participants); school inspection or audit (38 participants); mandatory or recommended textbooks (38 participants); curricular evaluation during or after implementation (35 participants); and the use of specially developed or recommended instructional activities (33 participants). The least widely used method was national assessments on learner samples (21 participants).

To support the implementation of the new curriculum, the South African Ministry of Education indicated that they provided instructional or pedagogical guides, notes and directives. However, according to Curriculum 2005, schools and teachers were not provided with recommended textbooks – rather, teachers developed their own set of learning support materials from a range of resources. On balance, it would seem that many of the TIMSS participating countries offered schools and teachers much more structured guidance (in the form of guides, notes and textbooks) than the South African Ministry of Education.

Different curricula emphasise different approaches and processes in the intended science curriculum. Internationally, the processes emphasised 'a lot' were: knowing basic science facts (35 countries); understanding scientific concepts (34 participants), and writing explanations on what was observed and why it happened (20 participants). By way of contrast, South African policy-makers indicated that in Curriculum 2005 there was 'some emphasis' on: knowing basic science facts; understanding scientific concepts; designing and planning experiments and investigations; conducting experiments or investigations; learning about the nature of science and inquiry; and understanding human impact on the environment. There was 'a lot of emphasis' on: integrating science with other subjects; learning about technology and its impact on society; and incorporating the experiences of different cultural/ethnic groups. Internationally, relative to the other approaches and processes, participants reported placing less emphasis on integrating science with other subjects and incorporating the experiences of different ethnic/ cultural groups. Four participants (Botswana, Israel, Italy and South Africa) reported placing a lot of emphasis on integrating science, and two countries, South Africa and Sweden, reported placing 'a lot of emphasis'on the multicultural approach when using the intended curriculum.

These findings highlight a major difference between South Africa's approach to the curriculum and that of most other countries. Whereas South Africa places 'a lot of emphasis' on integrating science and incorporating the experiences of different groups, most other countries put 'a lot of emphasis' on understanding science concepts and knowing basic facts.

To gather information about the implemented curriculum on science coverage in the classroom, science teachers were asked to indicate whether each of the TIMSS 2003 science topics was 'mostly taught before this year'; 'mostly taught this year'; or, 'not yet taught or just introduced'. Table 8.1 shows the response for South Africa averaged across the content areas, as well as a scaled international score for a global comparison.[3]

Table 8.1: Summary of percentage of learners taught the TIMSS science topics, and the average scale scores for each content area

	Overall (44 topics)	Life science (12 topics)	Chemistry (8 topics)	Physics (10 topics)	Earth science (11 topics)	Environmental science (3 topics)
South Africa	49%	57%	54%	46%	37%	63%
	244 (6.7)	250 (6.0)	285 (5.9)	244 (6.2)	247 (6.3)	261 (6.6)
International	67%	70%	70%	66%	61%	49%
	474 (0.6)	474 (0.5)	474 (0.5)	474 (0.5)	474 (0.5)	474 (0.5)

For most countries, a great deal of the science content addressed by the TIMSS 2003 assessment was included in their intended curriculum. In only eight countries were less than half the topics included in the Grade 8 curriculum: Belgium, Botswana, Cyprus, Indonesia, Lebanon, Morocco, South Africa and Tunisia. For South Africa, as one of these eight, the content area in which there was the greatest overlap with the TIMSS assessment frameworks was environmental science, and the content area with the least overlap is earth science. The corresponding achievement scores indicate South African learners performing best in chemistry (where there is 54 percent overlap) and weakest in physics (where there is 46 percent overlap).

While high coverage of the intended curriculum is important for higher performance, the relationship is not as straightforward as it may appear. There are some countries with low curriculum coverage that performed well (for example, Belgium). However, countries such as Botswana, Indonesia, Morocco and South Africa, all of whom indicated low curriculum coverage, attained low achievement scores. In addition to providing scale scores, TIMSS calculated the average percent correct for the items in TIMSS 2003. This statistic provides a better indication of what learners know. For South Africa, the average percent correct for all items in the science test was 19 per cent. To determine how performance is affected by curriculum coverage, TIMSS conducted a test curriculum matching analysis (TCMA), where the average percentage correct was calculated for those items that teachers indicated had been taught in the South African curriculum. South Africa achieved a 22 per cent success rate for items that were covered in the country's curriculum – still a low performance.

3 The complete description of performance in each of the topic areas is available in the international report.

Mathematics curriculum

Grade 8 South African learners have, since 2002, studied mathematical literacy, mathematics and mathematical sciences (MLMMS). They begin a study of numeracy in Grade 1 and follow a MLMMS curriculum from Grade 4. This subject is compulsory for all learners up to Grade 9. MLMMS is offered for 13 per cent of the instructional time in the Grade 7 to 9 band (the senior phase).

Education systems use different ways to achieve the best match between the *intended* and the *implemented* curriculum. Internationally, the most widely used methods for supporting and monitoring curriculum implementation reported by education ministries were: education ministry notes and directives (42 TIMSS participants); provision of instructional or pedagogical guides (41 TIMSS participants); school inspection or audit (40 participants); mandatory or recommended textbooks (38 participants); curricular evaluation during or after implementation (35 participants); and the use of specially developed or recommended instructional activities (33 participants). The least widely used method was national assessments on learner samples (25 participants).

To support the implementation of the new curriculum, the South African Ministry of Education indicated that they provided instructional or pedagogical guides, notes and directives. However, according to Curriculum 2005, schools and teachers were not provided with recommended textbooks – rather, teachers developed their own set of learning support materials from a range of resources. On balance, it would seem that many of the TIMSS participating countries offered schools and teachers much more structured guidance (in the form of guides, notes and textbooks) than the South African Ministry of Education.

Different curricula emphasise different approaches and processes in the intended mathematics curriculum. Internationally, the processes emphasised ‘a lot’ were: understanding mathematical concepts and principles (32 participants), and mastering basic skills (30 participants). By way of contrast, South African policymakers indicated that in Curriculum 2005 there was ‘some emphasis’ placed on: mastering basic skills; understanding mathematical concepts and principles, and reasoning mathematically. There was, ‘a lot of emphasis’ on: applying mathematics to real- life situations; communicating mathematically; integrating mathematics with other subjects; and incorporating the experiences of different cultural/ethnic groups. There was no emphasis on deriving formal proofs. Internationally, relative to the other approaches and processes, participants reported placing less emphasis on integrating mathematics with other subjects and incorporating the experiences of different ethnic/cultural groups. Three participants (Botswana, the Netherlands, and South Africa) reported placing a lot of emphasis on applying mathematics to real-life situations. Two countries, Ghana and South Africa, reported placing ‘a lot of emphasis’ on the multicultural approach when using the intended curriculum.

These findings highlight a major difference between South Africa’s approach to the curriculum and that of most other countries. Whereas South Africa places, ‘a lot of emphasis’ on applying mathematics to real-life situations and multicultural approaches, most other countries put ‘a lot of emphasis’ on understanding mathematical concepts and principles and mastering basic skills.

To gather information about the implemented curriculum on mathematics coverage in the classroom, mathematics teachers were asked to indicate whether each of the TIMSS 2003 mathematics topics was 'mostly taught before this year'; 'mostly taught this year'; or, 'not yet taught or just introduced'. Table 8.2 shows the response for South Africa averaged across the content areas, as well as a scaled international score for a global comparison.[4]

Table 8.2: Summary of percentage of learners taught the TIMSS mathematics topics and the average scale scores for each content area

	Overall (45 topics)	Number (10 topics)	Algebra (6 topics)	Measurement (8 topics)	Geometry (13 topics)	Data (8 topics)
South Africa	55%	77%	57%	49%	48%	40%
	264 (5.5)	274 (5.4)	275 (5.1)	298 (4.7)	247 (5.4)	296 (5.3)
International	72%	95%	66%	78%	69%	46%
	467 (0.5)	467 (0.5)	467 (0.5)	467 (0.5)	467 (0.5)	467 (0.5)

For most countries, a great deal of the mathematics content addressed by the TIMSS 2003 assessment was included in their intended curriculum. In only six countries were less than half the topics included in the Grade 8 curriculum: Botswana, Indonesia, Lebanon, Morocco, the Philippines, and Tunisia.

In South Africa, 55 per cent of the topics which were in the TIMSS assessment was covered in classrooms. The content area where there was the greatest overlap with the TIMSS assessment frameworks was number (77 per cent), and the content area with the least overlap was data (40 per cent). South African learners performed best in the content area of measurement, where 49 per cent had been taught all topics, while the poorest performance was in the area of geometry, where 48 per cent of learners had been taught all the topics.

While high coverage of the intended curriculum is important for higher performance, the relationship is not as straightforward as it may appear. There were some countries with low curriculum coverage that performed well (for example, Belgium). In addition to providing scale scores, TIMSS calculated the average percent correct for the items in TIMSS 2003. This statistic provides a better indication of what learners know. For South Africa, the average percent correct for all items in the mathematics test was 17 per cent. To determine how performance is affected by curriculum coverage, TIMSS conducted a test curriculum matching analysis (TCMA), where the average percent correct was calculated for those items that teachers indicated had been taught in the South African curriculum. South Africa achieved an 18 per cent success rate for items that were covered in the country's curriculum – still a low performance.

4 The complete description of performance in each of the topic areas is available in the international report.

Summary

South African society is highly stratified. Amongst the disadvantaged groups, Africans experience the highest levels of poverty. The new education system, introduced in 1994, has undergone many changes. Since 1997, there have been curriculum changes and the introduction of an outcomes-based education policy. The TIMSS assessment revealed that teachers were often uncertain regarding exactly what curriculum they should be implementing. Furthermore, the official curriculum in 2002, C2005, was characterised by (and criticised for) under-specification of basic knowledge and skills.

The South African curriculum is also one where, when compared internationally, there is the least overlap with the TIMSS assessment frameworks. This might have been anticipated to have an effect on the achievement scores. However, an analysis of performance on topics teachers indicated they *had* covered demonstrated that performance was still very poor: learners achieving only around 20 per cent correct on those items.