CHAPTER 10

The context of learning: teachers, classrooms and schools

Introduction

This chapter examines the context for TIMSS learners' learning; that is, teachers, classrooms and schools. The aim of this analysis is to describe those variables that are most likely to have an impact on, or be associated with, achievement.

This chapter draws on data collected for TIMSS 2003 by questionnaires completed by teachers and principals. The unit for sampling of learners within schools was an intact mathematics and science classroom. The mathematics teacher and the science teacher for that class were asked to complete a questionnaire for their respective subject. The mathematics and science teachers' responses to the questionnaires are not necessarily representative of all South African mathematics and science teachers, as they were simply the teachers of a representative sample of learners assessed as part of TIMSS 2003. This chapter should then be thought of as indicative of, rather than representative of, South-African teachers, classrooms and schools. When information from the teacher and school questionnaires was reported, the learner, however, remained the unit of analysis; that is, the data shown are the percentages of learners whose teachers or principals reported on various characteristics or instructional strategies.

The contextual framework

The major characteristics of the TIMSS-collected data reported on in this chapter are:

- Teachers and their preparation;
- Classroom characteristics, activities and resources; and
- The school context.

However, there is limited coverage in this chapter on each of these dimensions for two main reasons. Firstly, analysis of the teacher and learner questionnaires revealed different responses being given to the same exhibited phenomena. Secondly, responses to many questions seemed to be prompted by the need to say what would be considered socially desirable, and did not resonate with local understandings. This chapter will, therefore, describe the context of learning on several variables, but will not probe the degree of association between the variable and the achievement score. For an examination of the complete response set of South-African teachers, learners and principals, the international report should be consulted.

Science and mathematics teachers

The teacher is central in creating a supportive environment for learning science and mathematics. This section provides demographic information on the teaching force; teachers' academic preparation for teaching; professional development of teachers; and their readiness to teach the TIMSS curriculum topics. The South African response rate for most questions on the teacher questionnaire was between 70–85 per cent, a feature in about 20 per cent of other participating countries.

Mathematics teachers and their preparation for teaching

Gender, age and experience

In South Africa, about 40 per cent of mathematics learners were taught by females and 60 per cent by males. Internationally, 58 per cent of the learners were taught by female teachers. Countries where 40 per cent or less of mathematics learners were taught by females include: South Africa (40 per cent), Iran (39 per cent), Norway (36 per cent), the Netherlands (32 per cent), Tunisia (32 per cent), Japan (32 per cent), Botswana (27 per cent), Morocco (15 per cent), Egypt (14 per cent), and Ghana (11 per cent).

The majority of South African TIMSS mathematics teachers are aged between 30–39 years. The age profile of the teachers is as follows: 19 per cent of learners are taught by teachers aged between 20–29 years; 55 per cent are taught be teachers aged between 30–39 years; 21 per cent by teachers aged between 40–49 years, and 5 per cent by teachers older than 50. If there was a steady replenishment of the teaching force, one would expect about equal numbers of learners to be taught by teachers in the different age groups. This data suggests that in the last few years there have not been many new mathematics teachers joining the profession.

The average teaching experience of South African TIMSS mathematics teachers was 11 years, while the international average teaching experience was 16 years. Other countries where the average teaching experience of TIMSS mathematics teachers is less than 11 years were: the Philippines (11 years), Bahrain (11 years), Palestinian Authority (10 years), Saudi Arabia (10 years), Ghana (8 years), and Botswana (6 years).

Academic preparation

In 70 per cent of the TIMSS countries, the academic requirement for being a mathematics teacher is at least a university degree. That is not a requirement, as yet, in South Africa, although all new teachers need to register for a four-year degree qualification. Table 10.1 profiles the educational qualification levels of South African TIMSS mathematics teachers and teachers from other African countries.

Table 10.1: Highest educational level of mathematics teachers, by percentage of learners they teach

	Beyond first university degree	Finished university or equivalent	Finished post-secondary (not university)	Finished upper secondary	Did not finish upper secondary
South Africa	10	24	61	5	0
Botswana	0	8	89	3	0
Ghana	0	8	82	10	0
Egypt	1	99	0	0	0
Tunisia	61	32	2	5	0
Morocco	2	5	7	72	13
International average	17	59	20	4	0

Internationally, about three-quarters of learners are taught by teachers with a university qualification. Despite, on average, a relatively well-educated teaching force, the situation varied across countries. For example, at least half the learners were taught by teachers who had a qualification higher than an initial degree in Armenia, Australia, Bulgaria, the Russian Federation, Tunisia, and the United States. By way of contrast, 72 per cent of learners in Morocco were taught by teachers who had only completed secondary schooling.

In South Africa, 95 per cent of the TIMSS learners are taught by mathematics teachers who indicated they had completed a post-secondary qualification – of these, one-third are taught by teachers with at least an initial university qualification. About two-thirds of South-African learners were taught by teachers who indicated that they had studied for mathematics in their pre-service training courses. From this information it is possible to say that at least two-thirds of the Grade 8 mathematics learners are taught by a teaching force considered as qualified with respect to the content knowledge. Relatively speaking, however, the South African mathematics teaching force appears in the group with the least qualifications.

Professional development

In addition to the formal training for teaching mathematics, teachers have to update their knowledge continually. Teachers responding to the TIMSS questionnaire were asked about their participation in different types of professional development activities in the past two years. Table 10.2 indicates the involvement in professional development activities by teachers from South Africa and other African countries.

Table 10.2: Percentage of learners taught by teachers who had participated in professional mathematics development in the past two years

	Math content	Math pedagogy/ instruction	Math curriculum	Integrating info tech to math	Improving critical thinking	Mathematics assessment
South Africa	61	43	59	34	58	77
Botswana	39	24	18	17	50	40
Ghana	50	40	41	20	52	57
Egypt	28	49	28	48	80	60
Tunisia	26	42	22	16	46	46
International average	57	57	52	43	47	49

Internationally, between 43–57 per cent of learners were taught by teachers who indicated that they had participated in professional development activities in the past two years. The highest percentages were in activities related to mathematics content and pedagogy/instruction. South African teachers attended a higher number of professional development activities than the international average for activities related to mathematics content, mathematics curriculum, improving critical thinking, and mathematics assessment. South African teachers participated in a higher number of professional development activities than almost all the other African countries surveyed.

South Africa's high attendance at professional development activities in the past two years may be because the new OBE curriculum was introduced to Grade 8 classes for the first time in 2001. Teachers were invited to a number of professional development activities (offered by the national and provincial departments of education, universities and non-governmental organisations) relating to the new curriculum and its assessment. However, it is surprising that there was a relatively low percentage reporting on professional development activities relating to mathematics pedagogy or instruction, given that C2005 introduced a different way of organising classroom activities.

TIMSS only asked teachers about their attendance at professional development activities and not about the nature and quality of such activities. Given that many teachers reported that they had attended professional activities, and that these activities could provide leverage for improving the educational system, it is important to follow up on the nature and quality of these activities.

Readiness to teach

TIMSS 2003 asked teachers how ready they felt to teach the mathematics topics included in the TIMSS 2003 mathematics framework. Across the five content areas (number, algebra, measurement, geometry, and data), the Grade 8 teachers were asked about readiness in 18 sub-areas. Internationally, most teachers (that is, over 85 per cent) reported that they felt ready to teach most topics.

In South Africa, there was a similar pattern regarding the issue of readiness to teach. In 14 of the 18 topics queried, over 85 per cent of teachers indicated their readiness to teach that topic. Topics where less than 85 per cent of teachers indicated a readiness to teach were: measurements of irregular or compound areas (79 per cent); translation, reflection, rotation and enlargement in geometry (81 per cent); sources of error in collecting and organising data (83 per cent); and simple probability (83 per cent).

Science teachers and their preparation for teaching

Gender, age and experience

About equal numbers of South African TIMSS learners were taught by male and female science teachers. Internationally, 60 per cent of the learners were taught by female teachers and 40 per cent by male teachers. Countries where 40 per cent or less of the learners were taught by female teachers include: Norway (40 per cent), Iran (39 per cent), Botswana (39 per cent), Morocco (34 per cent), Tunisia (32 per cent), the Netherlands (27 per cent), Japan (20 per cent), Egypt (14 per cent), and Ghana (11 per cent).

The majority of South African TIMSS science teachers are aged between 30–39 years. The age profile of South African TIMSS science teachers is as follows: 24 per cent of learners are taught by teachers aged between 20–29; 51 per cent are taught by teachers aged between 30–39; 20 per cent by teachers aged between 40–49; and 4 per cent are taught by teachers above the age of 50. As for mathematics, this data suggests that in the last few years there have not been many new science teachers joining the profession.

The average teaching experience of South African TIMSS science teachers was 10 years. The international average number of years of teaching experience of the TIMSS science teacher was 15 years. Countries where the average experience of TIMSS science teachers

is less than 10 years were: Bahrain (9 years), Cyprus (9 years), Palestinian Authority (9 years), Saudi Arabia, Ghana (8 years), and Botswana (6 years).

Academic preparation

In 70 per cent of the TIMSS countries, the academic requirement for being a mathematics teacher is at least a university degree. That is not a requirement, as yet, in South Africa, although all new teachers need to register for a four-year degree qualification. Table 10.3 profiles the educational qualification levels of South African TIMSS science teachers and teachers from other African countries.

Table 10.3: Highest educational level of science teachers, by percentage of learners they teach

	Beyond first university degree	Finished university or equivalent	Finished post-secondary (not university)	Finished upper secondary	Did not finish upper secondary
South Africa	7	21	69	2	0
Botswana	4	34	61	1	0
Ghana	0	9	79	12	0
Egypt	8	92	0	0	0
Tunisia	81	17	1	0	0
Morocco	2	32	16	44	5
International average	22	57	18	3	0

Internationally, about 80 per cent of learners are taught by teachers with a university qualification. Despite, on average, a relatively well-educated teaching force, the situation varied across countries. For example, at least half the learners were taught by teachers who had a qualification higher than the initial degree in Armenia, Australia, Bulgaria, Lithuania, New Zealand, the Russian Federation, the United States, and the Basque region of Spain. By way of contrast, 44 per cent of learners in Morocco, and 25 per cent in Malaysia, were taught by teachers who had only completed secondary schooling.

In South Africa, 98 per cent of the TIMSS learners were taught by science teachers who indicated they had completed a post-secondary qualification – of these, 28 per cent of learners are taught by university-qualified teachers. About three-quarters of South-African learners were taught by teachers who reported that their major area of study during their pre-service training included biology, physics, chemistry, or Earth sciences. From this information it is possible to say that at least three-quarters of the Grade 8 science learners are taught by a teaching force considered qualified with respect to the content knowledge. Relatively speaking, with the exception of Ghana, the South African science teaching force seems to have the fewest number of teachers with a four-year qualification or above.

Professional development

In addition to the formal training for science teaching, teachers have to update their knowledge continually. Teachers responding to the TIMSS questionnaire were asked about their participation in different types of professional development activities in

the past two years. Table 10.4 indicates the involvement in professional development activities by teachers from South Africa and other African countries.

Table 10.4: Percentage of learners taught by teachers who had participated in professional science development in the past two years

	Science content	Science pedagogy/ instruction	Science curriculum	Integrating info tech into science	Improving critical thinking	Science assessment
South Africa	64	40	55	39	52	67
Botswana	27	22	10	18	32	33
Ghana	50	39	45	30	44	53
Egypt	41	56	27	49	66	66
Tunisia	29	56	42	28	48	54
International average	58	56	52	45	45	47

Internationally, between 45–58 per cent of learners were taught by teachers who indicated that they had participated in professional development activities in the past two years. The highest percentages were in activities related to science content and pedagogy/ instruction. South African teachers attended a higher number of professional development activities than the international average for activities related to science content, science curriculum, improving critical thinking, and science assessment. South African teachers participated in a higher number of professional development activities than almost all the other African countries surveyed.

South Africa's high attendance at professional development activities in the past two years may be because the new OBE curriculum was introduced to Grade 8 classes for the first time in 2001. Teachers were invited to a number of professional development activities (offered by the national and provincial departments of education, universities and non-governmental organisations) relating to the new curriculum and its assessment. However, it is surprising that there was a relatively low percentage reporting on professional development activities relating to science pedagogy or instruction, given that C2005 introduced a different way of organising classroom activities.

TIMSS only asked teachers about their attendance at professional development activities and not about the nature and quality of such activities. Given that many teachers reported that they had attended professional activities, and that these activities could provide leverage for improving the educational system, it is important to follow up on the nature and quality of these activities.

Readiness to teach

TIMSS 2003 asked teachers how ready they felt to teach the science topics included in the TIMSS 2003 science framework. Across the five content areas (life science, chemistry, physics, earth science, and environmental science) the Grade 8 teachers were asked about their readiness to teach science in these areas, which were then divided into 21 topics. Internationally, over 90 per cent most teachers reported that they felt ready to teach most

topics, except the three earth science topics and two of the three environmental science topics, where 85 per cent reported readiness.

In South Africa, there was a similar pattern regarding the issue of readiness to teach. In 13 of the 21 topics queried, over 85 per cent of teachers indicated their readiness to teach that topic. Topics where less than 85 per cent of teachers indicated a readiness to teach were: chemical change (77 per cent); physical states and changes in matter (82 per cent); and basic properties/behaviours of light and sound (77 per cent). For the environmental science topics, less than 85 per cent of teachers reported readiness in two areas: trends in human population and its effects on the environment (81 per cent), and changes in environments (76 per cent). Lower numbers of teachers reported readiness to teach the topics of earth science, with about two-thirds (approximately 66 per cent) indicating readiness in the topics of earth's structure and physical features; earth's processes, cycles and history; and earth in the solar system and the universe. This is not unexpected, as those topics were previously covered in a different part of the school curriculum (namely Geography) and would have been taught by a different teacher.

Classroom characteristics, activities and resources

Although the school provides the general context for learning, it is in the classroom setting and through the teacher's guidance that most instruction and learning takes place. In this section we will report on class size, time allocated for the teaching of mathematics and science, learner activities, textbooks for mathematics and science teaching, and test-item formats in mathematics and science classes.

Class size

Class size could affect the interactions and activities in a classroom. Table 10.5 provides information on this aspect for the TIMSS African countries.

Table 10.5: Mathematics and science class size, by percentage of learners in different class sizes and average mathematics scores

	Class size	1–24 learners	25–32 learners	33–41 learners	>41 learners
South Africa	45	4%	14%	30%	52%
		309 (35.8)	290 (23.8)	265 (11.7)	249 (8.7)
Botswana	37	1%	14%	60%	25%
		–	392 (9.1)	360 (3.7)	362 (4.1)
Ghana	37	16%	18%	29%	37%
		232 (7.4)	249 (8.9)	292 (9.0)	289 (9.1)
Egypt	38	3%	9%	61%	27%
		422 (13.8)	428 (11.3)	403 (4.3)	407 (7.5)
Tunisia	34	1%	26%	71%	2%
		–	404 (3.6)	412 (3.2)	–
International average	30	29%	35%	24%	13%
		461 (1.9)	473 (1.4)	470 (2.1)	448 (1.7)

Note: A dash (–) indicates that there was insufficient data to report.

Internationally, the average number of learners per TIMSS mathematics and science class was 30. There is variation in the average class size of different TIMSS countries – from the Philippines, with an average of 54 learners, to Belgium (Flemish), with an average of 20 learners. In South Africa the average class size was 45 – the second highest of all TIMSS participants.

Within a country there is a slight association, as expected, between mathematics achievement scores and class sizes – the scores were higher where class size was smaller. However, across countries, same-sized classes attained different achievement scores. For example, South African learners in classes where there were less than 24 learners attained a mathematics score of 309, whereas in Egypt a same-sized group attained a score of 422. Over half (52 per cent) of the South African learners were in classes with greater than 41 members and they attained a mathematics score of 249. In Botswana, a quarter of the learners were in classes with greater than 41 members and they attained a mathematics score of 362.

Other countries where over 40 per cent of the learners are in class sizes greater than 41 were: Philippines (91 per cent), Palestinian National Authority (50 per cent), Indonesia (48 per cent), and Hong Kong SAR (43 per cent). With the exception of Hong Kong, it would seem that class size affects performance in mathematics and science, as all the other countries achieved scores at the lower end of the spectrum..

Time allocated for mathematics and science

According to the guidelines in the curriculum questionnaire, the amount of time allocated for the teaching of mathematics and science at the Grade 8 level is, respectively, 13 per cent and 11 per cent of instructional time.

Learner activities in mathematics and science classrooms

Mathematics

TIMSS mathematics teachers were asked to report on the percentage of learners who spent more than half the lessons on the following mathematics content-related activities in the classroom. The South African mathematics teachers' responses were as follows:

- Practise adding, subtracting, multiplying and dividing without using a calculator (63 per cent);
- Work on fractions and decimals (26 per cent);
- Interpret data in tables, charts or graphs (26 per cent); and
- Write equations and functions to represent relationships (25 per cent).

Internationally, teachers reported the largest percentage of learners practising operations (62 per cent) and working on fractions and decimals (43 per cent). Less emphasis was placed on writing equations (30 per cent) and data interpretation (17 per cent). Compared to the international average, South African learners spend less time on fractions and decimals and more time on data interpretation.

The goal of improving learners' capacity for mathematics problem solving is important in all educational systems. TIMSS asked Grade 8 teachers how often learners were asked to perform the following activities – relate what is being learnt in mathematics to their daily lives; explain their answers, and decide procedures for solving complex problems.

The South African teachers' reported their learners allocating time to these activities in the following manner:

- Relating what is being learnt in mathematics to their daily lives (59 per cent);
- Explaining their answers (67 per cent); and
- Deciding procedures for solving complex problems (36 per cent).

Internationally, teachers reported a greater emphasis placed on asking learners to explain answers (about three-quarters of learners, in at least half the lessons) than asking learners to relate mathematics to their daily lives and to decide on procedures for solving complex problems (about half the learners doing so). There was a low emphasis in South African classrooms on asking learners to decide procedures for solving complex problems.

The emphasis on the content-related and problem-solving activities reported by South African mathematics teachers was in line with international trends.

Science

TIMSS science teachers were asked to indicate how instructional time in science was allocated across the five major content areas assessed in TIMSS 2003.

South African teachers reported the following allocation of time to each of the content areas:

- Life science (26 per cent);
- Chemistry (21 per cent);
- Physics (21 per cent);
- Earth sciences (13 per cent); and
- Environmental sciences (15 per cent).

Internationally, on average, the most time was devoted to life science (27 per cent). This was followed by physics (24 per cent), chemistry (21 per cent), earth science (13 per cent), and environmental science (9 per cent).

In many countries, the science curriculum places emphasis on engaging learners in scientific inquiry. TIMSS science teachers were asked to report on the percentage of learners who spent more than half the lessons on the following activities relating to scientific inquiry. The South African science teachers' responses were as follows:

- Watch the teacher demonstrate an experiment or investigation (24 per cent);
- Design or plan experiments or investigations (40 per cent);
- Conduct experiments or investigations (34 per cent);
- Work together in small groups on experiments or investigations (55 per cent);
- Write explanations of what was observed and why it happened (55 per cent); and
- Relate what learners are learning in science to daily lives (77 per cent).

Internationally, teachers of 38 percent of learners reported asking their learners to watch them demonstrate an experiment or investigation in at least half the lessons. The corresponding percentages of learners for designing or planning experiments or investigations was 31 per cent; for conducting experiments or investigations the figure was 54 per cent; for working together in small groups on experiments or investigations it was 57 per cent; for writing explanations of what was observed and why it happened accounted for 61 per cent, and for relating what learners are learning in science to daily lives the figure was 77 per cent.

The South African time allocation for each of the content areas (except environmental science) was similar to the international average. The international average and the prevalence of the scientific inquiry activities in South Africa was similar in all categories, except for watching a demonstration of an experiment or conducting an experiment. It would seem, in South Africa, that less than a third of the learners watched a demonstration or conducted an experiment.

Textbooks in mathematics and science classrooms

The textbook is an important resource for the teaching and learning of mathematics and science. Internationally, about two-thirds of mathematics teachers and just over half the science teachers reported using the textbook as the primary basis for their lessons. For the remaining group (approximately one-third of the mathematics and science teachers) the textbook was reported as a supplementary resource.

In South Africa, one-third of mathematics and science teachers reported that they used textbooks as the primary basis for lessons; the others used it as a supplementary resource. About one-third of mathematics and science teachers reported that shortage of textbooks for learners was one of the factors that limited the teaching in the classroom.

South African teachers were encouraged by C2005 to use a range of resources to develop a set of materials and activities for their learners. This could account for the lower reporting of the use of the textbook as a primary basis for lessons. Countries where over 80 per cent of the learners were taught by teachers reporting textbook use as the primary basis for lessons were: Chinese Taipei, Estonia, Hong Kong, Jordan, Korea, Lithuania, Moldova, Netherlands, Norway, Palestinian National Authority, Russian Federation, Scotland, and Sweden. In South Africa, we might have to re-examine the role the textbook performs as a primary basis for lessons.

Test item format

Mathematics and science teachers were asked to report on the extent to which they used multiple-choice and constructed-response questions in their classroom tests and examinations. Table 10.6 provides information on the percentage of learners who were given the two item formats in classroom tests and examinations, as reported by teachers.

Table 10.6: Item formats used by mathematics and science teachers in classrooms as reported by percentage of learners

	Only or mostly constructed response	About half constructed response and half MCQs	Only or mostly MCQs
Mathematics			
South Africa	45	44	11
International	56	32	12
Science			
South Africa	16	72	11
International	28	60	13

For South Africa, at least 55 per cent of the learners were exposed to mathematics MCQs, and at least 90 per cent to mathematics constructed-response questions. In science, at least 80 per cent of the learners were exposed to MCQs and at least 90 per cent to constructed-response questions. The South African patterns are similar to international patterns, and the type of questions asked in the TIMSS instrument would be familiar to most learners.

School contexts

Educational inputs largely take place in schools and these institutions are prime sites for the development of learner potential and performance. In poorer communities, the importance of the schools' role is particularly crucial. In these communities, and in developing countries, the schools very often substitute for a lack of cultural capital and home support; valuable resources that are typically present in more affluent communities and developed countries.

The school provides the context for teaching and learning the curriculum, including, for the purposes of this report, mathematics and science. In this section, information on the demographic characteristics of schools, school resources for mathematics and science teaching, perceptions of school climate, and school attendance problems will be provided. The data appearing in this section was collected from school principals and the mathematics and science teachers.

Schools demographic characteristics

The economic resources of the home and community have an influence on learner achievement. Principals were asked to indicate the percentage of learners in their schools who came from economically disadvantaged homes. Table 10.7 details the principals' responses.

Table 10.7: Principals' reports on the percentage of learners in their schools coming from economically disadvantaged homes, and their average mathematics score

	GNI per capita in US dollars	0–10% economically disadvantaged learners	11–25% economically disadvantaged learners	26–50% economically disadvantaged learners	> 50% economically disadvantaged learners
South Africa	2 500	3%	2%	9%	85%
		479 (44.9)	–	334 (25.7)	237 (3.4)
Botswana	3 010	15%	22%	25%	38%
		385 (11.0)	375 (6.2)	363 (3.2)	354 (3.2)
Ghana	270	4%	8%	18%	71%
		295 (24.1)	308 (14.9)	286 (9.0)	264 (5.9)
Egypt	1 470	11%	24%	23%	42%
		448 (11.8)	410 (8.2)	393 (6.3)	392 (5.5)
International Average		22%	26%	21%	31%
		496 (2.1)	476 (1.3)	460 (1.5)	439 (1.3)

Note: A dash (–) indicates that there was insufficient data to report.

Principals in each country used a definition of economic disadvantage that was relevant to their country. However, this means it is difficult to compare the percentage of learners in the different categories across countries.

In some countries; for example, Chile, Ghana, Indonesia, Lebanon, Malaysia, Morocco, the Palestinian National Authority, the Philippines, South Africa, and Tunisia, principals reported that more than half (52 to 85 per cent) the learners attended schools where the majority of learners came from disadvantaged homes.

Internationally, mathematics achievement scores for learners in schools with few (0–10 per cent) learners from economically disadvantaged homes were 57 scale points higher than for learners in schools possessing a higher percentage (more than 50 percent) of economically disadvantaged learners – 496 points versus 439 points. In South Africa, the average mathematics score for learners in schools with few (0–10 per cent) economically disadvantaged learners was 479, and 237 in schools where more than 50 per cent of the learners come from economically disadvantaged homes – a difference of 242 points. The figures reveal that in South Africa there is a significant impact on achievement scores when a high percentage of learners from economically disadvantaged homes are part of the school population.

School resources to support mathematics and science teaching

Some school resources are specific to mathematics and science, but many are general resources for improving learning opportunities across the curriculum. All resources work together to support mathematics and science teaching and learning.

TIMSS created an index of school resources for mathematics and science. The index for school resources for mathematics was based on the average response to five questions about shortages that affect the general capacity to provide instruction (instructional materials, budget for supplies, school buildings and grounds, heating/cooling and lighting systems, instructional space) and five questions about shortages that specifically affect mathematics teaching (computers for mathematics, computer software for mathematics instruction, calculators for mathematics instruction, library materials relevant to mathematics instruction, and audio-visual resources for mathematics instruction).

The index for availability of school resources for science was constructed in a similar way. The five questions about the general capacity to provide instruction were the same as those described for mathematics and the six questions about shortages that specifically affect science teaching were: science laboratory equipment and materials, computers for science instruction, computer software for science instruction, calculators for science instruction, library materials relevant to science instruction, and audio-visual resources for science instruction.

Learners were placed in the high category if principals reported that shortages, both general and those affecting mathematics in particular, had no or little effect on instructional capacity. The medium level indicates that one type of shortage affected instruction 'some' or 'a lot' and the low level indicates that both types of shortages affected instruction 'some' or 'a lot'. Table 10.8 indicates the percentage of learners in the high, medium and low categories of availability of resources for mathematics and science.

Table 10.8: Index of availability of school resources for mathematics and science, by percentage of learners

	High	Medium	Low
Mathematics			
Availability of resources in South Africa	8	53	39
Availability of resources internationally	26	64	11
Science			
Availability of resources in South Africa	9	52	39
Availability of resources internationally	22	63	12

Internationally, the countries which reported the highest availability of resources for mathematics and science teaching and learning were: Singapore, Hong Kong, the Netherlands, Belgium, Japan, and Australia. Countries which reported the lowest availability of resources for mathematics and science were: Moldova, Bulgaria, the Russian Federation, Serbia, and Botswana. The countries which indicated a high availability of resources attained high achievement scores in mathematics and science. For countries that reported low availability of resources their achievement scores were varied – from high to average to low.

In South African schools, there was a small percentage of schools with a 'high' availability of resources for mathematics and science. About 40 per cent of learners were in schools where principals indicated that the resources for mathematics and science teaching was 'low'. Comparing the South African and the international average suggests that the availability of resources for the teaching and learning of mathematics and science could affect learning outcomes.

Perceptions of school climate

The school environment establishes the climate for learning. TIMSS created two indices to measure the extent to which schools offer a positive school climate – one measured the views of principals and the other the views of teachers. The index was created on the principals and teachers characterisations of the following:

- Teachers' job satisfaction;
- Teachers' understanding of the schools' curricular goals;
- Teachers' degree of success in implementing the schools' curricula;
- Teachers' expectations for learners' achievement;
- Parental support for learners' achievement;
- Parental involvement in schools' activities;
- Learners' regard for school property; and
- Learners' desire to do well in school.

Learners in the high category attended schools where the principals (or teachers) averaged high, or very high, reports for each aspect of school climate. Learners whose principals (or teachers) characterised the school climate as medium were placed in the medium category and principals (or teachers) characterising the school climate as low or very low were placed in the low category. The index of principals' perception of school climate (PPSC) and teachers' perception of school climate (TPSC) is presented in Table 10.9.

Table 10.9: Index of principals' perception of school climate (PPSC) and teachers' perception of school climate (TPSC), by percentage of learners

		High	Medium	Low
South Africa	PPSC	7	45	48
	TPSC	10	46	44
Botswana	PPSC	1	31	68
	TPSC	3	29	68
Ghana	PPSC	13	68	18
	TPSC	17	54	30
International average	PPSC	15	67	18
	TPSC	10	60	30

Internationally, countries where a high number of both the principals and teachers (>40 per cent of learners in these schools) rated the perception of school climate as low were South Africa, Tunisia and Botswana. Countries where a high number of both principals and teachers rated the perception of school climate as high were the United States, Chinese Taipei, Philippines and Israel.

In South Africa, the principals and teachers rated the school climate in a similar way. Approximately half the learners are in schools where the principals' and mathematics and science teachers' perception of school climate is 'low'. Most countries which rated the school climate as high achieved higher achievement scores in mathematics and science. To improve mathematics and science learning in South African schools, interventions facilitating a more conducive teaching and learning environment would seem advisable. By doing this, current negative perceptions of school climate can be replaced by more positive ones, which can only benefit the teaching and learning experience of all concerned.

School attendance problems

School attendance can affect achievement and attitudes regarding mathematics and science. TIMSS constructed an index of good school and class attendance (GSCA), based on schools' responses to three questions about the seriousness of:

- Learners' absenteeism;
- Arriving late at school; and
- Skipping school.

The high index level indicates that a school reported that all three behaviours are not a problem. The low index level indicates that two or more behaviours are a serious problem, or two are a minor problem and one a serious problem. The medium category includes all other possible combinations of the responses. Table 10.10 presents the results of the index.

Table 10.10: Index of good school and class attendance (GSCA), by percentage of learners

	High GSCA	Medium GSCA	Low GSCA
South Africa	6	50	44
Botswana	5	62	33
Ghana	8	69	23
International	23	58	19

Internationally, countries where a high percentage of learners (> than 40 per cent) attended schools classified on the low-level index for GSCA were Lithuania, South Africa and Japan. Countries which achieved the highest GSCA were: Lebanon, Italy, Korea, Chinese Taipei and Belgium – that is, these schools have good school and class attendance.

The data suggests that in South Africa, school and class attendance is a problem – 44 per cent of learners attend schools where the GSCA is classified as low. Efforts to ensure better attendance by learners in South African schools would be energy well spent, as the clear correlation between good attendance and good academic results can only benefit the teaching and learning of mathematics and science in the country.

Summary

Teachers

In South Africa, about 40 per cent of mathematics learners and 50 per cent of science learners were taught by female teachers. The majority of mathematics and science teachers are aged between 30–39, while the average teaching experience of mathematics and science teachers is 11 and 10 years respectively. The international average teaching experience for mathematics and science teachers is 16 and 15 years respectively.

Internationally, about three-quarters of learners are taught by mathematics and science teachers with a university qualification. In South Africa, over 95 per cent of the TIMSS learners are taught by mathematics and teachers who indicated they had completed a post-secondary qualification. Over two-thirds of mathematics and science learners were taught by teachers who indicated that they had studied either mathematics or science in their pre-service training courses. Therefore, the South African mathematics and science teachers could be classified as qualified and knowledgeable in their subject areas. However, in relation to the TIMSS cadre of teachers, the South African mathematics and science teachers appear among the group having the lowest qualifications.

Internationally, about half the learners were taught by teachers who indicated that they had participated in professional development activities in the past two years. The type of professional development activities that most teachers participated in related to mathematics content, pedagogy or instruction. South African teachers attended a higher number of professional development activities than the international average for activities related to mathematics or science content, mathematics or science curriculum, improving critical thinking, and mathematics or science assessment. However, it is surprising that there was a relatively low percentage reporting on professional development activities

relating to mathematics or science pedagogy or instruction, given that C2005 introduced a different way of organising classroom activities.

Classrooms

Internationally, the average number of learners per TIMSS mathematics and science class was 30. In South Africa, the average class size is 45 – the second highest of all TIMSS participants. The South African average class size is large and there are 52 per cent of learners in classes having a class size greater than 41. Within a country there is a slight association, as expected, between achievement score and class size – the score is higher where the class size is smaller. Across countries, learners in similar class sizes achieve different achievement scores.

The emphasis on mathematics and science content-related activities in South Africa and internationally is similar. Also, the emphasis on problem-solving activities in mathematics and scientific investigations in science for South Africa mirrors the international trend.

Internationally, about two-thirds of mathematics teachers, and just over half the science teachers, reported using the textbook as the primary basis for their lessons, the remaining third reported it as a supplementary resource. In South Africa, one-third of mathematics and science teachers reported that they used textbooks as the primary basis for lessons; the others used it as a supplementary resource.

Schools

In South Africa, principals indicated that 3 per cent of learners attended schools with 0–10 per cent economically disadvantaged learners; 2 per cent attended schools with 11–25 per cent economically disadvantaged learners; 9 per cent attended schools with 26–50 per cent economically disadvantaged learners; and 85 per cent attended schools with more than 50 per cent economically disadvantaged learners present. Internationally, the mathematics achievement score for learners in schools with few (0–10 per cent) learners from economically disadvantaged homes was 57 scale points higher than for learners in schools with a higher percentage (more than 50 per cent) of economically disadvantaged learners – 496 points as opposed to 439 points. In South Africa, the average mathematics score for learners in schools with few (0–10 per cent) economically disadvantaged learners is 479, and it is 237 in schools where more than 50 per cent of the learners come from economically disadvantaged homes – a difference of 242 points. In South Africa, there is a high impact on achievement scores of having a high percentage of learners from economically disadvantaged homes.

The response to questions about school climate indicated that about 40 per cent of learners attended schools which had a low resource base for mathematics and science teaching and learning. Furthermore, about half the learners attended schools rated by teachers and principals as having a low school climate, and 44 per cent of learners attended schools which teachers and principals rated as having low school and class attendance. The school climate and environment for most learners do not seem to be conducive to high quality teaching and learning of mathematics and science.