



## The good teacher: what teachers need to teach well

Who are the teachers that get good results in teaching mathematics and science? Does gender, qualifications, attitude or experience have anything to do with it? *Fabian Arends* analysed results from the 2011 Trends in International Mathematics and Science Study (TIMSS) and found a dissonance between what teachers say about themselves and the achievements of their students.

**T**his article attempts to describe the characteristics of teachers that are most likely to have an impact on, or be associated with, learner achievement. 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 the 2011 TIMSS. As such, the findings should be thought of as indicative of, rather than representative of, South African teachers.

### Gender, age and experience

Most mathematics learners in grade 9 (58%) were taught by male teachers, while female teachers in science were in the majority (about 57%). Since 2002, the proportion of learners taught by female teachers has increased from 39% in 2002 to 42% in 2011 (mathematics), and from 43% in 2002 to 57% in 2011 (science). Mathematics and science achievement was on

average higher among learners taught by female teachers in mathematics (364 vs. 337) and science (330 vs. 318).

The TIMSS teacher corps has matured since 2002, with the majority of mathematics and science learners (2011) being taught by teachers in their Forties, while in 2002 the majority of mathematics and science learners were taught by teachers in their Thirties. Approximately 60% and more of mathematics and science learners were taught by teachers with more than 10 years' teaching experience. Of these, more than 30% of mathematics and science learners were taught by teachers with more than 20 years' teaching experience.

An important finding is that the results do not show a relationship between learner performance and the age of teachers, or learner performance and teachers' years of experience. This is in contrast with the international experience, where performance and teachers' experience have a positive correlation.

### Academic qualifications

Table 1 presents teachers' reports regarding their highest level of formal education. On average, across the ninth grade, 98% of the TIMSS learners had mathematics and science teachers with a post-secondary qualification. Of these, 43% and 33% respectively had mathematics and science teachers with at least an initial university degree, and 17% and 20% respectively had teachers with a completed postgraduate degree.

There was an increase in the percentage of teachers with both an initial and postgraduate degree from 2002 to 2011.

The percentage of mathematics teachers with an initial and postgraduate degree increased from 23% and 8% in 2002 respectively to 43% and 17% in 2011 respectively. The percentage of science teachers with an initial and postgraduate degree increased from 26% and 10% in 2002 respectively to 33% and 20% in 2011 respectively (Table 1). On average, mathematics and science learners taught by teachers with an initial and postgraduate degree scored higher than those learners taught by teachers with a diploma.

Table 1: Highest educational level of mathematics and science teachers: 2002 and 2011

		2011	Average Achievement	2002	Average Achievement
Mathematics teachers	Finished post-secondary education	38	338	64	269
	Completed bachelor's degree or equivalent	43	356	23	305
	Completed post-graduate university degree	17	353	8	367
Science teachers	Did not complete grade 12	1	-	1	-
	Finished post-secondary education	46	314	61	254
	Completed bachelor's degree or equivalent	33	326	26	287
	Completed post-graduate university degree	20	342	10	307

### 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.

Pedagogy training (the method and practise of teaching) seems to play an important role. Of grade 9 mathematics learners, some 54% were taught by teachers that specialised in mathematics but did not have any pedagogy training, and 27% specialised in both mathematics and pedagogy. Learners in the latter group scored higher than learners taught by teachers that specialised in either mathematics or pedagogy.

The same applied to teachers that specialised in science but not pedagogy: science achievement was highest, on average, among learners taught by teachers specialising in both science and pedagogy (20%).

### 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.

More than half the learners were taught by teachers who indicated that they had participated in professional development activities in the last two years. The type of professional development activities that most mathematics and science teachers had participated in related to

mathematics/science content, mathematics/science curriculum, and mathematics/science assessment.

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.

A relatively low percentage of learners were taught by mathematics and science teachers who had participated in professional development in mathematics or science pedagogy/instruction. There was a high level of professional development among TIMSS mathematics and science teachers, but this did not translate into outcomes for students.

### Readiness to teach

The 2011 TIMSS asked teachers how ready they felt to teach the mathematics and science topics included in the TIMSS mathematics and science framework.

In South Africa, about 80% and more of learners had mathematics teachers who felt very well prepared to teach the mathematics topics, and about 57% and more of learners had science teachers who felt very well prepared to teach the science topics. Across the mathematics content domains,

most learners had teachers who felt very well prepared to teach algebra (96%) with relatively fewer well prepared in numbers (86%), geometry (82%), data and chance (80%).

Across the science content domains, most learners had teachers who felt very well prepared to teach chemistry (74%) and biology (73%), and fewer learners had teachers who felt very well prepared to teach physics (62%) and the earth sciences (57%).

### The role of motivation and career satisfaction

Teachers who are satisfied with their profession and the working conditions at their schools are more motivated to teach and to prepare their instructions.

Overall, almost all teachers who taught mathematics and science, 90% and 92% respectively, reported that they were “satisfied” or “somewhat satisfied”. Teachers with a strong sense of personal ability to organise and execute teaching

are more open to new ideas and less likely to experience emotional burnout. Research has shown that self-confidence in their teaching skills is not only associated with professional behaviour, but also with learners’ performance and resulting motivation.

Internationally, more than 70% of learners had mathematics and science teachers who were very confident in teaching mathematics and science to their respective classes, while in South Africa, more than 80% of learners had teachers who felt this way (Table 2).

On average, the achievement scores of learners with teachers who felt very confident (mathematics 354 and science 332) were slightly higher than learners with teachers who were only somewhat confident (mathematics 336 and science 317). In conclusion, the South African 2011 TIMSS teachers were older; experienced; better qualified than they were in 2002; considered

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Table 2: Confidence in teaching and career satisfaction

Teachers’ confidence in teaching		Very confident		Somewhat confident	
		Learners %	AA*	Learners %	AA*
Mathematics	SA ave.**	88 (2.8)	350	12 (2.8)	333
	Int. ave.***	76 (0.5)	470	24 (0.5)	456
Science	SA ave.	81 (3.2)	327	19 (3.2)	316
	Int. ave	73 (0.4)	479	27 (0.4)	467

Note: \* Average Achievement; \*\* South African average; \*\*\* International average

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themselves to be well prepared to teach mathematics and science topics; were confident in teaching their respective subjects; and were well satisfied with their profession. While all the teacher ingredients that were needed for good learner outcomes were present in South African TIMSS schools, they did not translate into these outcomes for students.

The analysis showed the importance of teachers having pedagogic training, and although there was a focus on professional development, not enough emphasis was placed on mathematics and science pedagogy/instruction.

Further analysis is required to ascertain why teaching, which is arguably the strongest school-level determinant of student achievement, does not sufficiently contribute to higher learner mathematics and science achievement. ■

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