Informing mathematics pedagogy

Results from the most recent Trends in International Mathematics and Science Study can inform teaching methods in the classroom, says **Sue Thomson**.

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A new analysis of a selection of mathematics items from the 2007 Trends in International Mathematics and Science Study (TIMSS 2007) has illustrated areas of strength and, particularly weaknesses, for Australian students.

TIMSS 2007 was the fourth in a cycle of internationally comparative assessments, conducted by the International Association for the Evaluation of Educational Achievement (IEA), dedicated to improving teaching and learning in mathematics and science for students around the world.

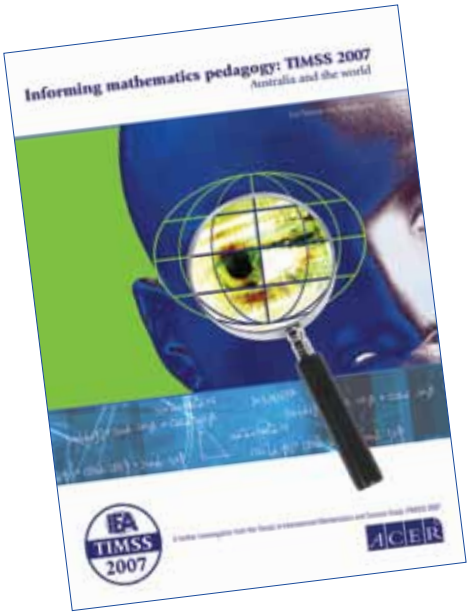
Carried out every four years with Year 4 and Year 8 students, TIMSS provides data about national and international trends in mathematics and science achievement. It provides a level of international benchmarking to complement national assessments at Years 3, 5, 7 and 9 and other sample-based national studies.

The main Australian national report, *TIMSS 2007: Taking a closer look at mathematics and science in Australia*, released in December last year, provided a 'big picture' view of Australian Year 4 and 8 students' achievement in mathematics and science. It found that Australian Year 4 students displayed some improvement in mathematics achievement since 2003 but achievement levels of Australian students remained static in Year 8 mathematics.

This new report, *Informing mathematics pedagogy: TIMSS 07 Australia and the world*, aims to provide teachers with more detailed information on what Australian students are actually able to do in mathematics in terms of the TIMSS assessment. The report discusses a selection of items from the publicly available questions of the TIMSS 2007 assessment.

The main purpose of this report is to present TIMSS 2007 results in a way that can inform pedagogy. The report explores students' responses to a selection of questions and then considers what these responses might indicate about students' level of understanding for a particular question and its content area. It breaks down responses to individual questions to allow teachers to ascertain whether the mistakes typically made by students in the sample are also mistakes made by their own students. This 'micro' perspective of student achievement may help teachers identify and address areas of weakness in their classes.

To place students' responses in a wider context, the item breakdown presented in this report for Australian students



was compared with the responses from two other countries for international comparison. The first was Chinese-Taipei, which consistently performed in the top three of the 36 countries at Year 4, and the 49 countries at Year 8. Comparison with these students' responses provided an 'upper benchmark' for Australian students. The second country chosen was the United States as the two countries are often compared to one another because of curriculum and general cultural similarities.

Students' responses to five mathematics items at each year level are explored.

Where a multiple-choice question was answered incorrectly it has been possible to determine which incorrect answer (or distracter) was chosen and why this may have been.

For example one Year 4 question asked students to calculate the area of a fence being painted. Forty two per cent of Australian students selected an incorrect answer to this question that suggested they had added rather than multiplied the width and length of the fence.

Another example indicated Australian Year 4 students had not mastered the ability to multiply two-digit numbers together, whereas half of US students and a majority of Chinese-Taipei students had.

While it is difficult to identify trends based on a small sample of items there were also some central themes that emerged through the item analysis conducted. The Year 4 mathematics items reviewed students' skills in number, geometry and data. Australian students performed well on the item assessing their understanding of shapes but their achievement was poorer for other areas, especially in terms related to multiplication, fractions and area.

For Year 8 mathematics, the five items investigated students' understanding of algebra, number, geometry and data. Items assessing algebra revealed a particular area of weakness for Australian students as did a data question that contained components of probability and fractions.

One Year 8 mathematics question, for example, required students to collect like terms in an algebraic expression. Results suggested that only half of the Australian students understood this concept. In contrast, 90 per cent of Chinese-Tapei students answered the question correctly.

Another question tested students' knowledge of data and chance. The question told students how many beads were in a bowl and the probability that a random bead would be blue, and asked them then to choose how many blue beads must then be in the bowl, testing students' understanding of probability and equivalent fractions. While only 45 per cent of Australian students answered this correctly, this is perhaps not too disappointing a result, given that teachers of only 35 per cent of Australian students reported that they had covered the topic of problem solving via the use of probabilistic outcomes.

For some of the items discussed the percentage of answers omitted was quite large. Avoidance of these items is an issue of concern whether it was due to poor competence beliefs or lack of effort. Lastly, larger gender differences for the rate of correct responses tended to favour boys. This trend meets with the general TIMSS 2007 finding that boys outperformed girls in mathematics.

On the most part, the international comparisons made between Australia, the US and Chinese-Taipei served to highlight areas of weakness for Australian students. There was an obvious gap between the understanding of Australian students and their Chinese-Taipei counterparts. Furthermore, where Australian and US students previously achieved at similar levels (see TIMSS 2003 results), the US outperformed Australia in almost all the items reviewed.

On the other hand, the international comparison made also illustrated the trap of simply considering average level results for a country. In three of the 10 items reviewed, Chinese-Taipei was outperformed by either the US or Australia. This finding does not diminish the high achievement levels of the Chinese-Taipei students who participated in TIMSS 2007 but emphasises that, while they were ranked in the top three for all grade/curriculum areas, Chinese-Taipei students still demonstrated skill deficiencies in some areas.

The strengths and weaknesses of students' responses highlighted in this report were likely due to many different factors. However, with more awareness of students' understanding in different curriculum areas, educators can develop learning strategies that suit their particular teaching styles and unique educational contexts.

Further information can be found in *Informing mathematics pedagogy: TIMSS 07 Australia and the world* by Sue Thomson and Sarah Buckley, available from the TIMSS website at <www.acer.edu.au/timss> A CD is included with the report that contains all of the TIMSS 2007 released items so that teachers may see the types of questions students completed when they participated in the project.

Further information and all reports on all TIMSS assessments are available from the TIMSS website at <www.acer.edu.au/timss> ■