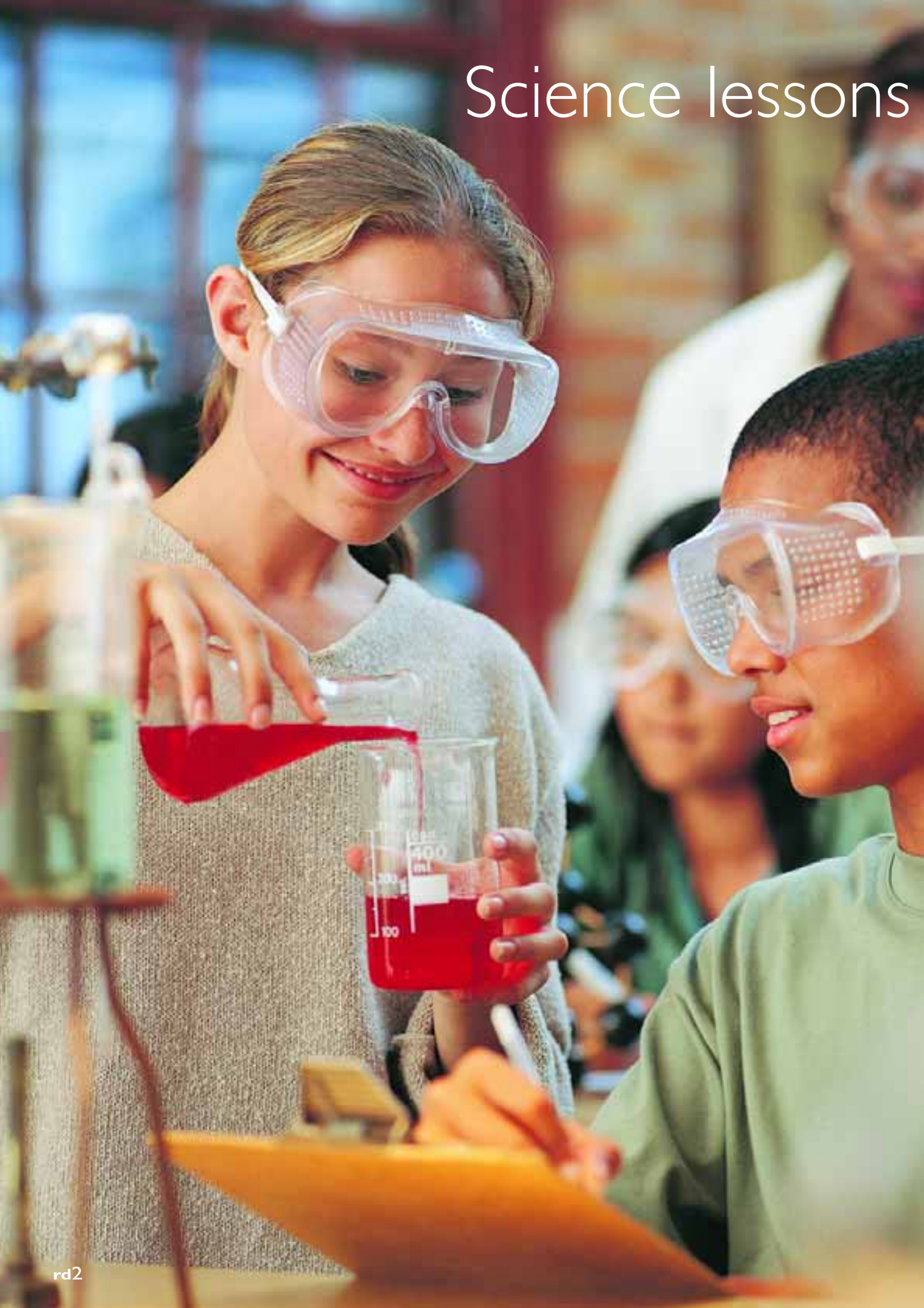
Science lessons



around the world

Dr Jan Lokan

Jan was an Assistant Director of ACER. She directed many projects, including the Australian TIMSS and PISA studies, before her recent retirement.

The quality of Year 8 science teaching in Australia has been endorsed by the latest findings from the Third International Mathematics and Science Study (TIMSS) 1999 Video Study. Co-author of the Australian report, ***Jan Lokan*** *explains the study's objectives and its findings.*

The study investigated Year 8 science teaching in Australia, Japan, The Czech Republic and The Netherlands, all of which achieved relatively highly in the TIMSS 1995 and 1999 written assessments, and the United States, which achieved at average level only. A sample of Year 8 science lessons in each country was videotaped and later analysed to identify common features as well as distinctive characteristics in teaching approaches across the five countries.

Internationally, the science component of the TIMSS Video study comprised a total of 439 Year 8 lessons collected from the five participating countries. In Australia the study involved 87 Australian teachers and around 2000 students in a randomly-selected sample of schools from all regions and school sectors. Lessons were videotaped between June 1999 and May 2000.

The international study was conducted by LessonLab Research Institute based in the United States. ACER conducted the Australian component of the study on behalf of the Commonwealth, state and territory governments. The Australian report, *Teaching Science in Australia*, by Jan Lokan, Hilary Hollingsworth and Mark Hackling was published by ACER in April.

The reports on science teaching follow the reports of the mathematics component of the study, which were released in 2003. The mathematics study involved seven countries, including Australia, and identified no single best method of teaching eighth-grade mathematics in high achieving countries.

Study objectives

The objectives of the TIMSS Video science study included developing observational measures of classroom instruction that could serve as indicators of teaching practices in each country; comparing teaching practices among countries and identifying similar or different lesson features across countries, in particular differences between higher and lower-achieving countries; and describing patterns of teaching practices within each country.

How does videotaping lessons help us to achieve these objectives? Video-based studies help researchers to better understand, and hopefully improve, student learning by making it possible to closely observe and analyse what happens in classroom situations. Researchers can observe interactions between teachers and students, break down the amount of time spent on different components of a lesson and analyse these components in detail. Further, the existence of the tapes means that lessons can be analysed many times from a variety of perspectives.

International findings

The researchers observed that there is more than one way to teach science successfully, supporting the proposition that teaching is culturally based. Teachers in the participating countries used a variety of teaching methods and combined them in different ways.

Of particular interest was whether it was possible to identify characteristics of science teaching shared by the higher-achieving countries that were different from those observed in the United States. The four higher-achieving countries shared two features. Firstly, lessons in each of the countries had high content standards and high expectations for student learning. Secondly, rather than exposing students to a variety of teaching methods and content, the science lessons in each higher-achieving country reflected a common core instructional approach that was content-focused. The main difference in Year 8 science teaching between the four higher-achieving countries and the United States was that, although United States students were exposed to a variety of organisational structures, content and activities, these features were not typically used in ways that would offer students a clear and coherent picture of conceptual links that can be made between content ideas.

Australian findings

Australian lessons typically involved gathering and analysing data through independent practical activity and interpreting the results to develop scientific concepts. Real-life experiences and issues were often used to help students connect ideas. In addition, Australian teachers were well trained and mostly well resourced. Compared to the other participating countries, Australian lessons most closely resembled those in Japan.

The style of science teaching in both countries tended to focus on developing a limited number of ideas by making connections between ideas and evidence. The lessons were more coherently presented than in the other countries and the students were typically engaged in practical investigations. In contrast with Japan, Australian science lessons supported the development of scientific ideas more often with real-life examples but less often with visual representations.

Despite the largely positive findings for Australia, there was a little emphasis on student-directed investigations and a generally basic level of content covered in the Australian lessons. Fifty-seven per cent of Australian lessons focused on content that was generally at only a basic level for Year 8 and would have offered limited challenge for students, particularly more able students. Thirty-three per cent of lessons provided a mix of basic and challenging content and only nine per cent involved content that was judged to be highly challenging throughout. The findings for Australia on this aspect were almost identical to those for Japan.

Conclusions

What did we learn about science teaching in Australia from observing the sample of Australian Year 8 lessons? In many respects Australian Year 8 science teaching was found to resemble a model of ideal science teaching derived from research and Australian curriculum documents. Students were provided with good opportunities to achieve the stated goals of the science curriculum and to develop aspects of their scientific literacy. Overall the Australian lessons can be characterised as providing many opportunities for students to practise several of the important scientific inquiry skills such as collection and interpretation of scientific data. Lessons were coherently-structured, generally providing connected, richly supported material as the content was developed.

There are areas where improvements could be made, including to the content of lessons, which was typically only at a basic level for Year 8. Students did not have much opportunity to formulate their own research questions, devise their own experimental procedures and determine how to analyse their own data because the independent practical work was largely teacher-directed. Opportunities to discuss conclusions arising from the practical activities were also missed in half of the Australian lessons that featured such activities. Australian Year 8 students would benefit from more opportunities to learn and practise higher-order inquiry skills such as designing their own investigations and taking part in more class discussions about the results of their practical work.

Given the centrality of inquiry-based learning in Australian science teaching, the commitment to scientific literacy and the emphasis on independent practical work, there appears to be a need to allow more student-directed investigations and more whole-class discussion of the results and conclusions arising from the practical activities to maximise students' opportunities to develop and consolidate the scientific concepts underlying their investigations.

Further information

More information about the study and additional findings are contained in the full report, *Teaching Science in Australia*, by Jan Lokan, Hilary Hollingsworth and Mark Hackling. The report is available from the ACER website at *www.acer.edu.au* ■

Key findings:

- The Australian teachers were mostly well-qualified to teach science, which they had been teaching for an average of 14 years. Most said they were familiar with current ideas in science teaching and learning.
- Ninety per cent of the lessons took place in science laboratories. The teachers said they had sufficient resources except for computers and Internet access.[1]
- Introduction of new content was by far the most common lesson activity in all countries, consuming two thirds or more of the lesson time, on average (Australia 85%). Other types of activity varied, including review of previous content, going over homework and assessing student learning, all of which occurred rarely in Australia, Japan and the United States.
- In Australia 60 per cent of the lessons were devoted entirely to the development of new content, compared with 16 per cent of Czech lessons and 91 per cent of Dutch lessons.
- Australia, along with Japan, had the highest average percentage of lesson time allocated to practical activities (42%), activities which occurred in 90 per cent of the Australian lessons. Although practical activities featured in over 80 per cent of lessons in the Czech Republic, these activities occupied an average of only 14 per cent of the lesson time.
- Australian lessons were well-structured. Australia and Japan were the only countries found to have strong conceptual links in the material presented in the majority of content-focused lessons.
- Real-life issues and first-hand data were used to support the development of ideas in the majority of lessons, which tended to feature multiple activities likely to engage the students' interest.

[1] By now this situation would be expected to be much improved.