

## Science education for global citizenship

*David Geelan*

Students need an understanding of the nature of science – what it means to make a scientific claim, what evidence is relevant to supporting such a claim and how to critically evaluate that evidence – and of the relationships between science, technology and society.

Such understanding will help science education to pursue its traditional role of training and educating the scientists and engineers of the future. Australia is currently struggling in this area, with fewer students choosing to study science in senior high school and at university. However, an understanding of the nature of science will also help to prepare students as citizens for many of the biggest issues that Australia will face in the next few decades.

These challenges share two characteristics: firstly, they are global rather than national in scope, and secondly, science is important in finding solutions to them. Facing issues such as climate change, pollution, pandemics and the management of water and energy, *all* students need to leave our schools with an understanding of science that prepares them to take an active role in making political decisions for the future.

Science in schools has historically tended to privilege science content at the expense of developing students' understanding of the social relevance of the subject, and school science has also lacked strong links to students' lived experience. In fact, science subjects have acted as sorting mechanisms to filter out the majority of students who will not proceed to science careers, sending them the unintended message 'you can't do science'. The need for a new approach has been acknowledged by many teachers, and for some it has become an area of focus, but the rate at which teachers are actually implementing change varies according to their levels of knowledge, skills and confidence.

Science education that prepares students for citizenship is not a new idea. A movement that emerged in the 1980s called for science education to include social contexts and technological perspectives, resulting in an approach that is now usually known as Science, Technology, Society and Environment (STSE).

In Australia, science syllabuses in each state are paying attention to these issues, which are also represented in current [national curriculum guidelines](#).

These syllabuses are supported by science education programs, which include the [Primary Connections](#) materials developed by the Australian Academy of Science, helping primary teachers cover science in connected and interdisciplinary ways, and [Science by Doing](#), another promising package, for the junior high-school level.

A further approach that facilitates this kind of planning and teaching is the 'Curricular Emphases' model of science education, developed by Dr Doug Roberts in Canada, and expanded and adapted by [Dr Frank Jenkins](#). This model has been tested over many years, and has informed my teacher education work with beginning middle and high-school science teachers in Canada and Australia. It can be applied to all levels of science education and may be especially helpful for beginning teachers and those with fairly limited science backgrounds. It offers a way to make science relevant and engaging for all students, without 'dumbing down' the subject; it delivers a full science curriculum.

The three curricular emphases described in this approach are: (1) Nature of Science, (2) Technology and (3) Science and Society. One of these three emphases is applied to each unit undertaken over the year in science classes. The emphasis chosen for a particular unit is the one that best fits with and complements that unit. These emphases are

selected by the curriculum planners – individual teachers, heads of department, or groups of staff who develop plans for classroom teaching from the government-mandated syllabus.

For example, a Year 10 science unit might introduce the basics of chemistry with a Nature of Science emphasis, covering science's 'rules of knowledge' that students, as citizens, can use to evaluate the knowledge claims made in advertisements and media reports. Student discussions are likely to form an important part of the unit. In some cases students may be called on to make scientific claims and support them with scientific evidence, rather than simply share opinions. By evaluating and synthesising knowledge they can learn to respect evidence and value intellectual honesty. Other discussions, for example, those around the topic of pollution, allow room for students' own views, because they call on students to relate science to social, environmental and economic issues where there are legitimate differences of opinion.

To take another example, a Year 12 physics class might focus on subatomic particles and the nature of matter, with a curricular emphasis on Science and Society. The unit could include interactive computer simulations of the key experiments in the history of scientific understanding of the atom, such as J.J. Thomson's experiments with cathode ray tubes in discovering the electron, Rutherford's alpha particle scattering experiment, Millikan's oil drop experiment and the photoelectric effect.

A third unit might give Year 12 physics a Technology emphasis. It could illustrate the interaction between science and technology, showing how in cases such as brewing and steelmaking, known technologies long preceded the science needed to explain them, and in other cases scientific advances did not occur until appropriate technologies were developed to allow necessary experiments to be conducted. While units focused on technology may involve sophisticated apparatus, there is value in using everyday materials found in the classroom, such as plastic rulers, to help link scientific understanding to students' everyday lives.

One of the challenges with STSE approaches to science education has been that teachers have felt overwhelmed. They have often felt as though they have to attend to everything, all the time. The Curricular Emphases model addresses this issue by separating out the various imperatives over time: each emphasis will be addressed in one or more units in the course of each year of schooling. The model integrates the STSE material with the science content, rather than adding it as yet another stressful demand on already busy teachers with full curriculums.

Science education that is inclusive rather than exclusive is a worthwhile goal. A science education that says to all of our children 'you can do science, and science is relevant to your life and your interests' will better serve the nation and the world – and also ensure the supply of future scientists.

*[Dr Geelan](#) is one of the authors in Pearson Education's [Science Ways](#) series; and a Senior Lecturer at the University of Queensland's School of Education. This article appeared in *Curriculum Leadership* on 6 November 2009*