Boosting science learning and engagement: What will it take?

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Responding to societal trends

- The public now needs to engage with science in very different ways
- Science itself has changed - we need to respond to the different environments in which scientists work
- Knowledge has changed dramatically in its availability, and form
- Changing nature of youth. Notions of career and the nature of occupations is very different.
- Science is being challenged from a range of directions.
- The changing nature of schooling.

Science education health check

- Declining participation in post compulsory science
- Shortage of science teachers
- International reports concerning decreasing student engagement with science

Do we need to re imagine science education?

What might that look like?

Deakin Science Teacher Education exploration: Data gathering 2005

- Exploring the nature of contemporary science through focus groups with scientists
- Exploring what a science degree offers, or should offer, to the 40+% of graduates working outside their discipline.
- Exploring what features of a science degree might widen the pool of students prepared to consider science, and science teaching.

Focus groups of scientists:
Australia's research priorities

- An environmentally sustainable Australia
  - Water – a critical resource
  - Responding to climate change and variability
- Promoting and maintaining good health
  - Preventative healthcare
- Frontier technologies for building and transforming Australian industry
  - Frontier technologies
  - Advanced materials
- Safeguarding Australia
  - Protecting Australia from diseases and pests

Science and the public

- The focus groups emphasised the importance of public perspectives and understandings in relation to science
- There were two aspects to this:

- The need to develop a culture of innovation and willingness to engage with new technologies.
  - The public must be engaged with science if we are to implement technologies which can save humanity and the planet (*Protecting Australia from invasive pests and diseases)*
  - There is a lack of awareness at community level with the consequent danger of the nation being left behind in manufacturing (*Advanced materials)*
  - There are many opportunities for new science-based technologies and we need the attitude and the dream to be able to grasp some of these (*Frontier technologies)*

- The need to develop a better understanding of science and technology to promote reasoned debate concerning impacts on individuals and communities.
  - It is imperative that individuals understand what the changes will mean for their area and what the impact will be (*Responding to climate change and variability)*
  - Community attitudes are important as professionals will not recommend the use of technologies if there is likely to be community concern with the outcomes (*Water – a critical resource*)

The nature of science

- The view of science that emerged, that was shared by all the groups, was one where:
  - Science is constantly evolving.
  - Science is practised in multidisciplinary teams.
  - All major areas of science are bound up with social and ethical issues and hence public policy. Science is never seen as providing all the answers for public or personal decision making.
  - Science and technology are inextricably linked.
  - Science often deals with complex systems which involve system level thinking, and balancing of interconnected effects when framing policy direction.

Capabilities of scientists

- The focus groups emphasised the importance of scientists
  - being able to communicate effectively to multiple audiences; and
  - to work in multidisciplinary teams;
  - to have well developed analytical thinking skills; and
  - to understand the social and ethical context in which they work.

- ‘science knowledge grows rapidly and so it is important that science graduates are committed to life-long learning and have the skills to be life-long learners’.
- ‘there is a blurring in the boundaries between the traditional sciences. It is inappropriate to prepare people in the traditional way when the workplace requires people to work across the discipline boundaries’.
- ‘It is inappropriate for scientists to be trained only in a narrow specialization. While expert knowledge is required, it is important that scientists understand the social context and ethical climate in which they work’.
- ‘emerging technologies are having a significant impact on the way in which science is being done. There will be increasing focus on systems which allow the manipulation of large amounts of data’.

So what of school science?

- A number of the focus groups noted a disjunction between traditional images of science, particularly represented in science education, and the way contemporary science operates and the abilities required of those working in the field

- The focus groups commonly recommended emphasizing:
  - the processes and skills and habits of mind of science were most frequently the focus, but also communication, team work, and lateral thinking.
  - the need to focus on relevance, engagement, enjoyment;
  - the need to teach science in a multidisciplinary framework
  - the need to teach science within contexts that allow discussion of ethical and social issues;
  - the need to appreciate the way sciences and scientists really work.

Study 2: Interviews with science graduates working outside their discipline

- The foci of the interview:
  - what led them to enrol in a BSc
  - the skills they utilise in their work
  - the provision of the BSc for their work place needs
  - the influence of tertiary science on their personal lives

Findings concerning skills and attributes

- They described similar skills to those described for people working in science research and development, and surprisingly little mention of knowledge even in related areas.
- The skills they particularly emphasized were:
  - Communication
  - Analytical thinking

Communication

- *And communication is a huge part of this role. So if you can communicate with them in their language and understand how they think, that helps.*
- *…science communication is critical … you're going to be dealing with people who are affected by your science, and if you don't make that connection that what you do as a scientist affects the community or it's going to affect somebody, then I don't think you should be doing science.*
- *In my role I have to deal with chemists, meteorologists, computer people, managers, members of the executive sometimes, marine biologists and we have to understand each other. So it is very important to be able to communicate across the disciplinary boundaries.*

Analytical thinking

- *I'd say the most relevant parts to my current working life would be just the ability to treat information in a methodical way. To be able to organise information; to be able to write concisely, in a scientific sense; to be able to make deductions, conclusions based on facts and inferences, and these are just as important in my current job as they would be in a purely scientific job.*
- *I do value being able to use that scientific method in a very general way in how I do my work–being able to look at the facts, and .. work out a theory that seems to explain what we are observing.*
- *The way of thinking about a problem… I am actually applying the basic scientific methodology.*

Market research with students

- 149 students at years 10 and 11
- The features of a science degree course most likely to encourage student entry are that at the completion of the course they would have a chance to:
  - have a variety of career possibilities;
  - get a job where they will be working with people;
- while the features least likely to encourage student entry :
  - become a science teacher;
  - work in a laboratory;
  - become a science researcher;

Implications of studies

- School science should reflect the range of contexts and ways in which people apply what has been learnt from their science studies. That is it should:
  - include a focus on science in contemporary settings, addressing social and ethical issues;
  - maximise opportunities for student to develop skills such as communicating and analytical thinking;
  - motivate and prepare students to engage with science ideas and issues throughout their lives;
  - create links with science practised outside the school setting.

Questions

- How can we ensure that school science programs reflect contemporary science?
- How do we ensure that citizens are able and interested to engage with social and ethical issues around applications of science?
- What image of potential careers do our science programs present? Is this an issue we should think about? What should be done?
- Given the issues and perspectives raised at this conference, how might we boost student engagement and learning in science?
- What are the key points at which we need to exert pressure for change?
- What examples can we find in our current practice that might give us directions for ways forward?