

Expert Working Group on Developing an Evidence Base for Science Engagement in Australia

Recommendations

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Executive summary

The Federal Government's goals for a better Australia rely on the creative capabilities of the constituent parts of the national innovation system, within which a scientifically aware Australian public needs to play a key role. The *Inspiring Australia* report, in particular Recommendation 15, recognises that Australia requires a strategic capability to design, target and review effective science engagement activities to guide future investment, contributing to the building of science communication capacity, professionalism and excellence:

Recommendation 15: Developing an Evidence Base

That the national initiative support a program of research in science engagement—such as baseline and longitudinal attitudinal and behavioural studies, activity audits, program evaluations and impact assessments—to inform future investment decisions by government and its partners.

To this aim, a short-term Expert Working Group was commissioned by the Department of Innovation, Industry, Science and Research to offer a plan for identifying and sharing best practice for an evidence base for science engagement in Australia.

The Expert Working Group finds that much needs to be done to create stronger links between the constituent parts of Australia's national innovation system. They propose ten recommendations divided into three main themes: *The Australian Public*, *Science Engagement Enterprises*, and *Funding for Science Communication*, that inform Recommendation 15 of the *Inspiring Australia* report.

The recommendations acknowledge the pivotal role ascribed to innovation by the *Powering Ideas* budget paper, in particular to prepare Australia to face future social, economic and environmental challenges mediated by global changes. Strong links between the constituent parts of Australia's national innovation system are key to addressing those challenges.

Consistent with Recommendation 15 of the *Inspiring Australia* report, the recommendations proposed by the Expert Working Group recognise the importance of science communication in strengthening links between the constituent parts and, by extension, enabling greater and more effective national contribution to innovation. This implies that the creative capabilities of Australian minds need to exploit fully the nature and effectiveness of these links by being open to synthesis of science and social science methods and knowledge. Developing strong links between constituent parts would enable Australians to inspire and participate in innovation by embracing multidisciplinary approaches across the sciences, the arts and the humanities. However, as the explorations of this Expert Working Group have demonstrated, research and evaluation into the role of science communication in these links is presently lacking.

The actions recommended to strengthen the links between the constituent parts of the national innovation system include: first, monitoring and addressing the Australian public's

diverse requirements for scientific engagement. The public's changing attitudes to national and global science and technology issues must also be monitored (Recommendation Theme One: *The Australian Public*). Second, science engagement enterprises in Australia need to be assessed in terms of how well they meet the Australian public's requirements for science engagement as well as in terms of the ability of these enterprises to yield definite and practical outcomes that are consistent with the aims of the *Inspiring Australia* report (Recommendation Theme Two: *Science Engagement Enterprises*). Third, there needs to be national recognition and formalised research funding for science communication and its sub-categories (Recommendation Theme Three: *Funding for Science Communication*).

These recommendations require immediate implementation if Australia is to make best use of the scientific research and development foreshadowed in the *Powering Ideas* agenda.

Recommendations

These recommendations require immediate implementation, with the exception of Recommendation 4, which requires a longer timeframe.

| Theme | Recommendations |
|-----------------------------------|--|
| The Australian Public | <ol style="list-style-type: none"> 1 Investigate and continue to monitor regularly the Australian public's attitudes towards new science and technology, and the public's perceptions of Australia's scientific research priorities. 2 Investigate and measure the different science engagement needs and requirements of the Australian public. 3 Assess the aims and objectives of science engagement enterprises, having measured and prioritised the science engagement needs and requirements of the Australian public. (see also Recommendation 2) 4 Conduct longitudinal studies to assess the Australian public's behavioural and attitudinal changes that may result from engagement with different enterprises, including the effect of science education on their subsequent engagement with science. |
| Science Engagement Enterprises | <ol style="list-style-type: none"> 5 Audit, classify and update the diverse enterprises which constitute science communication activities and programs that are currently conducted in Australia. 6 Develop, with input from scientists, science communicators and professionals from the social sciences, the arts and the humanities, effective, meaningful and research-based tools to measure rigorously the Australian public's engagement with science through science engagement enterprises. 7 Research and investigate the efficacy of innovative science engagement enterprises, including the role of popular media and social media. |
| Funding for Science Communication | <ol style="list-style-type: none"> 8 Immediately implement formal recognition by the Australian Research Council (ARC) and the National Health and Medical Research Council (NHMRC) of the discipline of Science Communication and its sub-categories of different aspects of science engagement. 9 Recognise and require, from the proposal stage of ARC and NHMRC grant applications, the communication of scientific research to a wide spectrum of constituents, within a framework of human endeavour. 10 Sustainably fund, through Government and other sources, science engagement enterprises that are innovative, creative and which can be shown to have definite and practical outcomes in keeping with the aims of the Inspiring Australia document. |

Rationale

The Australian Government's goal is to create a better Australia—a fairer, richer, healthier and greener Australia that can meet the challenges and grasp the opportunities of the twenty-first century. Our capacity for invention and discovery depends on the strength of our national innovation system.

One way to make the system stronger is by strengthening its constituent parts. The other is by strengthening the links between those parts. Australia needs to do both. (Extracts from *Powering Ideas: An Innovation Agenda for the 21st Century*, p. 1)

Powering Ideas: An Innovation Agenda for the 21st Century recognises the pivotal role of innovation in preparing Australia to face future economic, social, environmental and global challenges. The report acknowledges that our national innovation system relies on the creative capabilities of Australian 'entrepreneurs, policy-makers, researchers, workers and consumers'. These 'constituent parts' of the national innovation system require the support of a sound science education, whose long-term goal is to strengthen the scientific literacy base of Australia, thus making the system itself stronger.

Strengthening the 'links between the parts' is, however, dependent on *science communication* between the parts. Each part of the system needs to communicate with and be understood by the other parts, if the system is to function effectively. Strong links are forged through the application of a deep understanding of the scientific relationships between the parts, and an understanding of the contributions each can make to the scientific enterprise and, by extension, to innovation. It is essential, therefore, to research and evaluate these links in order to make them more effective. At present, little is known in this regard.

Conventional measurements of scientific literacy do not enable more immediate innovation outcomes because they do not measure the nature and strength of the links between constituent parts. They provide a snapshot of public knowledge of basic facts, which has been clearly demonstrated to be resistant to short-term change. Research in science communication, on the other hand, will address present engagement strategies, so as to enable action where needed to improve the nature of the links.

'More effective *dissemination* of new technologies, processes and ideas increases innovation across the economy' (*National Innovation Priority 4, our italics*). It is therefore clear that understanding and measuring engagement, diffusion and attitudes will inform immediate actions for effective dissemination across the economy. Further, effective science communication enables a continuum from vision to realisation by 'encouraging a culture of collaboration within the research sector and between researchers and industry' (*National Innovation Priority 5*). This collaboration includes the general public.

The *Inspiring Australia* report recognises that Australia requires a sound evidence base for engagement with science; *i.e.* a strategic capability to design, target and review effective science engagement with the aim of guiding future investment. Science communication

research must therefore investigate the value of engagement across a variety of participants and activities. It must recognise the diversity of the Australian public. It must seek to understand not only the needs of science communicators but the needs of those for whom the communication is designed.

The Expert Working Group emphasised the importance of putting science communication research into a social and cultural context, particularly in a country with diverse and multicultural people. It will therefore be essential to gain long-term understanding of how the public views the role of science in their lives and how their attitudes to science are shaped and changed. In the immediate future, however, the role of research must be to inform decisions about public engagement relating to the goals of the *Inspiring Australia* document.

The recommendations made by the Expert Working Group recognise the complex societal relationships within which science has an important role. In particular, the Group recognises not only the importance of the social sciences in this regard, but also the unique role of the arts and the humanities in connecting with the public. A synthesis of these disciplines with more traditional forms of science communication is, therefore, a necessary element of research. If, indeed we are to strengthen Australia's evidence base for science engagement, we need to investigate all contributing factors that will enable stronger links between the constituent parts of Australia's innovation system.

Theme One: The Australian Public

If communication of science is to be effective, it needs to recognise the audiences to be engaged. Activities need to be appropriate and relevant to local communities, and contextualised to acknowledge and value local perspectives. Activities need to build on each other, providing pathways to develop awareness and involvement.

(Extract from the Inspiring Australia report, p. xiii)

The Australian public's diverse needs and requirements for scientific engagement should be monitored and addressed through innovative and longitudinal measurements.

Australians, in general, support science and recognise its importance. This view is supported marginally by the high level of performance by Australian students taking part in measurements of scientific aptitude, such as the *Programme for International Student Assessment* (Organisation for Economic Co-operation and Development, 2006). However, these scales should be interpreted with care since performance in standardised examinations and everyday engagement with science may not similarly influence young Australians' decisions to continue to study science at an advanced level.

The needs and requirements for scientific engagement differ across different geographies, ethnicities, ages, races and political persuasions of Australians. The *Inspiring Australia* document recognises some of these audiences; namely scientists, the media, major science organisations, politicians and their advisers, business and industry executives, judges and opinion leaders, children and young families, and the general public at large.

Presently, there is insufficient evidence that describes the Australian public's needs and requirements for scientific engagement. There have been recent efforts internationally and in Australia to develop suitable tools to measure the public's attitudes to science. Three such tools are described below.

(a) *Reading the Public Mind* (RtPM) is a tool that measures public attitudes to specific scientific issues by monitoring the quality of dialogue between scientific researchers and the public (Fisher, Cribb & Peacock, 2007). RtPM creates a 'moving picture' of community opinion by 'Linking an overall score for the community's perceived value of a research project' (p. 1262). An explorative study using RtPM was conducted in Australia to investigate public attitudes about feral pest control.

(b) *Public Engagement for Science and Society* is a conversational tool developed by the Science for All Follow Up Group as an adaptable and practical instrument to evaluate the quality of dialogues about public engagement. This conversational tool works by 'sparking conversations about public engagement' (British Science Association, accessed 02.10.2010 from <http://enews.enewsplus.co.uk>).

(c) *ANUpoll* is a quarterly survey of the Australian public conducted by the Australian National University. In each survey, the poll examines topics of national importance. The

most recent ANUpoll (see Lamberts, Grant & Martin, 2010) found that the Australian public is very interested in news about science, in particular, health, medical discoveries, and the environment. The public felt, however, that they were poorly informed about science.

(d) An initial research study conducted by the Public Awareness and Community Engagement section in the Department of Innovation, Industry, Science and Research found that unengaged members of the public have different values, different interests and are differently engaged about science and technology from those sections of the public who tend to be involved in most science communication activities (Cormick, 2010).

Investigations to measure public attitudes about science also need to consider the changing social landscape in Australia, in order to situate scientific engagement within a wider and longer-term social context. It is essential to recognise the diversity within and among the Australian public, including non-traditional audiences who are difficult to reach and are usually unengaged with scientific issues, such as indigenous communities, migrant communities and English second-language speakers. Such an approach is vital to foster 'an appreciation of science and its contribution to solving complex issues; and a strong, open relationship between science and society' among the constituent parts of our national innovation system.

An example of this issue is the debate surrounding the applications of gene-technology, particularly in food production (see Blue, 2010). Writing to the *Canberra Times*, Cormick (2008) states that the general Australian public feels 'left out' of a current highly polarised debate regarding the safety of consuming genetically modified food products. Surveys of public attitudes about biotechnology that have been conducted by *Biotechnology Australia* have found that the public's attitude to complex scientific information relating to genetically modified food is often influenced by their values and beliefs about food safety rather than the actual science and technology that is involved (*Biotechnology Australia*, 2005).

Recommendation 1

(Requires immediate action)

Investigate and continue to monitor regularly the Australian public's attitudes towards new science and technology, and the public's perceptions of Australia's scientific research priorities.

RATIONALE:

The Australian Government is committed to the advancement of scientific research through *Super Science* and other national scientific research priorities. The diversity of the Australian public, which informs their attitudes to science and technology, may result in a variety of perceptions that are not necessarily consistent with these research priorities. Empirical studies have shown that the public is more aware of needs and requirements in their immediate environments, in comparison to scientists who may be focused on specific research interests. For example, *Reading the public mind* found dissonance between the Australian public's perceptions and attitudes and those of national research organisations. It is essential, therefore, to investigate and monitor on a regular, on-going basis the diverse attitudes and perceptions of the Australian public.

Recommendation 2

(Requires immediate action)

Investigate and measure the different science engagement needs and requirements of the Australian public.

RATIONALE

Australia is a scientifically high-performing country and relies on the brain power of a comparatively small population to sustain our national innovation system. It is, therefore, important to acknowledge the potential and interest of the Australian public in contributing collectively as a capable workforce. As identified in the *Inspiring Australia* report, different strategies are required to engage different groups of the Australian public. For example, the means by which science is communicated to children and young families do not match the science communication needs and requirements of business and industry executives. It is necessary, therefore, to understand the needs and requirements of those to whom science is communicated.

Recommendation 3

(Requires immediate action)

Assess the aims and objectives of science engagement enterprises, having measured and prioritised the science engagement needs and requirements of the Australian public.

RATIONALE

As stated in the *Inspiring Australia* report, ‘inspiration is simply too important to leave to chance’. While it is necessary, therefore, to understand the diversity of needs and requirements for scientific engagement of the Australian public, these needs should be measured and prioritised. By focusing on the most important requirements for scientific engagement, science communicators should match their aims to meet these needs of the Australian public. The *Inspiring Australia* report states, ‘concerted action is needed to ensure that the communication of science and its benefits has a coherent vision and direction’. It is, therefore, essential to assess the aims and objectives of science engagement enterprises, such as *National Science Week* and the *Australian Science Festival*, with respect to the diverse needs and requirements of the Australian public.

Recommendation 4

(Longer-term action is required)

Conduct longitudinal studies to assess the Australian public's behavioural and attitudinal changes that may result from engagement with different enterprises, including the effect of science education on their subsequent engagement with science.

RATIONALE

Australia invests strongly in its research base and this in turn requires a continuing supply of scientists, technologists and other constituents to address complex, future issues that will mandate the direction and outcomes of our national innovation system. These issues are informed by a constantly changing social, environmental and economic landscape that is influenced strongly by global change and demand. There will be changes in the needs and requirements of the Australian public, which will reciprocally influence the enterprises through which science is communicated. In order to assess and effectively address those changes, it is necessary to study longitudinally the Australian public's behavioural and attitudinal changes that may result from their engagement with different science communication enterprises, including formal and informal school communities. Such studies might collaborate with existing programs aimed at longitudinally investigating the public's behavioural and attitudinal change to specific areas of science and technology, such as social integration of biotechnology research in Australia.

Theme Two: Science Engagement Enterprises

‘Communicating science and its benefits’ refers to a wide range of activities that allow the public to interact with science, scientists and scientific issues and processes.

It is accepted that there are many different levels and kinds of science communication, with many organisations and individuals involved using many different media. (Extracts from the *Inspiring Australia* report, p. ix-x)

Science engagement enterprises in Australia should be evaluated nationally with respect to innovative goals and outcomes so as to promote effective engagement with science.

Efforts to communicate science comprise a variety of programs in Australia. These programs are provided nationally by CSIRO, Questacon, ABC, the Office of the Chief Scientist, and others. Science centres and museums, research agencies, universities, academies, professional and business bodies and community-based organisations also contribute substantially toward science communication in Australia. For purposes of this document, these diverse science communication programs are collectively referred to as ‘science engagement enterprises’.

While the *Inspiring Australia* report recognises that science communication is facilitated through diverse science engagement enterprises, it states that there has not been an evidence-based evaluation of the efficacy of these enterprises. Very few studies have attempted to examine how the Australian public engages with science in free choice settings. In a study that focused on adults’ learning about science in interactive science museums and public lectures, Rennie and Williams (2006) reported that ‘participants became less scientific in their thinking about the nature of scientific knowledge, becoming more likely to believe it (i.e. science) to be infallible’ (p. 871). Reasons for this unexpected outcome included the absolute and irrefutable structuring of science exhibits and lectures.

Science engagement enterprises in Australia need to be assessed, therefore, in terms of their innovativeness and ability to deliver definite outcomes for scientific engagement; and should involve scientists, science communicators and professionals from the arts and the humanities. As Silva and Bultitude (2009) state with reference to communication training for public engagement with science, technology, engineering and mathematics (STEM), it is essential to include both scientific experts and science communicators in training programs and evaluation.

Evaluations should also explore enterprises beyond the traditional scope of science communication, particularly those which synthesise the contributions of science with science related areas. Based on a content analysis of contemporary science websites on the internet, for example, Kouper (2010) reported that new information and communication technology (ICT) tools, such as blogging, could be used successfully to facilitate broader public engagement with science. While it is possible for innovative tools to be used to

reinforce more traditional modes of science communication, Kouper adds that empirical investigations need to be conducted in order to understand how these tools could promote 'more interactive forms of science communication' (accessed 28.10.2010 from <http://jcom.sissa.it>).

However, caution is advocated when using new technologies to promote scientific engagement (see Nisbet, Scheufele, Shanahan *et al*, 2002). For example, while television viewing could have a positive effect on scientific awareness, Brewer and Ley ((2010) found, based on a series of telephone surveys of residents in Milwaukee USA, that overall television viewing had a negative impact on self-perceived understandings of DNA technology. The researchers reported that crime drama and news media misinformed perceptions of DNA-based evidence testing (p. 108). Similar studies, such as Ho, Brossard & Scheufele (2008), conclude that media-based science engagement enterprises need to have definite and practical outcomes to engage the public with science, if they are to help build strong and open relationships between science and the public.

Recommendation 5

(Requires immediate action)

Audit, classify and update the diverse enterprises which constitute science communication activities and programs that are currently conducted in Australia.

RATIONALE

Over the years, Australian science communication providers have developed and produced a range of successful and effective science engagement enterprises. The *Inspiring Australia* report states that a coordinated national framework should recognise and harness the range of national, state and community-based science engagement enterprises that are undertaken by both professionals and volunteers.

Although there is a rich variety of local events, the lack of any coordinating mechanism continues to create actual or perceived duplication, overlap and fragmentation. (Extract from the Inspiring Australia report, p. 54)

An audit, based on best practices in different science communication activities and programs, would enable a national science engagement agenda by strengthening links between constituent parts, and promoting an appropriate and sustainable balance between existing science engagement enterprises. Auditing and classifying existing science engagement enterprises would also pave the way for new programs which would be targeted strategically to address the science engagement needs and requirements of members of the Australian public previously excluded from traditional science communication channels.

Recommendation 6

(Requires immediate action)

Develop, with input from scientists, science communicators and professionals from the social sciences, the arts and the humanities, effective, meaningful and research-based tools to measure rigorously the Australian public's engagement with science through science engagement enterprises.

RATIONALE

Successive Australian Governments have continued to fund science communication, thus enabling a variety of national, state and community-based science engagement enterprises. These enterprises have not, however, been undertaken within a holistic national strategy. For example, the prestigious *Prime Minister's Prize for Science*, and *National Science Week* remain individual events. Providers of science engagement enterprises need to align their contributions through coordination and consolidation.

Activities (i.e. science engagement enterprises) need to build on each other, to provide pathways towards various stages of awareness and involvement. (Extract from the Inspiring Australia report, p. 55)

Therefore, an effective, meaningful and research-based measure is required to streamline all of Australian science engagement enterprises into a national science engagement agenda. An effective national strategy for evaluating science engagement enterprises should not be developed solely by the Government or individual organisations. Scientists and science communicators need tools developed with the input of professionals from the social sciences, the arts and the humanities to measure the Australian public's engagement with science. Strategies should include research-based skills-training for science communicators in the use of evaluation tools and training for scientists in communication techniques with the media and the public.

The *Community Interest and Engagement with Science and Technology* developed by the Victorian Government offers the first step to a research-based tool that could be used nationally, with some modifications and development, to measure scientific engagement in Australia. The *Public Engagement Conversational Tool* developed by the Science for All Follow Up Group in UK is an overseas example of an instrument devised to obtain information about motives and types of public engagement with science.

Recommendation 7

(Requires immediate action)

Research and investigate the efficacy of innovative science engagement enterprises, including the role of popular media and social media.

RATIONALE

In addition to the physical and natural sciences, the *Inspiring Australia* report acknowledges the important role of the humanities, the arts and the social sciences to our national innovation system. Science engagement enterprises need to draw on and synthesise the creative potential of science and science-related areas. Innovative science engagement enterprises that have definite and practical outcomes and can effectively engage the Australian public need to be exploited fully. This should include research and evaluation of the potential to engage the public scientifically through popular Australian television and radio programs, and social media tools such as Facebook and Twitter.

Theme Three: Funding for Science Communication

The government has made a solid commitment to science and innovation through its Innovation Agenda.

Investments by DIISR and other Federal Government departments leverage national, state and local contributions for optimal effectiveness and efficiency.

Federal and state jurisdictions agree on strategic priorities and co-investment opportunities. (Extracts from the Inspiring Australia report, p. 55)

Funding for science communication through science engagement enterprises should be recognised and formalised nationally.

The Australian Government has made a strong commitment to invest in scientific research in order to maintain Australia as ‘a high-performing country in a wide range of areas across the sciences’, that include agriculture, astronomy, marine science, climate change, clean energy, biotechnology, nuclear science, nanotechnology and ICT. There is, however, a lack of awareness both within Australia and among its overseas trading partners about ‘Australia’s strengths in science and research’. The future of Australia’s economic prospects is, therefore, threatened by a dwindling supply of scientists who are integral to a strong national innovation system (Department of Innovation, Industry, Science and Research, 2010).

As argued by Braun and Schultz (2010) in the context of public debate around genetic testing in UK and Germany, public participation needs to develop beyond the theoretical desirability of participation (p. 414). Instead, more pragmatic outcome-focused initiatives are required to enable the public to identify with on-going scientific research.

In a survey conducted by Rowe, Rawsthorne, Scarpello and Dainty (2010) to investigate the UK public’s priorities for research funding, it was found that decisions to fund scientific research were largely based on personal and social relevance of the research outcomes, although ethical considerations such as ‘likeability’ and ‘trustworthiness’ of the research communication may have played a role in influencing the public’s decision making (p. 236). The views put forward in this study were found to be consistent with a similar survey conducted by Lach and Sanford (2010) in the US. They found that personalised, constructive consultation processes helped the public to reach consensus when debating risk-based relationships with federal agencies about new science and technology (p. 145).

As Katz, Solomon, Mee and Lovel (2009) found out, however, based on a series of workshops that explored the social issues surrounding nanotechnologies and nanoscientists, such elements of consultation need to be developed further as part of Australia’s science engagement with the public. The researchers state that in Australia ‘while the use of public engagement to investigate social aspects of emerging technologies is increasingly accepted,

incorporating social understandings into research and development processes is far less developed' (p. 531).

In order to achieve a scientifically engaged Australia, it will be necessary to develop a culture where the sciences are recognised as relevant to everyday life and where the government, business, and academic and public institutions work together with the science to provide a coherent approach to communicating science and its benefits (Extract from the Inspiring Australia report, p.xiv)

Although government reports, such as *Inspiring Australia* and the *International Science and Research Engagement Fact Sheet* published by DIISR in 2010, recognise the importance of communicating science, there is currently insufficient recognition nationally for science communication. This has an adverse impact on science communication research, which is essential to develop and evaluate effective and innovative science engagement enterprises. As Barben (2010) points out, with reference to a review of research approaches on the acceptance of science and technology, acceptance politics play a crucial role in building relevance and resonance of science and technology with the public. Barben adds that this issue is of particular significance in countries with 'divergent religious and philosophical traditions' (p. 289). Formalised funding for science communication research in Australia, therefore, needs to recognise science communication research, and carefully consider its important contribution to science engagement enterprises.

There has been some debate as to whether science communication constitutes its *own* field of research. Although there may presently seem to be a relative paucity of research-based knowledge among the science communication professional community, this is mainly because science communication as a discipline considers foremost the needs of the audience as opposed to making published resources available to researchers and scientists (see Nielson, 2010). This does not preclude, however, science communication being instrumental in including 'sciences in a broader social and democratic context' (accessed 28.10.10 from <http://jcom.sissa.it>).

While on the one hand there is a diversity of sub-categories within science communication itself, 'they show the will to build a more solid discipline identity... Science Communication has the chance to produce original, useful and recognisable knowledge' (Pitrelli, 2010, accessed 28.10.10 from <http://jcom.sissa.it>). Commenting to a special issue of the *Journal of Science Communication*, Gascoigne, Cheng, Claessens, Metcalfe *et al.* (2010) state that it is possible to differentiate science communication from closely-related disciplines by studying its emergence and the progress achieved by science communication (accessed 28.10.10 from <http://jcom.sissa.it>). This progress is currently impeded, however, by lack of funding.

Recommendation 8

(Requires immediate action)

Immediately implement formal recognition by the Australian Research Council (ARC) and the National Health and Medical Research Council (NHMRC) of the discipline of Science Communication and its sub-categories of different aspects of science engagement.

RATIONALE

The Australian Government's recognition of the importance of communicating science needs to be reflected by national funding organisations, in particular the Australian Research Council and the National Health and Medical Research Council. The ARC and NHMRC should formally recognise that science communication research is essential to understand and strengthen the links between the constituent parts of Australia's national innovation system. 'Science communication' needs to be classified independently, therefore, as a separate research discipline eligible for ARC and NHMRC funding. Funding of science communication research should not be restricted to traditional academic investigations, but should include the many aspects of science engagement enterprises that communicate science to the public.

Recommendation 9

(Requires immediate action)

Recognise and require, from the proposal stage of ARC and NHMRC grant applications, the communication of scientific research to a wide spectrum of constituents, within a framework of human endeavour.

RATIONALE

Australia's scientific and research strengths must be communicated widely both nationally and internationally. The ARC and NHMRC should recognise and promote public awareness about nationally funded scientific research enterprises within a framework of human endeavour. ARC and NHMRC grant applications for research in science and science-related areas should not limit their recognition of science communication to the dissemination of research outcomes to peers within the scientific community, and occasionally to key constituents. Instead, science communication to a wide spectrum of constituent parts of the national innovation system should be promoted as an integral element of grant applications, from the proposal stage onwards. Only through such an approach is it possible to create 'nationally, an awareness and understanding of why science and research are critical to our lives and for developing and sustaining an innovation culture'.

Recommendation 10

(Requires immediate action)

Sustainably fund, through Government and other sources, science engagement enterprises that are innovative, creative and which can be shown to have definite and practical outcomes in keeping with the aims of the Inspiring Australia document.

RATIONALE

For the first time, through the *Inspiring Australia* report, the Australian Government has recognised that it is necessary to have a ‘national approach for community engagement with the sciences’. This initiative requires government leadership to channel sources of investment to coordinate and sustain a national framework for public engagement. The government has guaranteed investment through Federal Government departments, such as DIISR, as well as by state and local contributors. Co-investment opportunities by federal and state jurisdictions have also been ensured. These investments need to support science engagement enterprises that demonstrate definite and practical outcomes to engage the Australian public with science.

Funding should also recognise and promote science engagement enterprises that communicate science through synthesis; i.e. by drawing creatively and innovatively from the arts, the humanities and the social sciences to communicate science beyond the scope of traditional science communication. The creative capabilities of science engagement enterprises need to be exploited in order to develop effective multidisciplinary approaches from science and social science methods and knowledge. Science communicators should be encouraged to embrace and be open to synthesis across the sciences, the arts and the humanities.

Conclusions

'A fairer, richer, healthier and greener Australia' depends on the creative capabilities of our national innovation system. The *Inspiring Australia* report states that Australia's capacity to achieve scientifically, through invention and discovery, relies on the strengths of the constituent parts of that system. Science communication is recognised as a major mode of linkage between those parts.

Several steps need to be taken to create strong links between the constituent parts of the Australian innovation system. These include monitoring and addressing the Australian public's diverse needs and requirements for scientific engagement, evaluating science engagement enterprises in Australia, and formalising recognition for science communication research funding. These measures need to be taken within the aims stipulated by the *Inspiring Australia* report with respect to innovative goals and definite, practical outcomes. These measures need to be taken soon.

The links between the contributing parts of the Australian innovation system must be understood in the context of social, environmental and economic variables which are all influenced by global variables. Science communication is a major mode of linkage between these parts, as is represented by the linking-arrows in Figure 1. Research into the nature and effectiveness of the links requires a synthesis of science and social science methods and knowledge. Understanding how to strengthen these links will require multidisciplinary approaches across the sciences, the arts and the humanities.

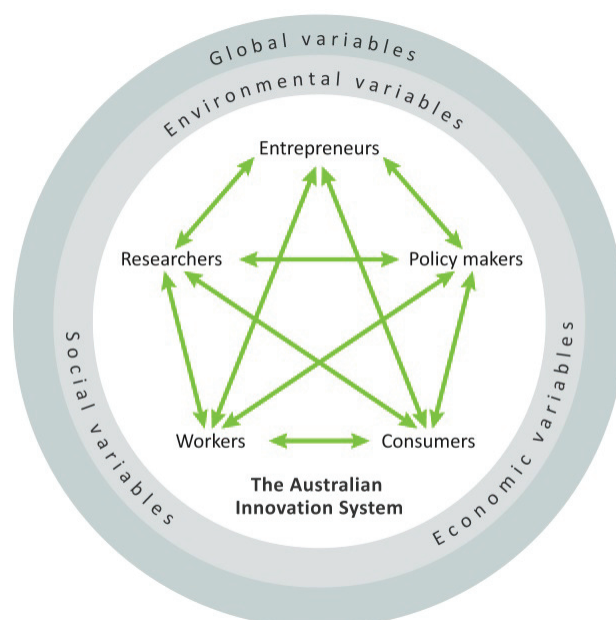


Figure 1. Linking-arrows in a model representing the Australian national innovation system and its constituent parts in the context of social, environmental and economic variables that are influenced by global variables.

Appendix 1 Project background

In February 2010, the Department of Innovation, Industry, Science and Research (DIISR) released the *Inspiring Australia* report, which presented a national strategy for engagement with the sciences. This report supported the outcomes anticipated by the Australian Government's previous budget paper—*Powering Ideas: An Innovation Agenda for the 21st Century*. Both these Government documents acknowledged the key social role of innovation in developing a scientifically aware Australian public, capable of engaging in informed decision-making and contributing to a technologically-skilled workforce.

The *Inspiring Australia* report, in particular, proposed fifteen Recommendations that were premised on effective communication, and aimed at promoting stronger links between science and the constituent parts of Australia's national innovation system. Recommendation 15 recognised specifically that Australia requires a strategic evaluation capability to design, target and review effective science engagement activities in order to guide future investment, contributing to the building of science communication capacity, professionalism and excellence.

Recommendation 15: Developing an Evidence Base

That the national initiative support a program of research in science engagement—such as baseline and longitudinal attitudinal and behavioural studies, activity audits, program evaluations and impact assessments—to inform future investment decisions by government and its partners.

It was decided, based on the above Recommendation, to convene a short-term Expert Working Group to develop a plan for identifying and sharing best practice in science engagement. The Australian National Centre for the Public Awareness of Science at The Australian National University was commissioned by the Department of Innovation, Industry, Science and Research to convene the above Expert Working Group, with the aim of investigating an evidence base for science engagement in Australia.

The Expert Working Group, chaired by Mr Richard Eckersley (Founding Director *Australia 21*), reviewed contemporary international efforts geared towards establishing an evidence base for science engagement. Elements that would constitute best practice for an evidence base for science engagement nationally were explored in the science communication literature and through independent consultations with science communication practitioners and researchers within Australia. The outcomes of the Expert Working Group served to inform Recommendation 15 of the *Inspiring Australia* report.

A draft document consisting of ten recommendations, within three main themes, was submitted by the Expert Working Group to Questacon for presentation to the Department of Innovation, Industry, Science and Research in November 2010. A further Draft Report for Discussion comprising background information and the Expert Working Group's recommendations was made available online through the DIISR Innovations website (see www.innovation.gov.au/Science/InspiringAustralia). Feedback to the Draft Report was invited

from all interested parties from 2 to 18 February 2011. A further online version of the report, incorporating feedback, was made available on the above website in March 2011.

Appendix 2 Expert Working Group—Terms of Reference

Recommendation 15: Developing an Evidence Base

That the national initiative support a program of research in science engagement—such as baseline and longitudinal attitudinal and behavioural studies, activity audits, program evaluations and impact assessments—to inform future investment decisions by government and its partners.

Background

The *Inspiring Australia* report recognises that Australia requires a strategic and evaluation capability to design, target and review effective science engagement activities and to guide future investment, contributing to the building of science communication capacity, professionalism and excellence.

The report identifies a research agenda (p. 52) for understanding science engagement in Australia:

To gain greater understanding of Australian attitudes towards science in terms of level of interest and engagement. Baseline and longitudinal studies to be carried out in all states and territories, as well as to address specifically identified population groups. (The report references research undertaken by the Victorian Government and the UK provide good models.)

To be aware of the full range and reach of science engagement activities by undertaking a broad audit of current activity.

To evaluate programs to determine what works best with particular audiences. Developing an evaluation pro forma or core set of performance indicators that collects data consistently will allow comparison among various activities. Systematic evaluation is also necessary to add to the knowledge base of which types of activities work best with different segments of the population.

To assess the impact of science engagement activities with respect to long-term behavioural change.

Inspiring Australia also identifies a number of possible activities that could help harness Australia's most creative and talented communicators to achieve the goals of a scientifically engaged Australia, including 'convening of a short-term working group to develop a plan for identifying and sharing best practice in science engagement'.

Aim of Steering Committee

To develop a national strategy and a set of evaluation priorities which will strengthen the national evidence base in science engagement and in turn inform future investment decisions by the Australian Government and its partners. To this end the Committee will:

- Develop a series of recommendations which propose short- and long-term forward strategies for developing an evidence base in science engagement.

These recommendations could include items such as:

- Broad suggestions for new research projects,
- Coordination and networking mechanisms,
- Analysis of appropriateness of Commonwealth as well as other sources of support,
- Priority areas for Commonwealth support, and
- Areas for developing and sourcing other support.

Appendix 3 The Immediate Context: review of initiatives to establish an evidence base for science engagement

Reports in the literature were reviewed in two stages. First, a preliminary exploration was undertaken to gather information about contemporary international efforts pertaining to evidence-based science engagement in developed nations. This included government commissioned research reports in the United States, United Kingdom, New Zealand, Japan and some European nations. Next, an extensive review of science communication literature was conducted to understand the crucial elements for an evidence base for science engagement in Australia.

United States

In the US an important source of information about the public's attitudes and understandings about science is the national *Science and Engineering Indicators Survey*. The *Indicators* provide information specifically about the US public's information sources, interest, and involvement with science; knowledge about science and technology issues; general attitudes towards science and technology; and attitudes about specific science and technology issues (for example, nanotechnology, stem cell research).

The most recent *Science and Engineering Indicators* (National Science Board, 2010) revealed that:

- Television is the primary and most relied source of science and technology information for Americans. This is followed by the Internet, which provides information about specific scientific issues.
- While Americans may seem to express a high level of interest in surveys relating to science and technology, the types of news topics they closely followed imply a lower level of interest.
- The US public's understanding about the process of scientific inquiry has improved somewhat over the last fifteen years. However, many are still not successful in answering questions about basic scientific facts or the process of scientific inquiry. Nevertheless, Americans' factual scientific knowledge, in general, is comparable to the European public, and much greater than publics in Japan, China and Russia.
- Americans across all demographic groups endorse consistently the past achievements of science and technology. They have more favourable attitudes about the future promises of science and technology than their European, Russian and Japanese counterparts. In doing so, they strongly support government funding for scientific research.
- The US public accords great prestige to scientists and expresses confidence in scientific leaders.

- Americans have recently become more concerned about the quality of their environment, and have expressed support for alternative energy sources. This concern is, however, superseded by concern about the economy, unemployment and the war in Iraq.
- Americans are largely unfamiliar with nanotechnology, despite increased research funding in this area and numerous nanotechnology-based products in the market.
- The US public favours medical research involving stem cells, but is strongly opposed and sceptical about reproductive cloning technology.

A previous survey conducted by the Pew Research Center for the People and the Press, in Collaboration with the American Association for the Advancement of Science (Pew Research Center, 2009), found that the US public regard scientists and science positively, and believe that science has a beneficial impact on their lives. While members of the public approve of the US Government's investments in science and technology research, they are sceptical about the standing of US scientific research internationally. This view is inconsistent with the US scientific community, who believe that US scientific achievements are the best in the world. US scientists are critical of the public's lack of scientific knowledge, and blame the media, in particular television, for this discrepancy. They also express disappointment about the administrative procedures that obstruct the mobility of international scientists to engage in research in US.

United Kingdom

In the UK steps are currently under way to consider the findings and recommendations from the 2008 *Science and Society Consultation* in the wider context of other activities, policy planning, and strategic priorities for future action. The *Science and Society Consultation* (Department of Innovation, Universities and Skills, 2008) commenced discussions leading to new strategies for more mature relationships between science, policy and society by exploring the following themes:

A society that is excited about science and values its contribution to social and economic wellbeing

A society that feels confident in the use of science

A society that supports a representative, well-qualified scientific workforce.

The *Science and Society Consultation* revealed the following:

- A large network of libraries, museums and archives engage annually with a majority of the UK public; *New Scientist* and *Horizon* were cited as accessible means of communicating science to the public. There is, however, the perception that the British public's scientific literacy needs to be improved in order to facilitate more effective and purposeful engagement with scientific issues. This includes more accessible language when communicating science to the public.
- The UK public believes that the lack of public awareness about the contributions made by science to society impedes the advancement of science. They state, however, that

science in UK has an ‘image problem’ with few inspiring role models, which fail to attract enough high-quality graduates to the scientific workforce. This is aggravated by the lack of communication skills by scientists and a cultural system which does not reward science learning, over other subjects.

- While the British public noted that there has been an improvement in the quality of science reporting in the media over recent years, they were sceptical about the polarised views presented by the media regarding scientific issues. They felt strongly about the lack of scientific literacy in non-specialist media and the need for good science communicators and scientists to work with television program producers.
- The UK public expressed greater confidence in academic research and believed that governance systems in universities, learned societies and research councils were well developed and followed the ethical code.

In 2010 the *Science for All Expert Group* developed an *action plan* in consultation with the British Government and other key participants, in response to the *Science and Society Consultation*. The action plan proposed to:

- Deliver a shift in cultural awareness, recognition and support for science by building on the Science: [So what? So everything] campaign.
- Develop a co-ordinated public engagement framework which is sufficiently flexible to recognise a range of engagement activity (professional and volunteer, national and local) and creates the conditions for increased participation and debate.
- Achieve greater acknowledgement of the importance of public engagement activity supported by increased training and recognition in all sectors.
- Ensure public perspectives are sought, recognised and responded to by the scientific and policy communities.

The progress made by the action plan is reported regularly on the Department of Innovation, Universities and Skills website (see <http://interactive.bis.gov.uk/scienceandsociety>).

New Zealand

In New Zealand the Government periodically conducts studies to determine the public’s attitudes to science. In the most recent Neilson study commissioned by the Ministry of Research, Science and Technology (2010), it was found that:

- Science is seen to contribute to ‘everything’, but is largely hidden and lacks relevance in daily life. The proportion of the public who believe that science has personal significant to daily life has decreased since 2005.
- The three leading areas of science seen as being the most beneficial to humanity have remained relatively consistent; i.e. new medical techniques and treatment, improving quality of agriculture and horticulture, and new forms of energy for transport. The

proportion of the public who believe that communication technologies are beneficial has increased in more recent years.

- There has been a drop in the percentage of people who agree that the government should fund pure scientific research. Also a greater percentage (in comparison to the 2005 study) believes that there should be tighter controls on the experimental freedom executed by scientists, while most people agree that scientists need to explain and justify their research to the general public.
- Scientists who work in industry or the public sector remain the most trustworthy sources of information for scientific issues.
- The public's trustworthiness of the internet is increasing, with the general public trusting educational sites more than consumer-generated sites.

In addition, the New Zealand *Science and Technology Promotion Program* aims at encouraging the public's appreciation for science and technology by acknowledging that the country's future economic prosperity relies strongly on science and technology, and that a knowledge-based society is crucial for the well-being of its citizens (see Gascoigne & Metcalfe, 2001). An important emphasis of this *Program* is to develop research linkages between New Zealand and countries both within and outside the ASEAN region.

Japan

In Japan the Bureau of Science, Technology and Innovation Policy conducts periodic opinion polls on science and technology and society through Japan's Central Research Services Inc. The most recent poll in 2010 revealed that:

- The Japanese public, in general, is interested in science and technology news, and their primary source of information is television programs, followed by newspapers, magazines, the Internet, radio programs, discussion with family/friends and books.
- The Japanese public does not feel that scientists or engineers identify with them and that these groups have higher social status.
- Fewer people accessed informal science learning opportunities offered by science museums, while many more preferred to listen to talks given by scientists or engineers.
- Japanese people believe that their lives have been enriched by science and technology, and are optimistic that emerging issues related to energy, the environment, water, food and infectious disease will be resolved through advances in science and technology. Consequently, however, they have become more aware and concerned about global environmental issues, safety issues surrounding genetically modified organisms, atomic power generation, cybercrime, and ethical issues about cloning.
- The public believes that science and technology in Japan is more advanced than other countries and that science and technology development is necessary for Japan to become more competitive internationally.

- Medicine, environmental conservation, sustainable energy are identified as national science and technology policy priorities for Japan, and the public believes that funding for science and technology research and science communication needs to be factored by the Government.

The *Science and Technology Basic Plan (2011–2015)* issued by the Japanese Government identifies important themes for future action. They include, that:

Japanese Government support the coordinated efforts of science and technology communication in universities and public research organizations.

Researchers receiving grant funding (above a given threshold) communicate their research and findings to the public.

Universities and public research organizations monitor and promote science and technology communication activities and reflective evaluations of those activities.

Academic societies disseminate widely the outcomes of their research.

Europe

In Europe the most important gauge of the public's interest in science and technology is provided by the *Eurobarometer*. The special issue of the *Eurobarometer—'Europeans, Science and Technology'* (European Commission, 2005), indicates that:

- Europeans are critical about the level of their own scientific research. In particular, they are critical about their secondary status to the United States, resulting from deficiencies in education and training of scientists in European countries.
- Significant progress has been made by the *Science and Society Action Plan* to bridge the gap between science and society. However, Europeans consider themselves, in general, poorly informed about science and technology issues, and there exists a latent interest for science and technology among the European public.
- The European public holds a positive and optimistic attitude towards science and technology, especially with regard to medical research in improving the quality of life. There is, however, a contradiction between this optimism and traditional belief systems, in particular economic and spiritual, which negatively affect scientific and technological progress.
- The European public's image of science, especially scientists, is two-fold. While the positive role and need for greater involvement of scientists in policy-making is acknowledged, Europeans are sceptical about the obscurity of scientific processes and the way in which scientific information is communicated to the public. The European public would like ideally to impose a balance between ethics and scientific progress.
- The European public recognises the important role younger Europeans will need to play in scientific and technological development. Therefore, children's participation in science is supported, and women in particular are encouraged to engage with science.

To remedy these issues, European nations have ensured that a higher level of financial investment needs to be offered to scientific research. Secondly, through the European Union, greater collaboration has been guaranteed for scientific research in the region.

National programs in place in some European countries to promote public awareness of science, with a focus on innovation, were also reviewed.

Ireland

In Ireland the *Strategy for Science Technology and Innovation (SSTI)* (Advisory Council for Science, technology and Innovation, 2008) offers a blueprint for that country's transition to a knowledge-based and innovation driven economy. SSTI is targeted towards public and private decision-makers that influence education, business and the media. An important feature of SSTI is its emphasis on actively engaging with the international research community. To achieve this aim it is recommended that:

- There needs to be higher visibility of Ireland's international involvement in science, technology and innovation.
- Appropriate national bodies should be established to monitor and strategically evaluative existing research linkages. This should involve a structured evaluation program based on specific and measurable objectives.
- Appropriate national bodies should be established to identify scientific and technological 'hotspots' internationally. There should be provision to proactively approach new international research partners, including facilitation of bilateral partnerships outside Europe.
- Ireland's membership of and contribution to international research organisations need to be increased.
- State funded agencies, research institutions and private sector enterprises should actively ensure that students and researchers from Ireland are benefitted by both outward and inward mobility. For example, research students should be offered the possibility of training in overseas research institutions; and mid/late-stage researchers should receive funding for overseas travel.

Germany

In Germany *Science in Dialogue* is a national initiative that was founded on a public consultative process in 1999—*Donors Association for the Promotion of Science and Humanities* (see Gascoigne & Metcalfe, 2001). This initiative aims to promote dialogue with all members of German society by providing information about scientific research processes and by highlighting the interdependency among science, economy and society.

Sweden

In Sweden the Government has expressed the desire to strengthen the position of science and technology in Swedish society through the *Science Centre Movement* (Israelsson, 1994).

Since 1993, the Swedish Government has envisioned a wider scope for science centres, which include activities to renew advanced learning of science, teacher training and the overall promotion of science and technology among the general public. It is believed that by enabling science centres to offer a wider role within the community they would be able to positively influence both formal and informal science engagement within the Swedish public.

Australia

In Australia there has not been, thus far, a national evidence-based research output. The Expert Working Group reviewed, therefore, contemporary research efforts within Australia that offered elements of an evidence base for science engagement. Some important studies have been summarised here.

Report: The Evaluation of National Programs of Science Awareness (Gascoigne & Metcalfe, 2001)

This report identifies the importance for governments internationally to support Public Communication of Science and Technology (PCST). In doing so, it is believed that communities that are better informed about science would be able to contribute economically. The report questions, however, the bases of PCST activities and their ability to influence communities' attitudes to science (with reference to regional and international health programs). The report concludes by recommending the need for a greater presence of science in science communication and well-developed, long-term mechanisms for evaluation.

How much 'real' science do Australian newspapers publish? (McIlwaine, 2003)

Based on an analysis of nine metropolitan/national Australian newspapers, it was found that although the presence of scientific content had increased from 1993 to 2003, 'science' remained a fringe area. Even at the highest level of representation, the *Canberra Times* was found to contain less than 1.5 per cent of science content. This trend was consistent with prominent newspapers in US and UK, although significantly lower than their French and German counterparts which feature more science content. While it is customary for newspapers to reduce their science content proportionally to their editorial content, Australasian newspapers such as *The Australian*, *Canberra Times* and *Sydney Morning Herald*, that have designated science writers, remain exceptions. Findings in this study are consistent with those reported earlier by Weigold (2001); i.e. 'the importance of science news is poorly benchmarked by the attention it receives in most mass media' (p. 164).

Community interest and engagement with science and technology in Victoria (Victorian Department of Innovation, Industry and Regional Development, 2007)

This research report, commissioned by the Victorian State Government, explored Victorian public's attitudes to science and technology issues. The report found that:

- The Victorian public expressed greater interest in technology than in science. However, only a fraction in each group actually engaged (at a mediocre level) with their areas of interest.

- Victorians regard positively the promotion of science and technology, and expressed that they would like to receive more information. The Internet is the most common source of information, followed by television and newspapers. Victorians are concerned, however, about the way in which science is communicated, and prefer easy to follow documentaries.
- Victorians are optimistic about the impact of science and technology on their life and society. They believe that science and technology are progressing steadily and that they (i.e. the public) can comfortably accommodate new developments.
- The Victorian public expressed the need for greater public participation in decision-making that involved science and technology. They did not believe that the government presently sought public views sufficiently, but they believed that the government needs to closely monitor scientific and technological development.

Results from a segmentation study developed by the above Victorian department found that members of the public who described themselves as 'not engaged on science issues' indicated that:

Their interactions with S&T were not immediately visible, recalled nor valued.

They tended to seek information on science and technology issues primarily from friends and family, with little reference to experts.

They were not generally interested in knowing the science behind how something worked, rather all they needed to know was that it worked and would solve a problem.

They responded to science and technology discussions overwhelmingly in terms of application.

Preliminary PhD research findings by S. Searle published in Open Science (Cribb & Sari, 2010)

These preliminary findings describe the communication views, practices and workplace-culture of more than 1,500 Australian scientists. The findings suggest that 'more of Australia's scientists would communicate their knowledge with the general public if it was a higher priority for their employers and formally part of their job' (p. 168). Further results from Searle's research will be available in 2011.

In a previous study titled: Incentives and implements to scientists communicating through the media, Gascoigne and Metcalfe (1997) concur that:

- Communication through the media is generally seen as an optional activity for scientists, but not a basic part of their work.
- Among the benefits of working with the media, scientists include gaining support for research funding, maintenance of corporate image, and public accountability.
- Scientists who have little or no media experience are more suspicious of the media and its motives, while scientists with media experience value media training. (p. 267)

ANUpoll: Public opinion about science (Lamberts, Grant & Martin, 2010)

A recent poll by researchers at the Australian National University found that the Australian public preferred news about science, in particular, health, medical discoveries, and the environment. However, the public felt that they were poorly informed about science. The ANUpoll also found that:

- Australians believe that scientists, among other professions, make a significant contribution to society.
- Australians are positive about the benefits of science, but believe that science is not solving the problems of poverty and hunger around the world.
- The Australian public remains divided and unsure about climate science; i.e. both in terms of what climate scientists think is happening with climate change, and its causes.
- Many Australians are dissatisfied with the way the country is heading, and feel that politicians do not properly consider scientific advice.

Appendix 4 Activities of the Expert Working Group

The meeting of the Expert Working Group

The Expert Working Group met on Thursday 22 July 2010 at The Australian National University Canberra. The meeting comprised:

- Mr Richard Eckersley (Chair) (Founding Director *Australia 21*)
- Associate Professor Susan Stocklmayer (Deputy Chair) (The Australian National University)
- Professor Emeritus Chris Bryant (The Australian National University)
- Mr Julian Cribb (Julian Cribb Associates)
- Dr John Curran (CSIRO)
- Ms Jenny Dettrick (Questacon)
- Professor Barry McGaw (Australian Curriculum, Assessment and Reporting Authority)
- Ms Jenni Metcalfe (Econnect Communication)
- Professor Léonie Rennie (Curtin University of Technology)
- Dr Jesse Shore (Australian Science Communicators)
- Ms Mary-Anne Waldren (Australian Science Festival)

(In attendance: Dr Sean Perera, Executive Officer, Expert Working Group).

The following Expert Working Group members provided written comments in absentia:

- Professor Gavin Brown (The Royal Institution of Australia)
- Ms Lynette Liddle (The Australian National University)
- Professor Emeritus Ian Lowe (Griffith University)
- Mr Bill Mackey (Australian Academy of Technological Sciences and Engineering)
- Dr Sue Meek (Australian Academy of Science)
- Ms Wendy Williams (Victorian Dept. of Innovation, Industry and Regional Development).

The Expert Working Group commenced deliberations with a review of contemporary international efforts to establish an evidence base for science engagement. A considerable body of national and international science communication literature, including government reports, was reviewed by the Expert Working Group to offer context to develop best practice

for an evidence base specific to the science engagement needs and requirements of Australia.

The Expert Working Group also undertook a series of consultations with two independent Expert Sub-Groups comprising university-based science communication researchers as well as developers and providers of science programs in Australia. Their feedback was iterated through a series of Delphi questionnaires to the Expert Working Group to assist in deliberations. Ten recommendations, within three main themes, that informed Recommendation 15 of the *Inspiring Australia* report, were formulated by the Expert Working Group.

Expert sub-groups

Under the purview of the above main Expert Working Group, two Expert Sub-Groups were convened. Extensive consultations were undertaken independently with each Expert Sub-Group through a Delphi Process of iterations.¹

The first Expert Sub-Group comprised university-based science communication researchers:

- Dr Rod Lamberts (Chair) (The Australian National University)
- Dr Terry Burns (University of Newcastle)
- Dr Will Grant (The Australian National University)
- Dr Joan Leach (University of Queensland)
- A/Prof Nancy Longnecker (University of Western Australia)
- Dr Jenny Martin (University of Melbourne)
- Prof Rob Morrison (Flinders University)
- Dr Carol Oliver (University of New South Wales)
- Dr Will Rifkin (University of New South Wales)
- Dr Renato Schibeci (Murdoch University)

The second Expert Sub-Group consisted of science communication program developers and providers in Australia:

- Ms Jenny Dettrick (Chair) (Questacon)
- Ms Sarah Bugg (Scitech, WA)

¹ Participants were sent a series of questionnaires. The first questionnaire asked each participant to engage in individual brainstorming so as to identify the issues and generate as many ideas as possible for dealing with the issues. The second questionnaire contained all the ideas sent in response to the first questionnaire and provided space for participants to refine each idea, to comment (i.e. by agreeing or disagreeing) on the strengths and weaknesses of each idea for addressing the issue, and to identify new ideas. The end product was a list of ideas with their concomitant strengths and weaknesses.

- Dr Lynda Kelly (Australian Museum, NSW)
- Ms Frankie Lee (Australian Broadcasting Corporation)
- Dr Sophie Lieberman (Australian Museum, NSW)
- Dr Richard Morante (Department of Education, NSW)
- Mr Allen Rooney (Questacon)
- Ms Sarah Tennant (Queensland Institute of Medical Research)
- Ms Amanda Tyndall (RI Australia, SA)

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