National audit of Australian science engagement activities, 2012

Project final report

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Inspiring AUSTRALIA

A national strategy for engagement with the sciences

The national audit of science engagement activities reported on in this document was funded by the Federal Government's *Inspiring Australia* program. It aimed to gain a national picture of science engagement activities so that people involved in science communication could access the data to research trends, discover new ideas, look for complementary projects and avoid duplication of activities.

Econnect Communication worked with Bridge8 and the Australian Science Communicators (ASC) to conduct and report on the audit.

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Contents

Summary: Australia's first ever snapshot of science engagement

The first national audit of its kind ever to be held in Australia recorded information about 411 different activities that aim to engage ordinary people with science. The survey asked for engagement activities held between January 2011 and June 2013.

The online survey, open from July to September this year (2012), gathered activities from universities, science centres, museums, zoos, CSIRO, businesses and private individuals.

The audit was funded by the Federal Government's *Inspiring Australia* program. It aimed to gain a national picture of science engagement activities so that people involved in science communication could access the data to research trends, discover new ideas, look for complementary projects and avoid duplication of activities. Econnect Communication worked with Bridge8 and the Australian Science Communicators to conduct the audit.

The majority of activities recorded:

- started recently, or are about to start, and are ongoing in nature
- involve presentations, seminars, lectures, educational activities or visits to schools or regional communities
- are about biological and environmental sciences (and not so much about information and computing, engineering or mathematical sciences)
- involve people learning from watching, listening or viewing lectures, media or exhibits and, to a lesser extent, asking questions or interactive inquiry (and rarely about group problem-solving, consulting or sharing views)
- commonly use websites, face to face interactions, social media, newsletters and traditional media as tools of engagement
- are about ongoing science, and to a lesser extent about completed science (and rarely about gaining funding or support before or during the science, or about shaping the science question)
- focus activities on 'understanding of the natural and human-made world' (and rarely about 'institutional priority or public policy change related to science and technology').

The most important *Inspiring Australia* outcomes desired by the science engagement activities recorded are to 'inspire target groups and get them to value scientific endeavour' and to 'encourage young people to pursue scientific studies/careers'. Critically engaging target groups about scientific issues and attracting increasing interest in science are seen to be less important.

Most science engagement activities in Australia aim to increase awareness about science, make science fun or more appealing, support educational programs, or improve scientific literacy. Few aim to change or influence specific behaviours or policies, or to encourage critical thinking about scientific issues.

We conclude that the nature of science engagement in Australia tends to be dominated by one-way communication rather than participatory engagement that encourages critical thinking about issues or involvement in shaping the science questions. It is mostly engagement that seeks to promote awareness about science and the benefits of studying science in school or at university. It is far less

about engagement that aims to change behaviours, to help individual or institutional decision-making, or increase direct participation in science.

The groups targeted by the current science engagement activities in Australia tend to be mostly large groups of school-aged children and the general public. There is far less targeting of specific groups such as farmers, businesses or community groups.

However, there is a diverse range of people and organisations involved in science engagement activities—including universities, businesses, research organisations, governments and non-government organisations. The scientists who did or are doing the research, and professional science communicators, are the most involved in delivering the engagement activity.

The largest sources of funding for science activities are governments, especially the Federal Government, universities, science centres and museums, and sponsorship or grant schemes.

Most science engagement activities are inspired by the success of past, similar projects or the experiences of those driving the activity. They are evaluated largely informally and in-house using feedback forms, surveys and quantitative monitoring tools. Qualitative and formative means of evaluation are rarely used. People driving the engagement tend to rely on reputable scientists or organisations to make sure of the accuracy and credibility of the science involved in the engagement.

More than 250 people participated in the survey and they were mostly from universities, research organisations such as CSIRO or museums and science centres. Although participants were self-selected, results were regularly reviewed to encourage 'missing' organisations to complete the survey. We believe the audit gathered a representative sample of science engagement activities across Australia; the only gaps are collecting more activities from local and state government agencies.

The data collected by the survey was put into a database that was used by specially designed visualisation tools to look at the data using bubbles and a map. These tools allow quantitative results of the survey to be compared quickly and visually. This tool will be made publically available on the Australian Science Communicators' website.

We also ran seven focus groups with science communicators around Australia. These focus groups, along with an open question in the audit survey, were designed to gain the views of professionals about the gaps and opportunities for making science engagement more effective in Australia. Analysis of this data shows that most people favoured participatory, critical approaches to science engagement but felt hindered by a lack of resources and organisational motivations or incentives to direct or participate in such engagement.

We recommend making the data from the audit publically available on a specially designed website, linked to an improved survey for people to continuously add or update activities. The website would include an evaluation tool developed by another Inspiring Australia project, and would link to and improve on the visualisation tool developed by this project. The website and survey would be regularly promoted to ensure a continuous and up-to-date snapshot of Australian science engagement activities.

We recommend that science engagement in Australia needs to be improved by:

- showcasing successful case studies, including those that are more participatory in nature
- funding activities that include testing and piloting of activities
- encouraging activities that target specific groups, focus on uptake of research, are about consulting or sharing of ideas, include critical thinking and seek to achieve behavioural or policy change
- promoting simple evaluation tools
- requiring researchers to engage with non-scientific groups about their work.

Introduction

This report provides the results from Inspiring Australia's project—a National Audit of Science Engagement activities.

This project arose in response to the 2011 report from the Expert Working Group on Developing and Evidence Base for Science Engagement Activities. This report sought to find the best way forward to advance Recommendation 15 of the Inspiring Australia strategy:

> 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.

The purpose of the national audit was to create a national snapshot or database of science engagement activities.

This database could then be used by science communication researchers as an open resource for their investigations. It could be used by science communication practitioners to look at similar projects and to gain new ideas. It could be used by funders and policymakers to identify specific gaps, duplications and opportunities for improving science engagement nationally.

Project aims

This project aimed to:

- collect data about Australia's science engagement activities
- create an online database tool which permits comparisons between science engagement activities to determine engagement gaps, collaborative opportunities and duplications within Australia
- update and maintain information on science engagement activities through liaison with national bodies and organisations
- capture the views of scientists and science communicators about how science engagement could be more effective in Australia.

Project team

The project was run and directed through Jenni Metcalfe of Econnect Communication. Jenni worked with Kristin Alford of Bridge8 and Jesse Shore, President of the Australian Science Communicators (ASC). Staff from Econnect, Bridge8 and ASC supported the project.

We formed an informal academic advisory group with Dr Nancy Longnecker from the University of Western Australia, Dr Joan Leach from The University of Queensland and Dr Rod Lamberts from the Australian National University.

This report

This report provides the results of the national audit, discusses the implications of those results and makes recommendations about the future development, maintenance and use of the data collected.

Included in this report is a description of the online visualisation tool developed as part of this project and the key results from that tool.

We also provide an analysis of the focus group discussions run with ASC members in seven different locations across Australia.

Method

We used an online survey tool (see Appendix A), focus-group discussions with ASC members in seven locations across Australia, and an online visualisation tool to fulfil the objectives of this project.

Online survey tool

We used SurveyMonkey to develop an online survey tool (see Appendix A). This survey aimed to collect information about:

- how much each activity sought to achieve the four key outcomes of the Inspiring Australia strategy
- who was targeted by and involved in the activity, including those directing and funding the activity
- the type of involvement and tools used to engage people
- whether the activity was evaluated and, if so, how it was done.

We also sought people's views on how science engagement activities in Australia could be improved. This information was analysed with the ASC focus-group information.

Once the survey was drafted, we asked our informal advisory committee to review it and we also sent the survey for review to Professor Martin Bauer at the London School of Economics. Professor Bauer is an eminent science communication scholar with a special interest in survey tools.

The next draft of the survey was piloted with eight activities and then redrafted based on the feedback of the people entering those activities.

The survey was first promoted on 13 May 2012 through the ASC email list, Inspiring Australia contacts, and other databases of science organisations. The promotional document is shown at Appendix B.

The survey was due to close at the end of June 2012, but to include as many National Science Week (11–19 August 2012) events as possible, we extended it until the end of August.

During the time the survey was open, we monitored entries and sought to make sure that that we were getting adequate entries from various sectors of the science community. This resulted in us identifying key people from universities; cooperative research centres; CSIRO and other nationally funded research centres; medical research and public health centres; local, state and federal government departments; museums and science centres; national parks, botanical gardens and zoos; consultancies; non-government organisations and community groups. We further promoted the audit to these people through meetings, phone calls and emails. Where needed, members of our team met with key groups to collect the data needed by the audit.

We analysed the survey's quantitative data using normal statistical analysis. This included some cross tabulation to examine the four major outcomes desired by the Inspiring Australia strategy. We analysed answers to 'other' question options and open-ended questions using a thematic analysis approach where we looked for common themes and counted how many times those themes occurred.

Data visualisation

We contracted Flink Labs to present the raw audit data visually online. The aim of these visualisations was to let people quickly see the trends in data and to allow them to compare different data sets.

These visualisations will be freely available online through the ASC website by the end of 2012. The two types of visualisations developed were a set of bubbles and a map. The map was based on the postcodes of those entering the information into the audit, rather than where their target groups were based.

The bubbles provide a comparison between different categories of questions. Some of the trends from these comparisons are included in this report.

Some important points about the visualisations are that they do not:

- depict text answers given in response to 'other' in survey questions
- show text from open-ended qualitative questions
- fully represent rankings in questions; for example, from lowest to highest
- represent the total numbers of people expected to be involved under 'target groups'
- have data about funding organisations or percentage amounts of funding.

Focus groups with Australian Science Communicators members

The objectives of the focus groups were to engage those people currently involved in communicating and engaging the public in science to contribute to the national audit.

There were three key aims:

- to involve scientists and science communicators in the process
- to capture their views, particularly in regards to how science engagement could be more effective in Australia
- to encourage them to participate in the survey so that the content of their initiatives could be captured in the audit.

A total of seven focus groups were conducted across Australia during May and June 2012 as indicated in Table 1. Attendees were invited to the focus groups through the Australian Science Communicators network and the events were also advertised using the #ausciaudit hashtag on Twitter.

Each focus group was scheduled for 1.5 hours and facilitated either as round table or in smaller groups, depending on attendee numbers. The questions posed to the focus groups are outlined in the moderator's guide, which was reviewed by our informal advisory group (see Appendix C).

To analyse the outputs and contribute to the evidence base for this report, the focus group discussions were recorded and then transcribed. Each transcription was reviewed for responses to the questions and to draw out the themes of the discussion.

Quotes were highlighted, sorted into a database where attendee identification was removed, and the quotes were coded according to categories that represented the themes and examples elicited during the focus group discussions. The number of quotes under each theme and sub-category is provided as a guide to the frequency of that topic within the discussions.

Table 1 Summary of focus groups attendance and quotes

Location	Format	Facilitator	Number of attendees	Number of quotes
Adelaide	Small groups of 5–6 people with reporting back to moderators	Kristin Alford	24	101
Brisbane	Round-table discussion	Jenni Metcalfe	17	98
Canberra	Round-table discussion	Jesse Shore	22	149
Melbourne	Two large groups with reporting back to moderators	Kristin Alford	20	74
Newcastle	Round-table discussion	Jesse Shore	11	102
Perth	Small groups of 5–6 with reporting back to moderators	Kristin Alford	26	132
Sydney	Round-table discussion	Jesse Shore	9	80
TOTAL			**129**	**741**

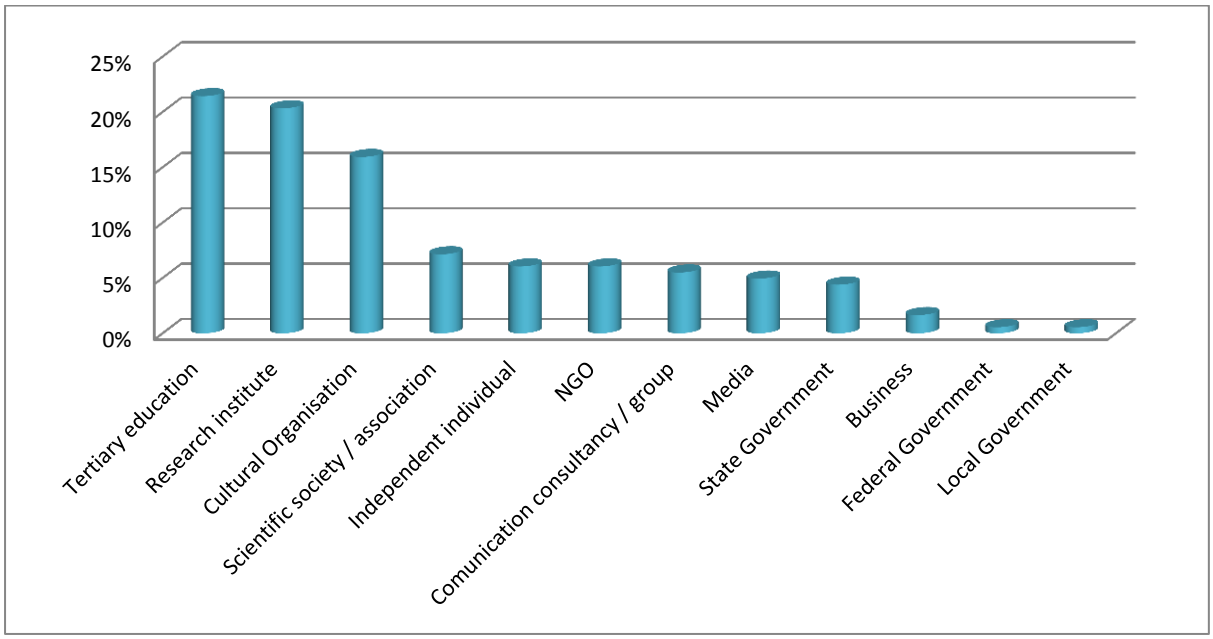
Audit survey response

We gathered information about 411 activities from around Australia from 254 respondents. Fifty-six respondents did not finish the survey:

- 22 did not proceed past the first eight questions (overview of the activity)
- another eight stopping after the next eight questions (who is involved in the activity and funding)
- another 10 stopping after or during the following five questions (engagement activity in more depth)
- 16 not starting the last series of questions about evaluation.

The respondents who completed the survey were mostly from tertiary education institutes—largely universities or research institutions, as shown in the graph below. This was followed by cultural organisations, including science centres, museums, zoos, art galleries and wildlife centres.

Figure 1 The types of organisations who completed the audit survey, shown as a percentage of total respondents



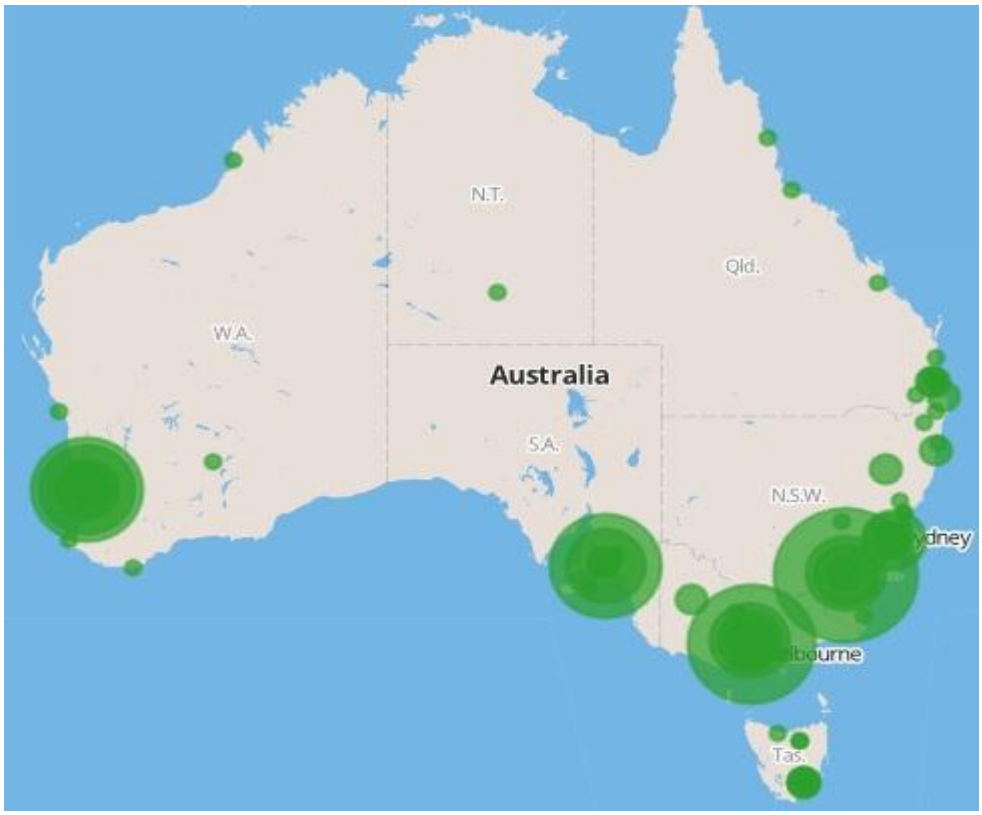
While this sample is self-selecting, our team regularly reviewed the data to identify gaps and encourage participation in the audit survey. We believe the audit has captured a wide cross-section of the community involved in science engagement, including those often not included in such surveys—such as national parks, libraries and art galleries. The biggest gaps in the survey data appear to be those involved in science engagement from:

- local government
- state government, especially those involved in public health.

While there were not many entries from representatives of business or federal government agencies, it is clear from the data that they are involved in science engagement activities, but are less likely to be directly organising those activities and are thus less likely to be the respondents completing the survey.

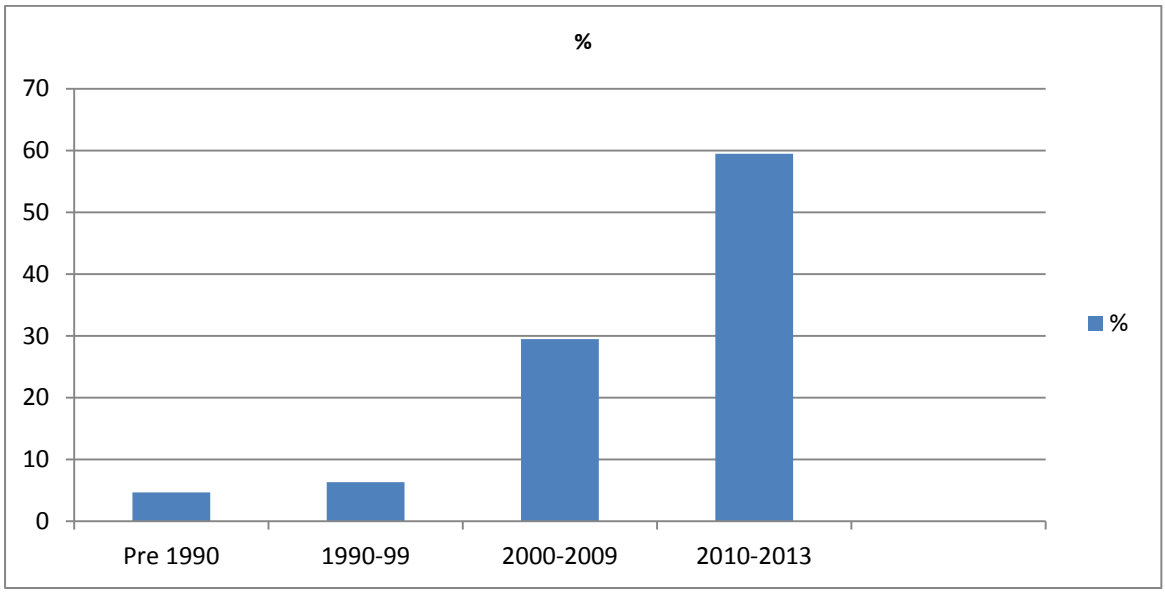
The map in Figure 2 shows that most respondents were from Australia's capital cities, especially Sydney, Canberra, Perth, Melbourne, Adelaide and—to a lesser extent—Brisbane. However, people from across Australia entered data.

Figure 2 The location by postcodes of those who submitted data to the audit survey. The size of the circles represents the number of respondents from that location.



Respondents were asked to complete the audit for activities taking place or planned to take place between January 2011 and June 2013. However, they were also asked when the activity started. As can be seen in Figure 3, the majority (52 per cent) of the activities recorded started or will start in the year range 2010–13.

Figure 3 Years when science engagement activity started



The nature of the engagement

Describing the activity

Respondents were asked in an open-ended question to briefly describe their activity. The results of our content analysis of these activities showed that almost a quarter were about presentations, seminars or lectures. This was closely followed by school-based educational activities. The top 10 themes emerging from the descriptions are listed below, in order of frequency of occurrence, with some example quotes that illustrate that activity.

1. Presentation/seminar/lecture
    - *"Lectures are offered on a regular basis and aim to deliver the latest information regarding any new discoveries or advances in what we know about the Universe around us."*
    - *"Monthly free public lecture on topics in astronomy."*
2. Educational/school-based activity
    - *"Managing the education program for the CRC"*
    - *"School students participated in a program which included an introduction to the history of scientific illustration and its role in describing, identifying and classifying natural history specimens with reference to the Museum's archival collections."*
3. Visit/tour (including school visits)
    - *"Visiting science shows for schools, hands-on programs, Day With a Scientist, Family Science Show, Family Science Night, Scientist in Residence, Vacation Science Programs, Teacher Workshops, International Science Poetry Competition, and The Science Education Review."*
    - *"Scitech Outreach Science Shows - A compliment of nine 30 minute interactive, highly entertaining science shows for schools or school age children. These shows tour all of WA over a rostered touring program, including metro Perth."*
4. Skills or professional development workshop/course
    - *"An Indigenous public health teaching & learning workshop hosted by the Public Health Indigenous Leadership in Education Network (PHILE Network)"*
    - *"Parents, caregivers, preschool educators and others provide many creative opportunities for young children to explore their world. That's why we've created the Little Bang Discovery Club. This 4-week course shows how discovering relates to genuine scientific enquiry and why this makes understanding how the world works so much better."*
5. Hands-on activity
    - *"MadLab is an electronics workshop where participants are each shown safe use of soldering irons as they assemble and construct an imaginative electronic gadget, which they take home. The joy of MadLab is in understanding all about the common electrical components and how they work together in a printed circuit board to create unique machines. Learning the skill of soldering is something everyone also takes away."*
    - *"We lend museum specimens and artefacts of Queensland's natural and cultural histories to Queensland schools and communities."*
    - *"Free family science fair, 10am to 3pm, all ages welcome, hands-on science and science shows"*

6. Shows/demonstrations
    - *"Using innovative Virtual Reality technologies developed by the Centre for Astrophysics and Supercomputing, AstroTours are designed to educate and entertain audiences about astronomy."*
    - *"Presenting everyday science demos/activities using everyday materials. Visitors are participants in the show, helping with demonstrations. There are lots of opportunities for fun, sharing and testing out ideas and lots of questions."*
7. Exhibits/posters
    - *"Photography exhibition at museums, libraries, etc. Our scientists have captured fourteen amazing images using microscopes, macro cameras and even lasers to provide a rare view deep inside plants. The images reveal some of the incredible adaptations and clever defence tactics that plants use to survive hostile environments."*
    - *"For the month leading up to and including National Science Week we will be providing engaging science posters on the back of toilet doors in airports, shopping centres and pubs."*
8. Publications/tools
    - *"Presenting everyday science demos/activities using everyday materials. Visitors are participants in the show, helping with demonstrations. There are lots of opportunities for fun, sharing and testing out ideas and lots of questions."*
    - *"The program has developed an extensive workbook, with information and activity ideas on local plants, animals, water places, soils and fire use; local plant and animal photo-cards, and many other resources."*
9. Quiz/competition/prizes
    - *"I am running the ESP program with Year 9 and 10 students (20 students in total) who are working to complete the Bronze Crest Award from the CSIRO. I also run a weekly science lesson for visiting Yr 6 students from feeder primary schools and organise all the Science competitions and excursions at the College. I promote and inform staff, students and parents of upcoming events such as The Science Experience through the newsletter and daily bulletin."*
    - *"Logo competitions - school children will design a new logo each year Science in the Bush - 2 days yrs 5&6 and yr7-9 students visit UNE campus and take part in a day of hands on science activities from a wide range of disciplines."*
10. Art and science interaction
    - *"Unique events allowing adult audiences the chance to explore and enjoy STEM. Scitech offers an array of opportunities for adults to rediscover Scitech and explore and enjoy their own STEM experiences. Currently these activities include Profs and Pints (STEM topics debated and discussed in a pub); Analogue to Digital (a science/music/art crossover event); the ever-popular Scitech After Dark series, and the annual Scitech National Science Week Comedy Debate."*
    - *"Concept Radical was an art competition that called for artists' impressions of free radicals. Submissions were displayed on an online gallery, and finalists' work exhibited at the George Paton Gallery Melbourne. Public workshops were held alongside the art competition that educated artists about free radicals."*

As can be seen, much of this activity is one-way though displays, seminars, performances and presentations. Interactive activities were mostly hands-on activities led by science communicators or projects that called for user-generated materials for competitions.

Most activities sought to raise awareness or improve knowledge. Participatory dialogue events were less common.

About five per cent of entries mentioned in their descriptions that their activity was part of National Science Week.

Duration of activities

The majority of activities (52 per cent) recorded were ongoing; 13 per cent said their activities were 'one-off'; eight per cent said their activities lasted up to five years; seven per cent up to one year; and six per cent reported an annual event.

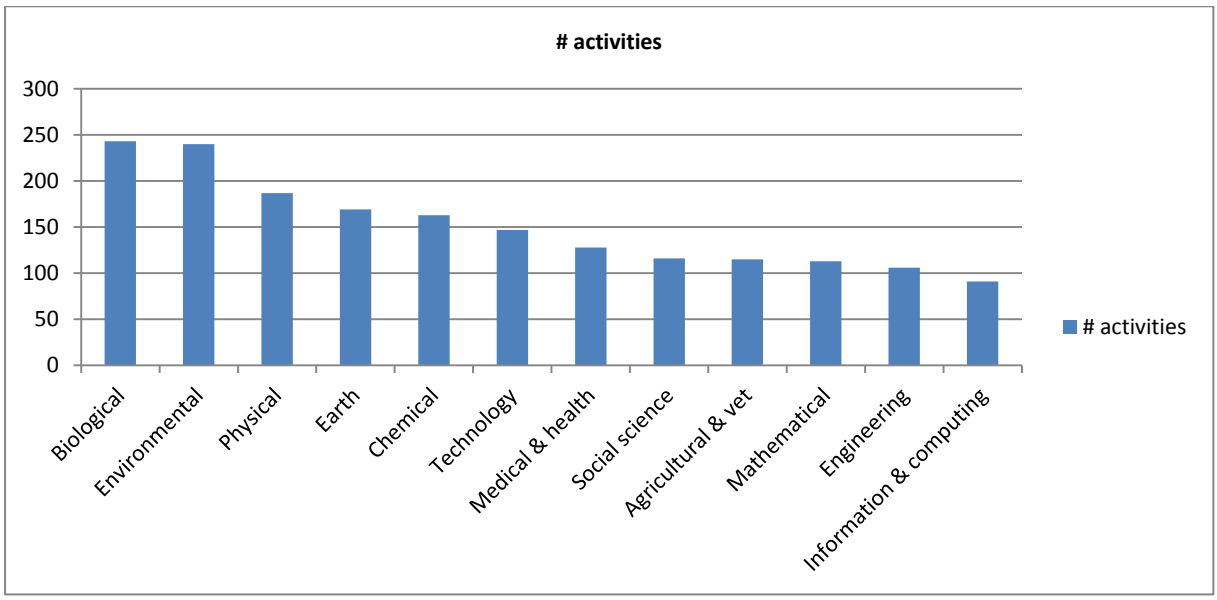
The rest of the responses said their activities ranged between one week and 20 years of duration.

Science disciplines involved

When asked about the disciplines that were involved in the science engagement, the most common responses, as seen in Figure 4, were about biological or environmental sciences.

The least common responses involved information and computing, engineering and mathematical sciences.

Figure 4 The number of activities engaging in each scientific discipline



The majority of activities (46 per cent) covered from one to three of the 12 disciplines provided in the audit survey choices, with only 15 per cent of activities covering a majority (10–12) of disciplines.

When comparing the disciplines covered with other questions through the bubble visualisations, some of the interesting trends were that:

- When business leaders were targeted by the activity, it was more likely to be about medical and health sciences than biological sciences.

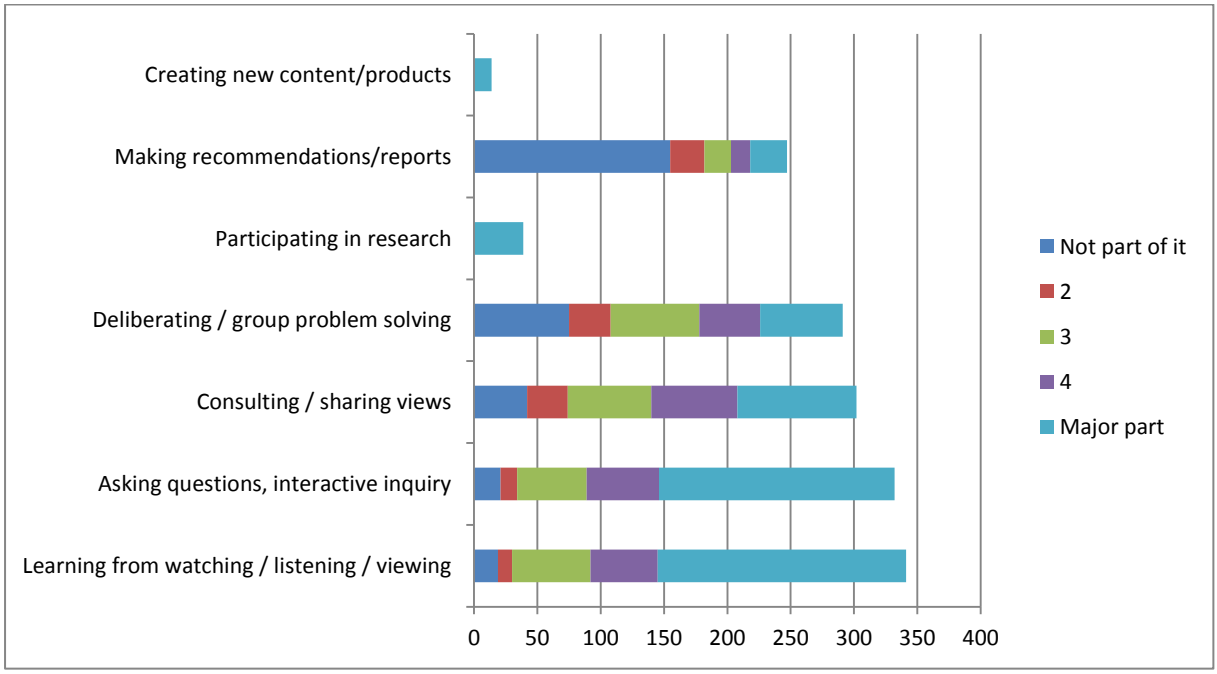
- When farmers were targeted by an activity, it was more likely to be about agricultural and veterinary sciences than biological or mathematical sciences.
- When politicians were targeted by an activity, it was more likely to be about information and computing sciences than biological sciences.
- Volunteers are more likely to be involved in delivering the science engagement activity when it is about earth sciences or technology compared to medical and health sciences.

How people were engaged

A major part of most of involving people in activities, as shown in Figure 5, was about 'learning from watching, listening, viewing lectures, media and/or exhibits'. Of far lesser importance was 'producing recommendations or reports'.

A few interesting 'other' responses indicated that people are also being involved in activities by directly participating in research and creating new science content or products.

Figure 5 Responses to the Australian national audit survey asking respondents how people were engaged in their activities, from 5 (a major component) to 1 (not a part of it). Note: 'participating in research' and 'creating new content/products' were two common 'other' items listed by survey respondents.



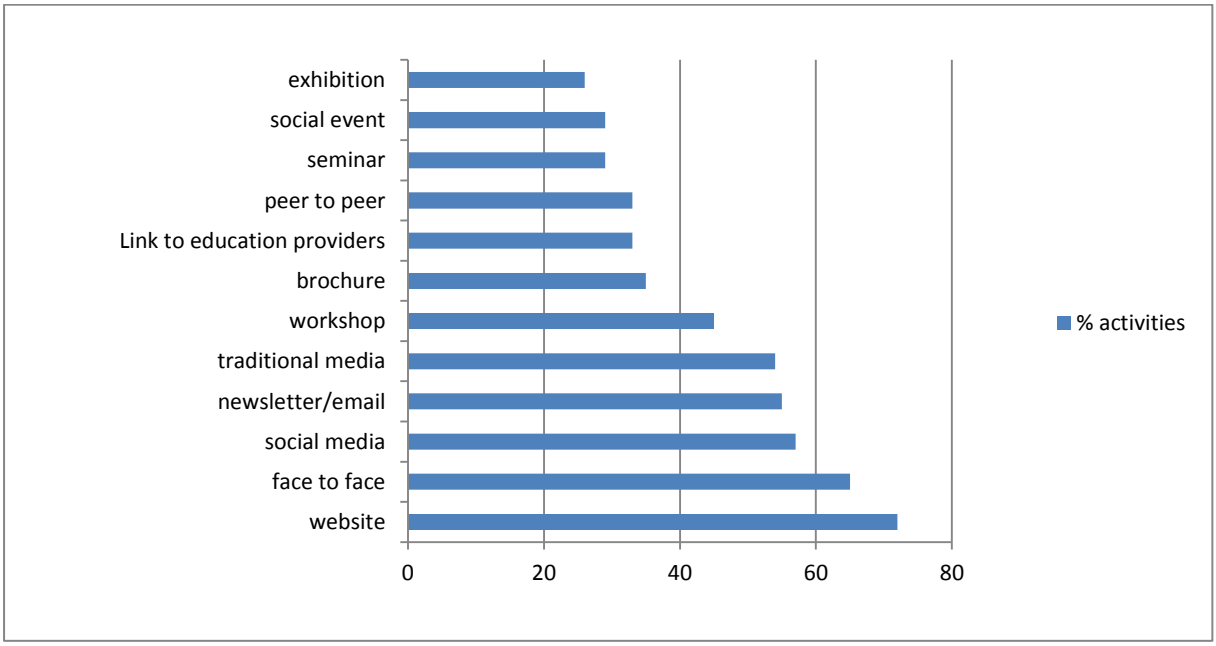
Tools engaging people

The tools that survey respondents chose to use to engage people in science, as shown in Figure 6, were often about one-way dissemination through websites, newsletters, brochures, seminars and exhibitions.

However, the dominance of face to face interactions and the strong use of social media may indicate that people are moving towards a more participatory approach to science engagement.

Interestingly, when comparing the data, face to face tools were used the most (71 per cent) when Indigenous groups were targeted, and least (61 per cent) when the general public is targeted.

Figure 6 Responses to the Australian national audit survey asking respondents what tools they commonly used to engage people in their activities



When the activity is happening in the scientific process

Those completing the audit were also asked when in the scientific process the engagement activity was happening. Figure 7 shows that most activities are about ongoing science and, to a lesser extent, were about involving them in doing the science or about completed science.

There were fewer activities designed to engage people in shaping the science questions or to get funding or support during or before the science happens.

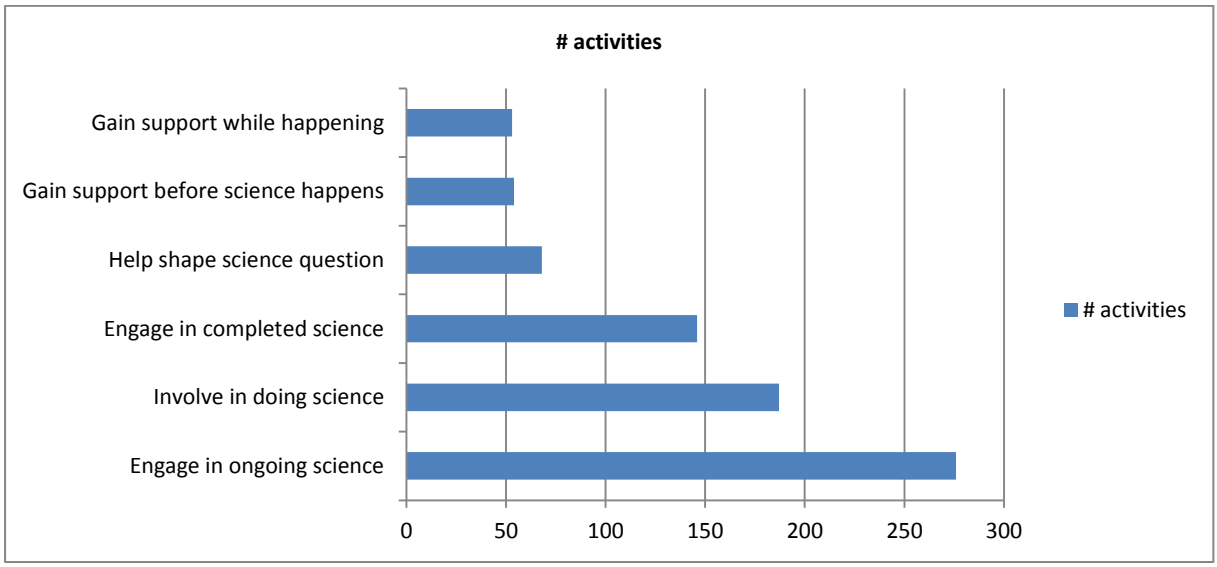
The majority of activities involve just one (36 per cent) or two (34 per cent) of these stages in the science process, with only 6 per cent encompassing all stages of the science process.

When this question was compared to the target groups involved in the engagement, we found that when the science engagement was timed ‘to get target groups involved in shaping the science question', it was highest for Indigenous communities, policymakers and advisors, and decision-makers. It was lowest for school-aged children.

When business leaders were targeted by the activity, it was more likely (64 per cent) aimed to get support or funding during the science rather than involving them in doing the science (33 per cent).

When the engagement activity was about medical or health sciences, it was most likely to be about completed science (48 per cent) compared to involving them in doing the science (25 per cent).

Figure 7 When in the science process the engagement activity is happening



Desired outcomes, focus and motivation for the activities

Importance of outcomes from the Inspiring Australia strategy

The audit asked respondents to rate how important the four outcomes of the Australian Government's Inspiring Australia strategy were to the activity they were recording:

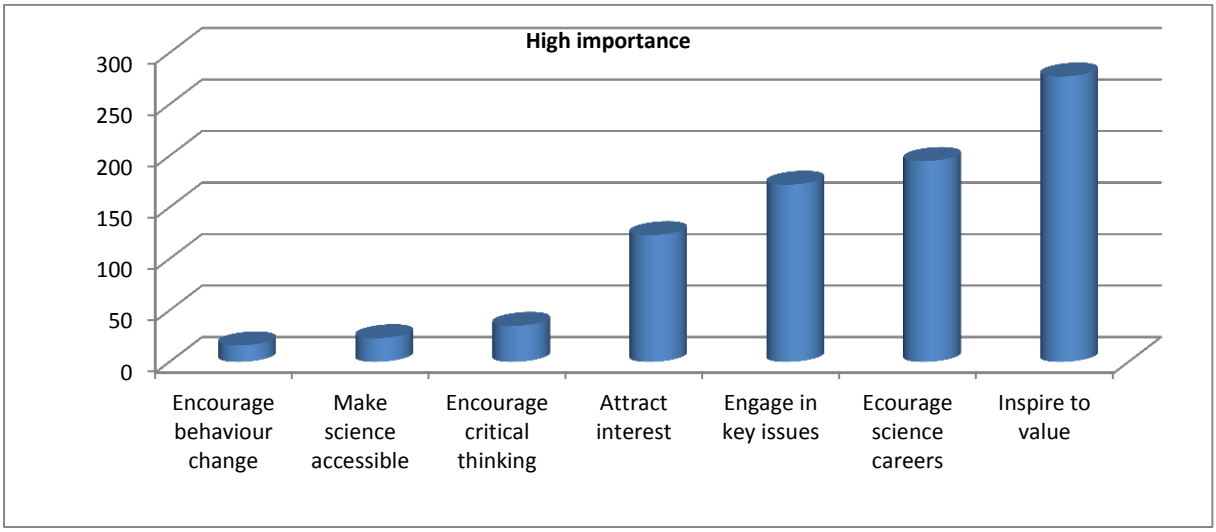
1. Inspire target groups and get them to value scientific endeavour
2. Attract increasing national and international interest in science
3. Critically engage target groups with key scientific issues
4. Encourage young people to pursue scientific studies/careers

Survey respondents could also list 'other' outcomes and their importance. The results, as shown in Figure 8, show that the most important outcome nominated by the government was the first listed above.

It appears that, for most of the people directing public engagement in science in Australia, it is about celebrating and promoting science, rather than about getting people to participate in the science and critically evaluate it.

However, the most common 'other' responses were to 'encourage critical thinking', 'make science more accessible', and 'encourage behaviour change'. This indicates that at least some are moving their public engagement towards more critical thinking and openness and as means of encouraging behavioural change.

Figure 8 Responses to the Australian national audit survey asking respondents how important the four outcomes were to their engagement activity. The graph shows the number of activities where the respondent said the outcome was of 'high importance' to their activity.



When the results of this question were compared with other questions through the bubble visualisations, we found some interesting differences.

Firstly, there were discipline-based differences. As mentioned previously, for all activities recorded for the survey, the field of biological science was most involved and environmental sciences was the second most involved.

When the outcome sought for an activity was to either 'inspire target groups and get them to value scientific endeavour' or 'attract increasing national and international interest in science', the top field of science for the activity was biological science.

When the outcome sought for an activity was to either 'critically engage target groups with key scientific issues' or 'encourage young people to pursue scientific studies/careers', the top field of science for the activity was environmental science.

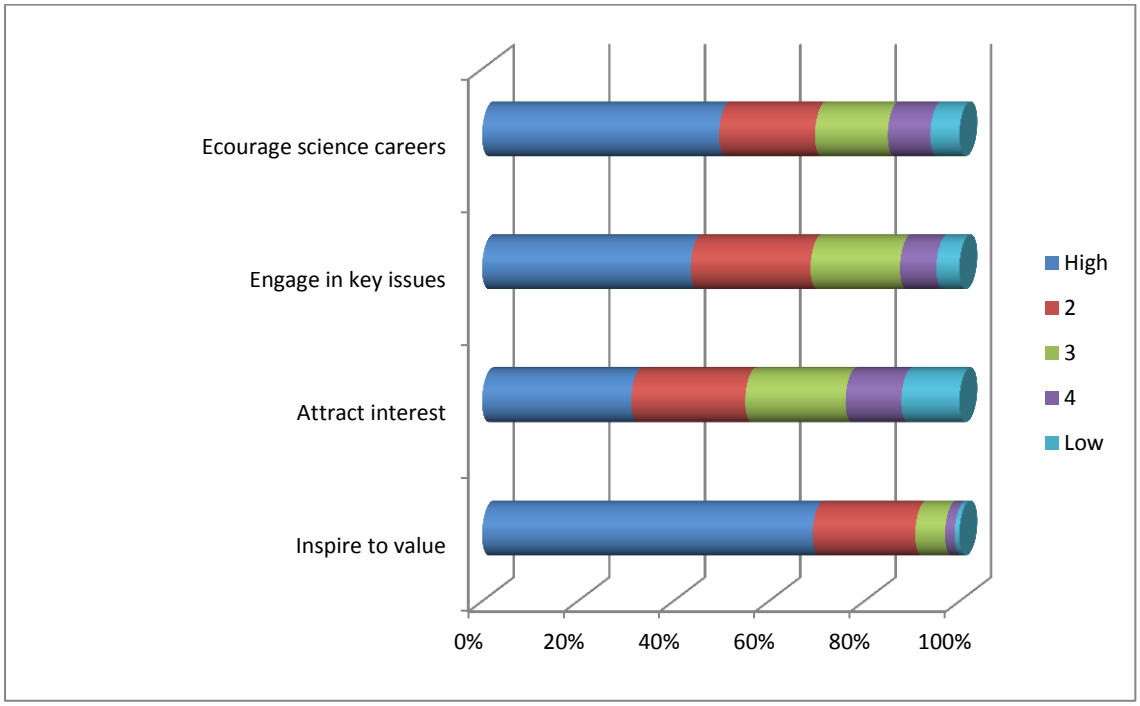
The involvement in the discipline of engineering, although not high overall, was slightly higher for the outcomes 'attract increasing national and international interest in science' and 'encourage young people to pursue scientific studies/careers' compared to the other two outcomes.

Most outcomes addressed similar audiences. However, not surprisingly, school-aged children were most favoured for the outcome 'encourage young people to pursue scientific studies/careers'.

Secondly, there were some differences related to the focus of the activity, which are discussed further below.

Figure 9 compares the four Inspiring Australia outcomes according to their degree of importance to respondents for their engagement activity.

Figure 9 Responses to the Australian National Audit survey asking respondents how important the four Inspiring Australia outcomes were to their engagement activity. The graph shows relative importance of each outcome from 1 (high) to 5 (low).



Significant issues, needs or priorities addressed

We asked respondents to the audit to describe the significant issues, needs or priorities their activity was addressing in an open-ended question. Respondents completed this part of the survey for all except for 18 of the 411 activities.

When analysing results, the most common response (18 per cent) was about promoting doing science in schools or taking it up as career, similar to Inspiring Australia's fourth outcome. At a similar but slightly lower level, were themes related to the need to (in order of frequency, highest to lowest):

- **Increase awareness**
    - *"Making students aware of environmental and conservation issues, inspiring behavioural changes to promote sustainability and environmental awareness and increasing student's knowledge of the living world, focusing primarily on marine life.*"
    - *"General awareness of the world around us, encouraging people to be aware of scientific advancements in our knowledge and appreciation of the universe in which we live."*
- **Make science fun/appealing/exciting/interesting**
    - *"Making Science fun and entertaining while bringing fascinating snippets of scientific information available to the public."*
    - *"The program uses passionate scientists to guide students through fun science projects from a young age. Addressing the need for future plant scientists and an appreciation of good scientific process."*
- **Educate/support educational programs**
    - *"We are educating the public about plant science, what DNA is, GM, etc."*
    - *"Educating the general public, secondary teachers and students about modern techniques used in plant science."*
- **Improve scientific literacy/knowledge/understanding**
    - *"Improves scientific literacy in both young children and adults. Encourages a culture of effective learning in the home and provides opportunities for community engagement with Australian scientific research."*
    - *"The programs foster key skills for 21st-century living, such as improved scientific and digital literacy, critical and creative thinking, collaboration, innovation and developing sustainable design and environmental solutions. New hands-on design workshops challenge students to explore the choices we make as consumers, experiment with the creative skills of designing and making, and explore the design process as a critical means of developing more socially responsible design solutions for the future."*
- **Respond to or manage environmental issues**
    - *"Raise awareness and motivate engagement in issues related to coral reef conservation and climate change."*
    - *"Contributing to raising the awareness of subjects of importance including environmental impact, sustainability and animal biodiversity to the community and the nation, and of the current and potential roles of science in addressing these"*
    - *"Climate change impacts on health (including mental health), agriculture, infrastructure, and the economy. Policies and technologies that mitigate against dangerous climate change."*

Less common responses (< eight per cent) were about the need to:

- **Improve the engagement of specific groups, such as women, people in remote communities, Indigenous groups, youth and toddlers**
    - *"Student Engagement in Science Public Engagement in Science Education in Science Indigenous education"*
    - *"Bringing science to low socio economic regional areas with a reasonably high indigenous population. By providing simple activities show the carers how to do them with children under their care."*
    - *"Regional access to science experiences, engaging audiences previously without access"*
- **Change behaviours or create specific actions**
    - *"Public interest in mathematics is often low. There is a need to publicly celebrate the wonder of maths as both a world to study and a human endeavour."*
    - *"The need to increase interest and participation in science and technology among people that may not normally be exposed to opportunities that encourage this."*
    - *"Overcome isolation/stigmatisation for students interested in topics that are not universally popular; show students how higher and research mathematics differs from traditional textbook material, get students to meet real-live mathematicians who have a variety of careers and live across different parts of Australia."*
- **Disseminate information**
    - *"Wounds are mostly manageable and not fatal. However, wounds are the elephant in the room that no one is talking about. This unique event offers an opportunity for Queensland's leaders in wound management and research, health professionals and interested members of the public to come together to learn more about wound management and the latest in scientific research."*
    - *"Distribution of science information to community, building networks of innovators, training in clean energy and digital economy tools."*
- **Make science part of culture or everyday life**
    - *"Embedding science in existing cultural festivals. Normalising science, making it part of everyday life."*
    - *"Recognises science as a part of Australian culture."*

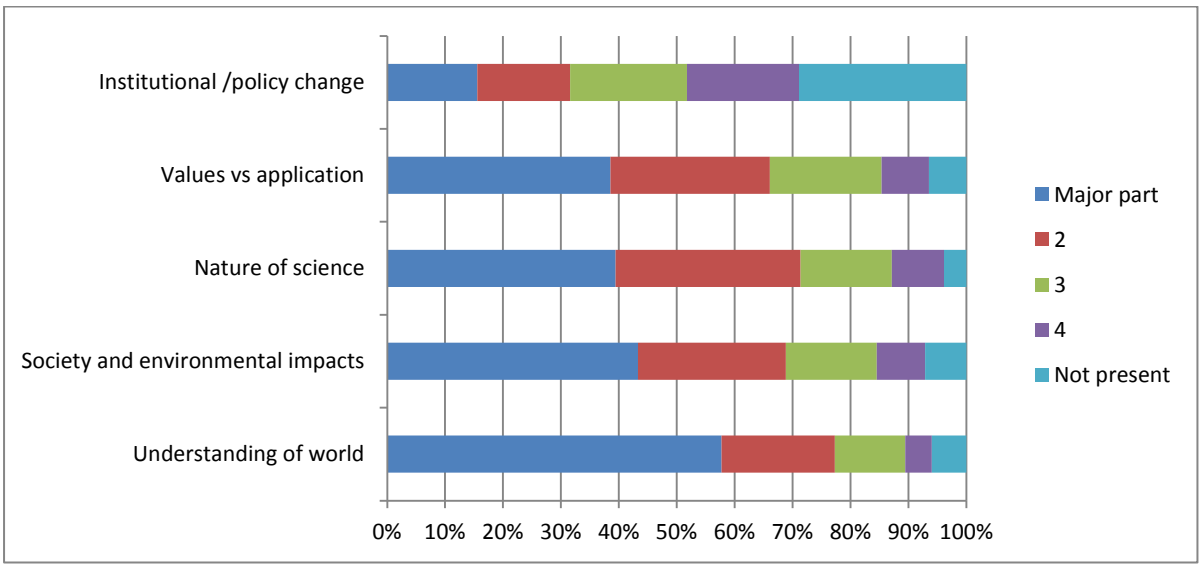
Focus of activity

We also asked respondents a closed-ended question about what their activity specifically focused on, where five options were given and they were asked to rank how important the options were to their activity.

The majority of people rated 'understanding of the natural and human-made world' as the most important aspect of their engagement activity.

As can be seen in Figure 10, the least important component of their activity was 'institutional priority or public policy change related to science and technology'. Again, this appears to emphasise the celebratory and promotional nature of much of the engagement activity with people being less engaged in critical thinking, considering the impacts of science and technology or creating change.

Figure 10 Responses to the Australian national audit survey asking respondents what their engagement activity focused on. The graph shows relative importance of each type of focus from 1 (high) to 5 (low).



When we compared the four Inspiring Australia outcomes with the focus of the activity though the visualisation bubbles, we found some interesting differences.

When 'institutional priority or public policy change related to science and technology' was the major focus of an activity, engagement happened primarily about ongoing science, and secondly about completed science.

When the focus of the activity was about 'understanding of the natural and human-made world', engagement happened primarily about ongoing science, and secondly because the activity wanted to involve people in doing the science.

When comparing focus of activity with other results, we also found that:

- The discipline of chemical sciences was about 15 per cent higher when the focus was on 'the nature of the scientific process or enterprise' compared to other focus areas.
- Politicians and business leaders were 20 per cent more likely to be a target group for the science engagement activity when the focus was on 'institutional priority or public policy change related to science and technology' compared to other target groups; school children were the least likely to be involved in activities with this focus.
- Interpretation specialists such as museum curators, science centre education officers or rangers, were more than twice as likely to be involved in delivering the science engagement activity when the focus was about 'understanding of the natural and human-made world' compared to when the focus was about 'institutional priority or public policy change related to science and technology'.
- For activities focused on 'understanding of the natural and human-made world' the Indigenous community (40 per cent) is 9 per cent more likely to be to be the target audience than politicians.
- When the focus is on 'institutional priority or public policy change related to science and technology', the science engagement activity is most likely to be directed about ongoing science (65 per cent), rather than funding of science before it happens (20 per cent).

Who are targeted by and involved in the engagement activity

Audit survey respondents were asked a series of questions about who their activity was targeting and who was involved.

Target groups

As Figure 11 shows, most activities targeted school children or the general public, followed by metropolitan and regional communities. Specific groups like farmers and business were less likely to be targeted.

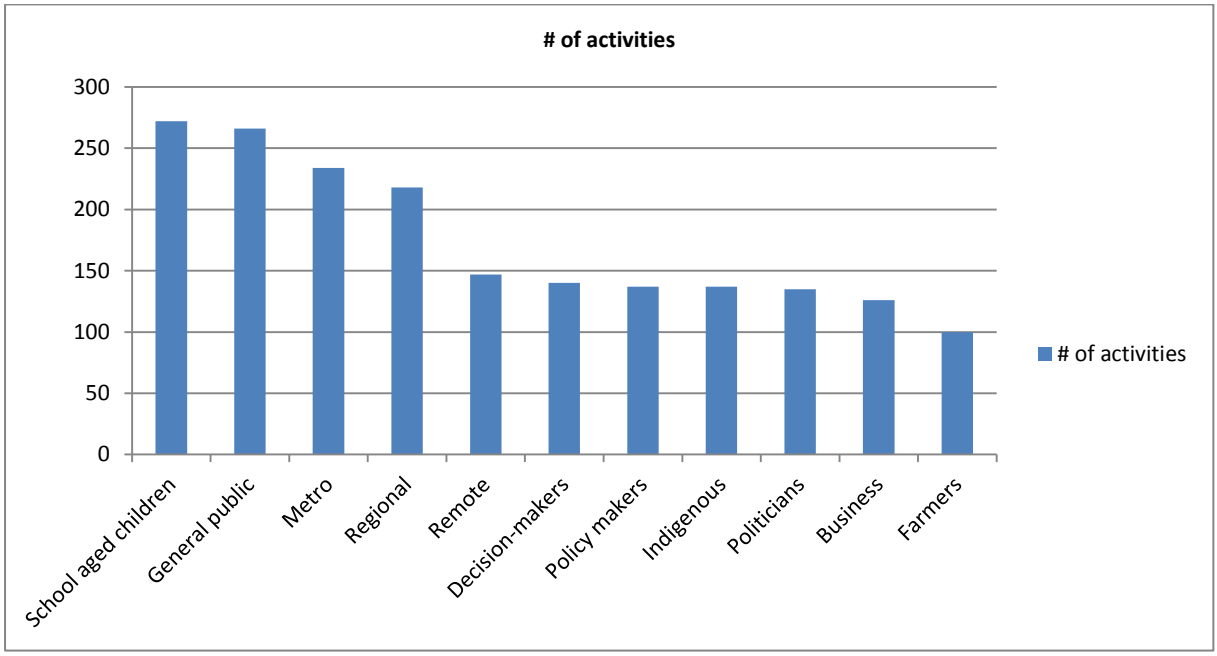
When respondents were asked to say how many people within each group they targeted, it wasn't surprising that for the most popular target groups such as school children and the general public, most targeted more than 500 people.

It was only when specific groups were chosen, such as with politicians and farmers, that people were more likely to targeted fewer than 20 people.

One quarter of respondents targeted two to three groups, with almost the same number (23 per cent) targeting four to five groups. Only 10 per cent targeted one specific group, and almost one fifth (19 per cent) targeted more than 10 different groups.

Respondents could also record additional 'other' groups they targeted. The most common 'other' groups mentioned were teachers, scientific community, parents and tertiary students.

Figure 11 The most common target groups for science engagement activities

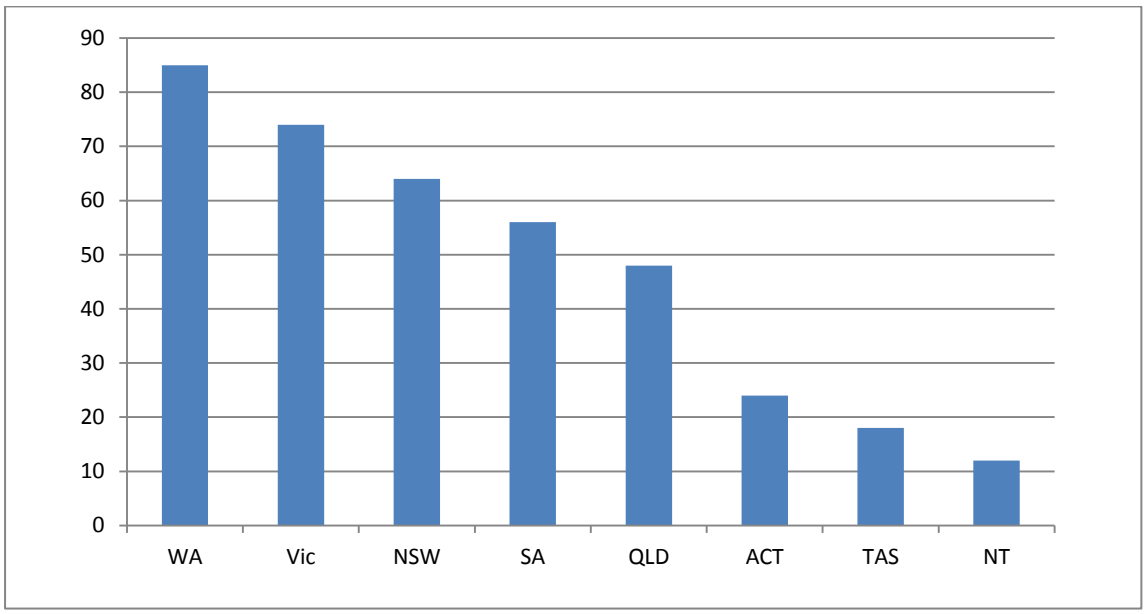


We also asked where the targeted groups were based. Most of the engagement activities targeted Australian audiences, with only 74 activities targeting international audiences—mostly in North America, Europe, Asia and Oceania. Of these international activities, only three did not also target Australia.

Respondents listed many specific regions and towns in Australia where their activity was targeted, however this data was difficult to analyse as people interpreted the definitions of city, town, suburb and region differently. It is recommended that this question be restructured in the revised survey tool.

Almost a quarter of activities (23 per cent) targeted all states and territories with their engagement activities, while others were specific to one state or territory. This can be seen in Figure 12, with Western Australia dominating the responses.

Figure 12 The number of state- or territory-based science engagement activities



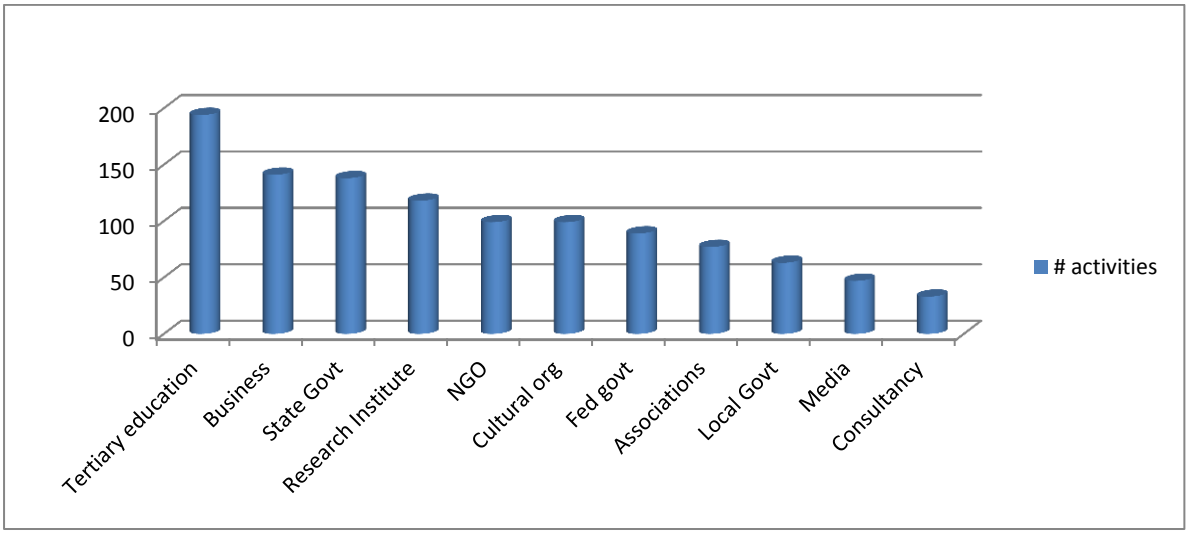
The people and organisations involved in the activity

We also asked respondents to choose from a list of options about people who were involved in the activity. We also asked respondents to provide any specific names of organisations involved.

We found that most activities involve tertiary education providers, businesses, state government agencies or government-funded research organisations such as CSIRO, as shown in Figure 13.

Frequent groups listed under 'other' and not included on our list were community groups, schools, freelancers, international research institutes, the general population, and scientists.

Figure 13 Groups involved in science engagement activities



The number of businesses involved was surprising. In exploring this data, the mining industry was especially dominant (26 per cent of business entries), followed by primary industries (12 per cent), energy and water (10 per cent), and small business (9 per cent).

Victoria had the highest level of tertiary institution involvement in science engagement activities, followed by Western Australia, New South Wales, and Queensland.

The Western Australian state government had almost twice the level of involvement in science engagement of any other state government, with New South Wales and Queensland next on the list.

CSIRO was by far the most involved government-funded research organisation, and was more than four times likely to be involved compared to research and development corporations or cooperative research centres.

The most commonly involved non-government organisations were community-based groups, followed by conservation and natural resources groups. The Royal Institution of Australia (RiAus) provided 15 science engagement activities to the Audit.

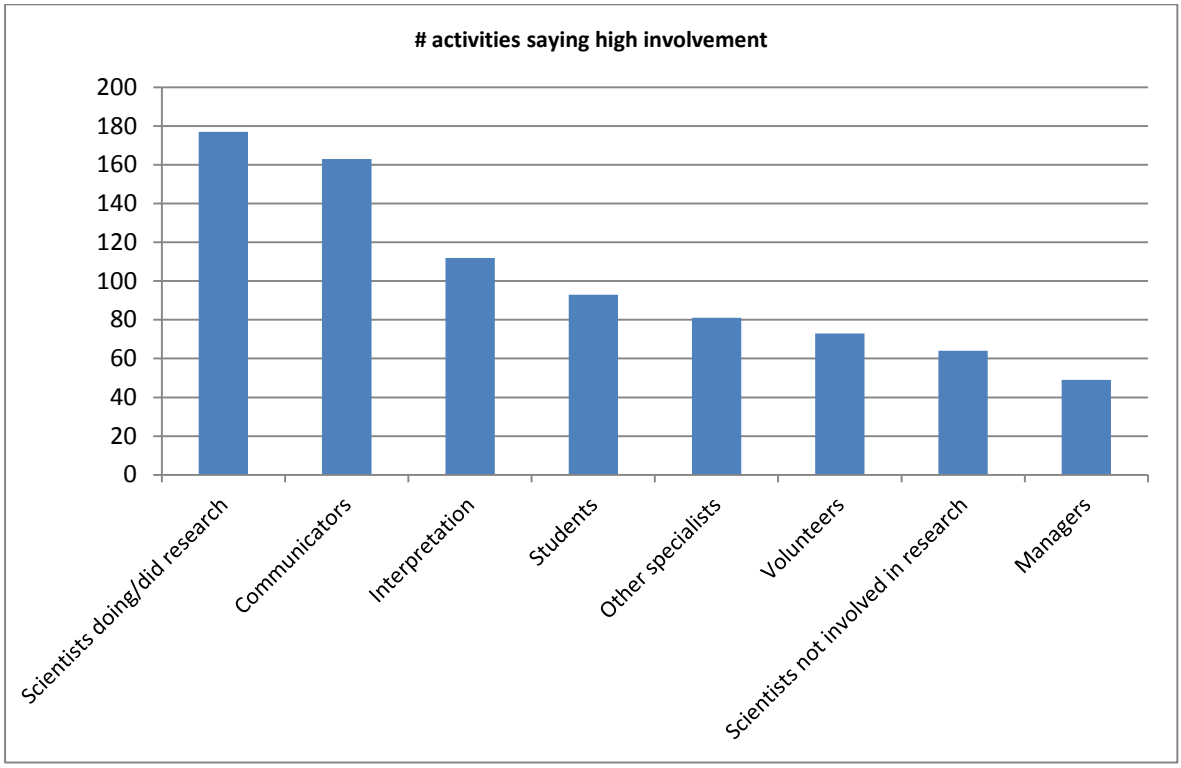
When asked about how involved various groups were in the delivery of the engagement activity, survey respondents said that 'scientists who did or are doing the research' are most engaged, followed by communication professionals and interpretation specialists, such as museum curators and science education officers. This is shown in Figure 14. Two other groups who were also mentioned as having a high level of involvement in response to 'other', were teachers or academics and community representatives.

When we compared who is delivering the engagement with other questions through the visualisation bubbles, we found that:

- Scientists who did or are doing the research were more likely (20 per cent) to focus on 'institutional priority or public policy change related to the science and technology' than interpretation specialists (9 per cent), who are more likely (68 per cent) to focus on 'understanding of the natural and human-made world'.
- Interpretation specialists tend not to target politicians, decision-makers, policymakers and advisors, business leaders or farmers, which are more likely (by 15–20 per cent) to be targeted by scientists who did or are doing the research and communication professionals.

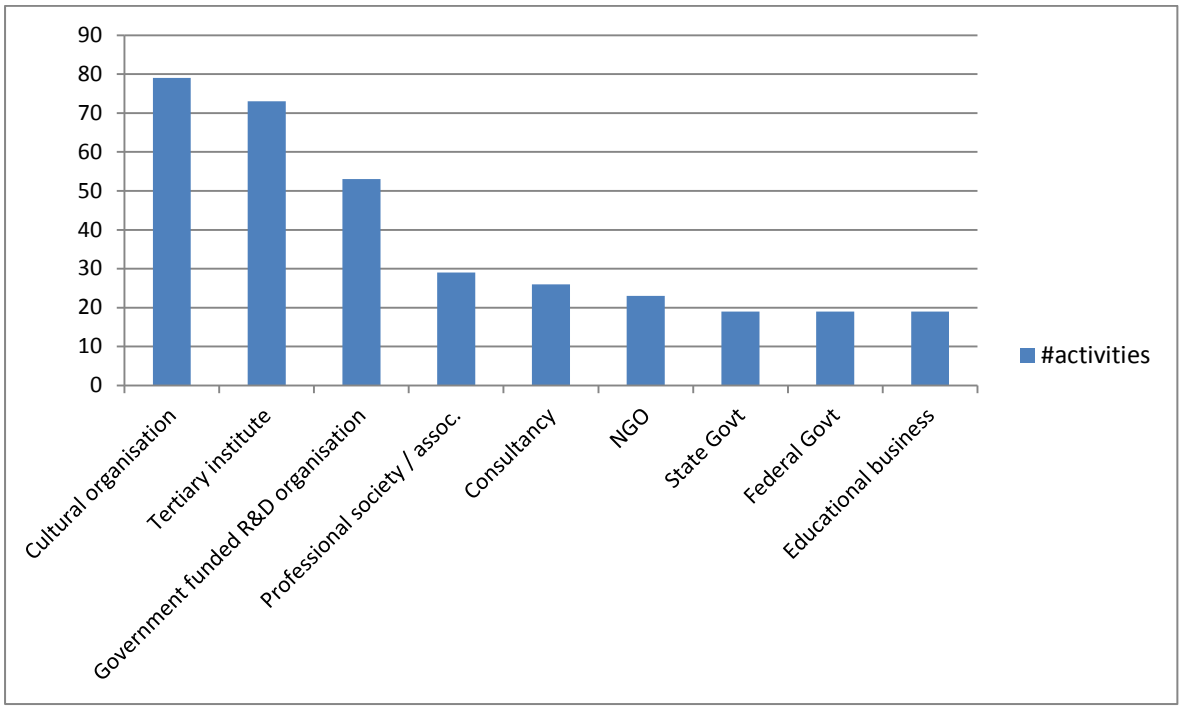
- Seminars are more likely to be used as an engagement tool by other scientists not directly involved in the research (46 per cent), students (40 per cent), and scientists who did or are doing the research (38 per cent) and less so by other groups.
- Managers are more likely (26 per cent) to be interested in getting target group involvement in shaping the science question compared to other groups, with interpretation specialists being the lowest (12 per cent); likewise, managers are more interested (23 per cent) in getting support or funding for science before it happens compared to other groups, with the interpretation specialists being the lowest again (13 per cent).

Figure 14 The people most involved in the delivery of the engagement activity



Audit survey respondents were also asked, in an open-ended question, about the main agency leading the activity. The main types of organisations leading the science engagement activity are shown in Figure 15.

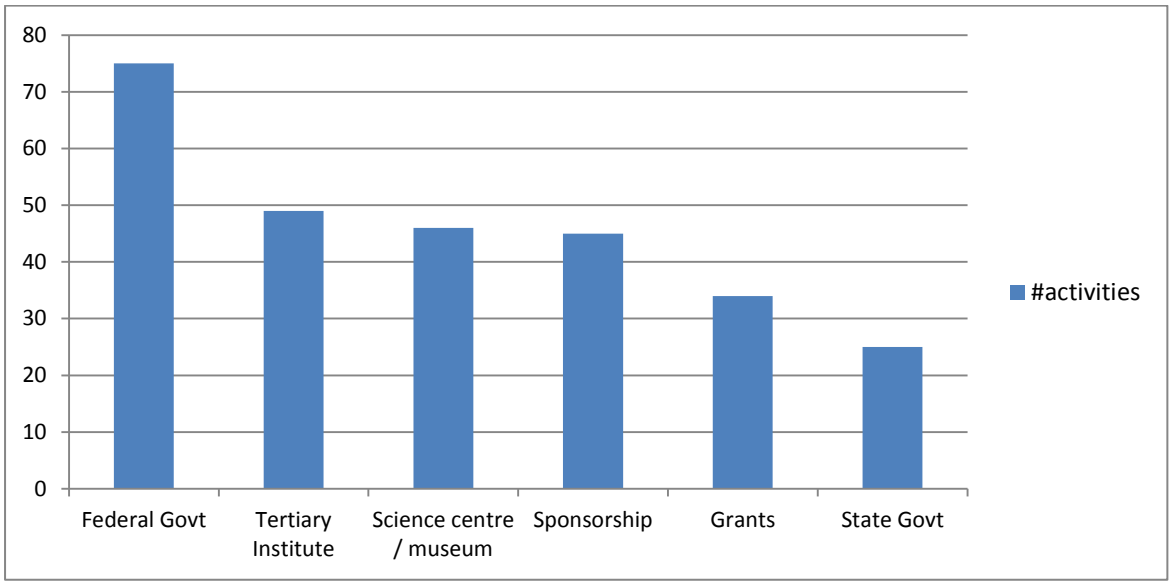
Figure 15 Organisations involved in science engagement activities



Funders of science engagement activities

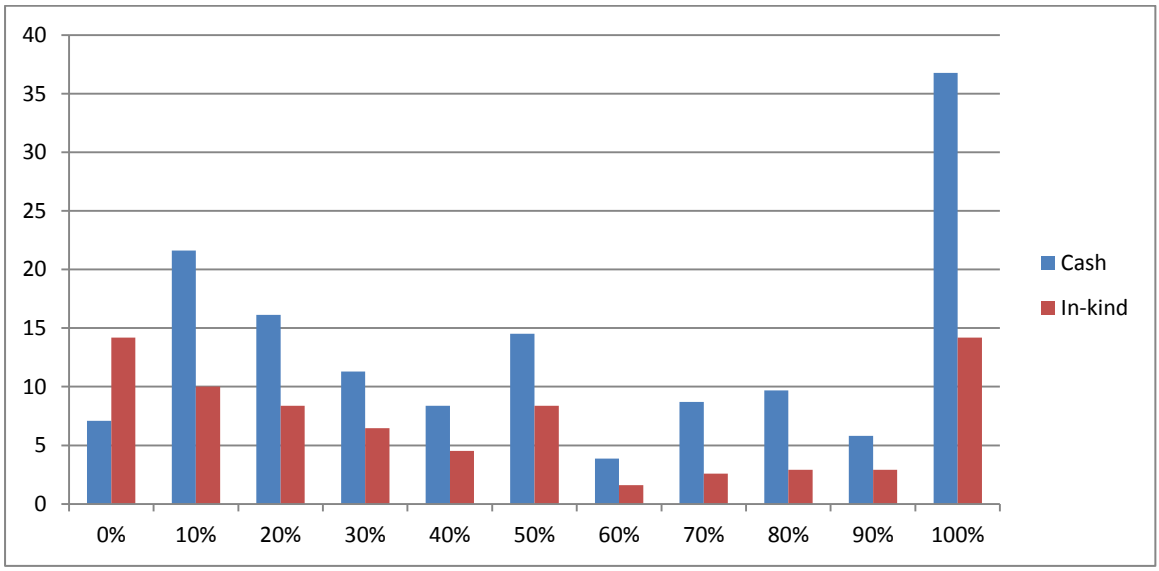
The largest funder of science engagement activities collected in the audit is the federal government. Their contribution is almost twice that of the next major funder: tertiary institutions. The graph in Figure 16 shows the major contributors to funding Australia's science engagement activities.

Figure 16 The major funders of Australia's science engagement activities



Survey respondents were also asked how much their funders provided through cash or in-kind support as a percentage of costs. This was the least answered question of the survey and the data provided was difficult to analyse. However, it appears that most science engagements (37 per cent) receive all their funding through cash support with only 14 per cent receiving 100 per cent of their funding from in-kind support. This is further shown in Figure 17.

Figure 17 Cash versus in-kind support for Australia's science engagement activities.

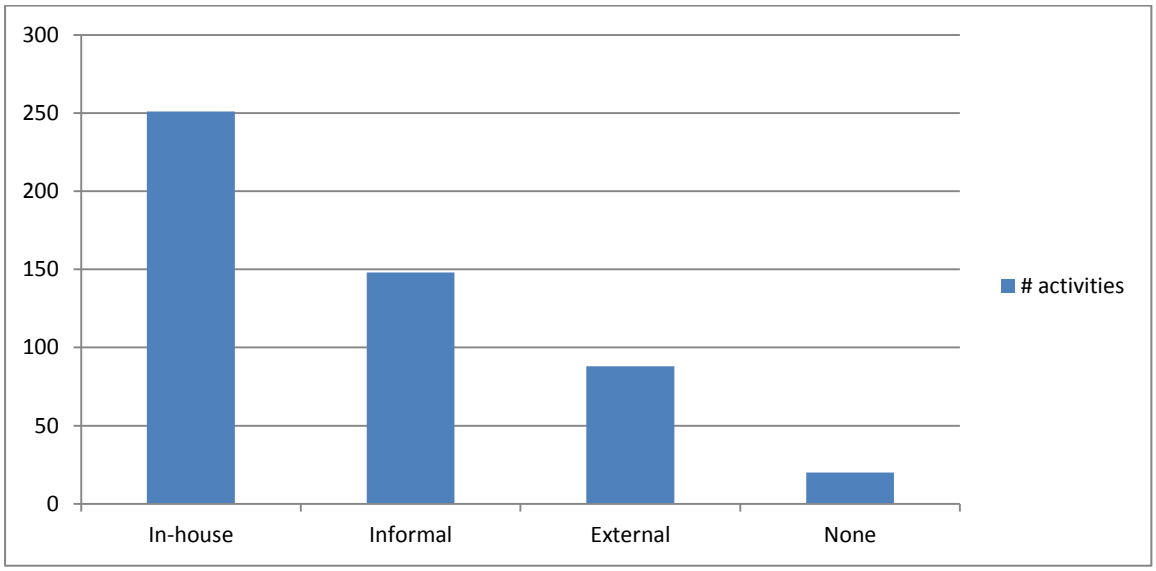


Evaluation

The national audit included a section on evaluation. The first question asked what kind of evaluation they had done or planned to do on their science engagement activity.

The results to this question, as shown in Figure 18, indicate that most evaluation happens in-house and is informal. Respondents could choose more than one kind of evaluation activity, but most (56 per cent) chose just one kind of evaluation, and 30 per cent chose two kinds.

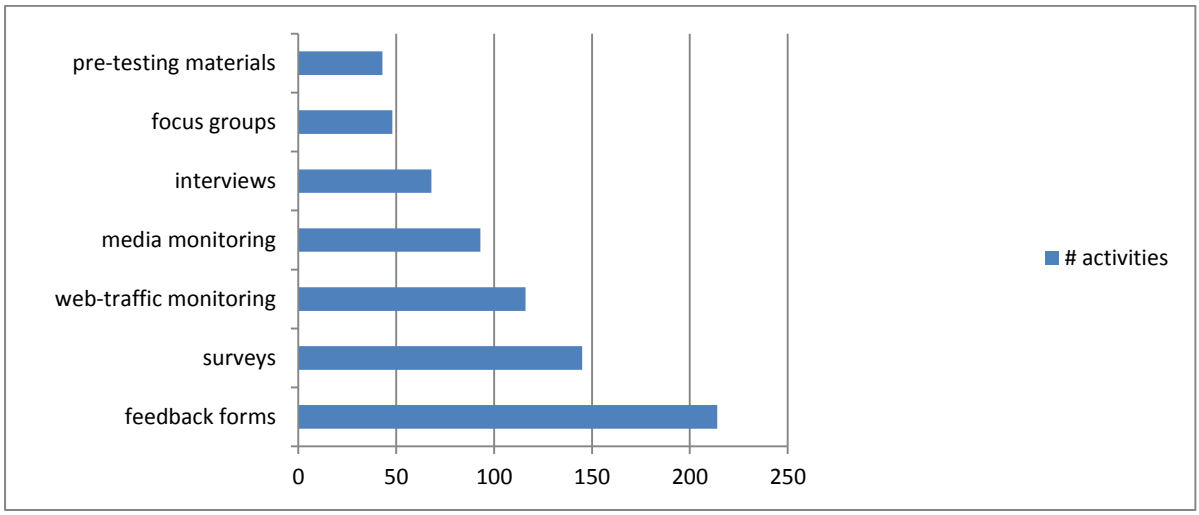
Figure 18 The kinds of evaluation carried out for science engagement activities



Survey respondents were also asked how they had evaluated or planned to evaluate their activity. As Figure 19 shows, the most popular tools were feedback forms and surveys. Other tools highlighted were general feedback through face-to-face interactions, letters, emails or a suggestion box. Others mentioned using attendance records or doing research-related evaluation.

When asked this question, most respondents use only one tool (36 per cent) or two to three tools (44 per cent).

Figure 19 Preferred tools of evaluation



The evaluation section of the audit included three open-ended questions.

The first question asked if they had any evidence before starting the engagement activity that that it was likely to work. Almost a quarter of respondents (n = 98) did not answer this question, and 34 respondents said they had no evidence prior to starting that it would work. A content analysis of the themes of responses is summarised in Table 2. Most relied on the presumed success of past activities or similar programs as evidence that their activity was likely to be successful.

Table 2 Evidence that their science engagement activity was likely to be successful: common themes from a content analysis of answers

Term/phrase	Number of relevant quotes
Past activities successful *Shown to be the most popular activity at the Edinburgh International Science Festival year after year, plus schools touring program and invitations to appear at science festivals and special events throughout the UK, large parts of Europe and other countries across the world.* Previous 'Invite a Scientist to Dinner' events have been very successful in engaging people in science	60
The past success of similar programs *This activity was a fusion of other successful models, but it has been reworked a number of times to better suit the audience.* *Similar programs have demonstrated a per cent of retention of students in the sector following completion of honours or PhD studies*	43
Community support or demand *The demand for the activity indicated that it would work.* *Requests from community for access to museum specimens and artefacts over past 100+ years*	33
Past experiences *But we have experience running seminars and workshops with local groups - often with feedback that it would be good to run something focused on local marine life.* *The Australian Museum has decades of experience with engaging people in science*	29

Term/phrase	Number of relevant quotes
History of positive feedback *Ongoing feedback - formally and informal, for over 25 years. Including questionnaires, anecdotes, observations etc.* *we have several years' worth of survey data from attendees demonstrating business deals that have been initiated from CeBIT.*	20
Overseas examples *In the US, the UK, and Canada, science talks by eminent scientists to the general public are seen as being important and occur regularly.* *I have done a similar but slightly different program that worked well in the US*	18
Research (journals, conferences) *Yes, through Public Attitude Research on Emerging Technologies, which is conducted annually.* *Numerous articles in science communication journals and conferences (including IMTAL) suggesting theatre powerful medium to engage audiences.*	18
Target audience research *We received a lot of informal feedback from teachers that this activity would be useful.* *I always ask the target group what they think they would benefit from most before deciding the activity*	16
Trials/pilots before implementation *User group testing of farmers* *formal market testing engaged focus groups which included children (5-8 y.o.), parents, Stage 1 students in schools and teachers.*	14
Anecdotal evidence *My understanding is that there's a lot of evidence of peer-to-peer learning - learning 'over the fence' as it were - farmer to farmer* *Anecdotal suggestions that current students attended previous events*	12
Others' expertise or support *The 'Biodiversity Kits' were produced as part of a Commonwealth grant and have been used in other settings/different delivery methods. The use of volunteers and making the activity a part of the holiday program were new aspects, and previous use of the kits had proved successful.* *Sufficient local support to warrant a small symposium*	7
Evaluation of past activities *Extensive evaluation of previous exhibitions, focus group evaluation - of overall exhibition topic and testing interactive exhibits* *Yes, part of ongoing core programming which is evaluated on an ongoing basis. Special programs are researched, developed and delivered - after surveying other programs out there and trying new programs to fill gaps where there is a demand or untapped audience.*	6
Current issue/topic of public interest *People love watching rockets being launched.*	4

Respondents were also asked how they made sure of the credibility, currency and accuracy of the science involved in their engagement activities. Table 3 shows a high reliance on scientists, experts and reputable organisations.

Table 3 Making sure of scientific credibility, currency and accuracy: common themes from a content analysis of answers

Term/phrase	Number of relevant quotes
Work directly with scientists/experts *We engage regularly with a diverse range of scientists who are actively involved in the areas of interest.* *Engagement with professionals in industry, R&D and university*	88
Review/input by experts/scientists *We have checked it by using many different scientists. A lot of the principles are well established.* *The program was designed with input from the scientists who do the related science.*	81
Credibility/reputation of organisation/individuals *We use recognised experts from the University* *Questacon has a pool of excellent researchers and educators.*	60
Ongoing monitoring/evaluation/updating *Ongoing post visit evaluation (informal and formal, internal and external).* *Evaluations are actively sort from schools following delivery. Workshops are reviewed on an annual basis for currency and content.*	39
Peer review sources or input *The activity was developed using current scientific literature and conversing with research scientists. The activity outline was then sent to the scientists to review.* *Every scientist that speaks at BrisScience is thoroughly researched to make sure the quality of their research and the level of their communication skills*	38
Experience/track record of provider *Previous track record of provider, many other Research and Development Corporations investing in the program making it less risky.* *Years of experience in organising science activities. Extensive presenter and exhibitor forms that must be filled out and evaluated by science communication professionals before the show/workshop/seminar/talk are accepted into the program*	34
Based on research/use of scientific literature *Some information comes from peer reviewed journals.* *Maintain strong connexions to various leading scientists subscribe to regular updates of the science from various agencies and media; consult the peer-reviewed literature regularly.*	32
Involves professional communicators/team/educators *Many of our volunteers are either professionally trained scientists, educators, or retired scientists, either from industry or academia.* *Using professional expertise in consultation process*	26
Advisory committee/panel of experts *Communicate regularly with scientists about the currency of work; all work passes a panel of scientific experts before publication.* *We invite experts to be on the panel, so the explanation of the science comes from them.*	13
Network with experts/mentors *I am passionate and dedicated to my job, I network with other people in the field and I facilitated with schools on a regular basis to remain helpful.* *Network and communicate with practitioners, scope media-based 'community of practice' network, data sharing platforms.*	12

Term/phrase	Number of relevant quotes
Well established program/activity/method *We select projects that have advanced to a mature stage so that they are well established and highly credible.* *Investing in a well established program with investment from other organisations*	7
Training/professional development *The published results come from peer reviewed models and are supported with "how to use" documentation and training workshops.* *Regular updates and training for presenters*	7
Constant fact checking *Research, fact checking, and consultation with experts* *The content is crafted by experienced science journalists and communicators and is edited to make sure a high quality product, including fact checking.*	7
Discussed as part of process *Scientists involved in process of writing engagement materials, followed by peer review process within both CRC for Mental Health and Dax Centre.*	6
Funder support/investment *Reference to ERA journal & conference rankings; industry funding (cash + in-kind) indicates industry value.*	4
Journalistic practices *Standard journalistic practices*	2
Wikipedia *I research the scientific correctness of the chemical and physical explanations by consulting with Scientists and Wikipedia*	1

The last open-ended evaluation question asked respondents what the one thing was that would tell them their engagement had been successful. A content analysis of the 330 responses to this question revealed a number of success indicators, and the top 11 of these are shown in Table 4.

Table 4 The top 11 signs of success: common themes from a content analysis of answers

Term/phrase	Number of relevant quotes
High/increased numbers of attendance/participation/downloads/etc *Huge attendance to our meetings, people contacting us to join, members sending ideas to us for the next meeting* *Repeat attendance at workshops, increasing attendance, media attention suggests that people remember. Time will tell if we have changed people's actions* *Increasing numbers of people watching on-line and downloading the resources*	94
Reported through feedback/positive comments to be successful *Overwhelming positive feedback, both anecdotal and formal evaluation responses. All tickets sold out prior to the event opening.* *Positive teacher feedback; statistics relating to engagement*	43

Return visits/participation/activities done/demanded *If you receive great feedback and are invited back you are addressing the user group's needs.* *In future, hearing that schools are using farming children's experience in their teaching and that they are going to participate in Science Talent Search for the first time.*	43
Increased enrolment in science courses/increased uptake of science careers *Students choosing to continue with scientific study and career.* *Number of young people entering professional careers, especially in science and engineering*	25
Improvement in behaviour or adoption of research *Students commenting on intention to change behaviours as a result of the Museum experience* *If there was 100 per cent adoption of the recommended 'best practice' approach to pest animal management across all NRM regions, involving widespread uptake of new tools and information.*	23
Review at end *Successful reviews in mainstream and on-line media.* *That our information is collected and reviewed by the Territory authorities and the ACT Commissioner for the Environment...it is and they do!*	18
Increased support/investment *Significant community support and funding for ongoing activities.* *More people supporting the campaign and actively seeking or asking for more information about the science informing the basin plan.*	18
Increased level of interest *Increased interest in plant science from school students.* *Increased interest from business and government in our research.*	18
Participants have conversations about experiences *Participants (teenagers) talking enthusiastically with their peers about the project.* *Friends and relatives talking about the science in the performance in their own social settings*	14
Creates enthusiasm/hype/buzz *Student enthusiasm and achievements plus growth in involvement over the years* *Enthusiasm from young people and their families and rising numbers of members*	13
Recommended to others/word of mouth promotion *People coming back to listen again/recommending it to friends.* *return visits to the activity from participants; positive 'word of mouth' recommendations*	12

Qualitative analysis of focus groups

The following describes the results from the analysis of the focus groups.

Science communication, science engagement

The first major theme to emerge from the focus group discussions was defining the scope of what is considered to be 'science engagement', and covering the difference perspectives of science communication and science engagement.

Key questions

1. When you think of the phrase 'science engagement' what sorts of things first come to mind?
2. Is 'science engagement' the same as 'science communication'?

The discussion points that emerged under the theme of science communication (130 quotes captured in total) are summarised in Table 5.

Table 5 Summary of discussion sub-categories on science communication

Sub-Categories	Summary	Number of relevant quotes
Spectrum: action	Science communication and engagement are part of a spectrum where communication in more passive, engagement active	40
One-way	Science communication is one-way, engagement is two-way, or is it?	34
Spectrum: opinion	Is it about shaping opinion, or to enable people to form their own opinions?	14
Listening	Whatever definition, the listening component is important	13
Entertaining	Science engagement is more entertaining or engrossing	12
Self-initiated	Engagement might be self-propelled, initiated by the person, not just in response.	12
Measureable	Science communication can be measured, engagement is harder to measure	5

Figure 20 is a word cloud of the terms that arose during this part of the seven focus-group discussions. It is interesting to note that words such as 'change', 'active', 'think', 'involved' and 'understanding' feature prominently. The focus groups favoured interaction—or even if it was one-way, then a sense of fun—rather than passive receipt of information.

Figure 20 Word cloud—terms arising around science communication and science engagement

In thinking through whether there were differences between science communication and science engagement, there was a lot of back and forth discussion on whether communication was one-way delivery:

> *Communication can just be done at you, whereas engagement really requires some sort of involvement* (Adelaide)
>
> *Just putting a document on a website is not communication—it's information provision* (Brisbane)
>
> *You can engage without communicating but you can't communicate without engaging* (Perth)

or two-way interaction:

> *Communication is a two-way thing, you're still communicating, there's still someone listening and someone talking which can reverse in a conversation* (Brisbane)
>
> *I see science engagement as a two-way thing, a two-way exchange of information. Science communication is just broadcasting the information to whoever gets it at the other end* (Perth)

> *But communication is never one-way—it's always two-way. Always a message is transmitted and how a person perceives that can seem different between two people. There's probably more similarity between engagement and communication* (Perth)

The other reflection on two-way communication was expressed as if there might be a spectrum of engagement, with science communication at one end and science engagement at the other. For some, this was expressed along a spectrum from passive to active, where science engagement meant the person was compelled to do something as a result of the science intervention:

> *Communication can just be done at you, whereas engagement really requires some sort of involvement* (Adelaide)

> *Because you can communicate all you want, but they're not necessarily listening or not going to change the way you think* (Newcastle)

> *So the communication can happen but if there's no real change in behaviour that results from it, have I succeeded?* (Canberra)

The other spectrum was between providing information or shaping an opinion, versus enabling someone to shape their own ideas and conclusions:

> *Maybe communicating is more a focus on the person who's delivering, whereas engagement might be more focussed on the person who's receiving* (Perth)

> *Science communication is driving to be opinion shaping and opinion directing rather than helping individuals achieve their own opinion as an outcome* (Adelaide)

Regardless of the spectrum, there was support for listening; that listening and developing a shared understanding was an essential part of the communication and/or engagement process:

> *They think it's relevant and they're taking it further and saying "I want to communicate with you as well"* (Brisbane)

> *Mutual interest, mutual understanding* (Canberra)

Engagement also had some other qualities that weren't necessarily directly associated with communication. For example, engagement implied that there was some fun, or a sense of entertainment:

> *Science is fun, they're actively taking part in science* (Newcastle)

> *In terms of science engagement, what you're trying to do is create a visceral experience. It has to be sensory* (Melbourne)

The other factor was that sometimes engagement did not start from a place of science communication or a science engagement activity, that it could be self-initiated. Examples included a sense of curiosity from viewing the stars, the local landscape or fixing a car:

> *Engagement can also be self-propelled* (Adelaide)

> *Most people participate in science very single day as part of their normal day life, they just don't know that it's science* (Newcastle)

Finally the focus groups touched on whether there was a difference in being able to measure communication and engagement. They asserted that communication can be measured, but the measure of engagement is less meaningful unless it is a signal that the person is engaged:

> *Communication can be measured because you're doing it, can see it happen, but whether or not someone actually engages, you're not necessarily sure* (Adelaide)

> *You can have bad science communication, but if you have bad science engagement than it's not engagement* (Perth)

Identifying good practices in science engagement

What is good practice? What makes a science engagement initiative effective? The focus groups were asked the following questions to explore this theme.

3. What are some of the good things happening in science engagement in Australia and overseas?
4. What do you think is the best time in to engage publics with the science and why? (Before research starts, during research, peer reviewed only, etc.)
5. Are there examples of science engagement activities you see as 'best practice'? And does the timing of when engagement happens affect these examples?
6. What are the factors that make for effective science engagement?

In responding to Question 3, the focus groups were asked to think about examples of where science was engagement, good practices of science communication, as well as where they themselves would seek out science. The discussion points that emerged under the theme of good examples (166 quotes captured in total) are summarised in Table 6.

Table 6 Summary of discussion sub-categories on good examples of science engagement

Sub-Categories	Summary	Number of relevant quotes
TV	TV programming	28
Organisations	Specific organisational approaches including NASA, science museums etc	24
Online	Content specifically developed for online including podcasts, blogs etc (some overlap with social media)	18
Citizen Science	Citizen science, participatory programs	14
Boffin	The approachable boffin or well-known personality	11
Print	Traditional media, especially written eg newspapers, magazines	11
Interactives	Participatory programs that have a hands-on elements	11
Social Media	Especially YouTube, FB, Twitter where ideas are easily shared between peers	10
Face to face	Seminars, workshops, any face-to-face process	10
Ideas festivals	TEDx, TEDTalks, Festivals of Ideas where science sits in the larger context of ideas	6
Arts	Arts, science, literature	6
Government Policy	Examples where government policy has influenced types of science engagement	6
Awards	Awards that recognise scientists and science communicators	3
Conferences	Impact of scientific conferences	3
National Science Week	National Science Week activities and concept as a whole	2
Public Health	Public health campaigns	2
Industry	Workplace or industry extension programs eg agriculture	1

Television rated highly, especially programs like Mythbusters and BBC documentaries:

> *TV documentaries, particularly ones that are personality driven—David Attenborough, Myth Busters, Brian Cox, Boat that Guy Built, Top Gear, Rocket City Rednecks* (Adelaide)

Some of the specific examples included key personalities, those 'approachable boffins' that are familiar to broad audiences:

> *There are also the conduits through the media of people who are like the science champions or the science trusted advisors, In Australia the most recognised are Dr Karl or Adam Spencer* (Newcastle)

> *There's always Dr Karl!* (Sydney)

There were also a range of online media cited—including YouTube, Facebook and Twitter where material could be easily shared, and other online material such as TED conferences, blogs and online news. Some of these online or mobile platforms were recognised as enabling citizen science projects:

> *People don't go to Facebook to learn science. They go there to communicate with friends. And when you get that little clip it's under the radar* (Canberra)

> *There's a new online magazine called The Conversation which has lots of science articles which I find engaged* (Melbourne)

> *Science and educational app development and gamification of science topics, so you can make learning topics and engaging topics that are more and more fun* (Adelaide)

> *iPads and iphones, which don't necessarily teach much science, but kids use them for example in tracking migrating birds and sharks around the world…with the help of some pretty innovative researchers*. (Adelaide)

> *TED is just amazing* (Melbourne)

When traditional print media were seen to get the science right, it worked well:

> *We have very strong engagement with the local newspaper. The director of the laboratory has lunch with the editor every so often, and does a lot of media*. (Brisbane)

> *The Guardian newspaper science pages in the UK are really, really good examples of communicating complex ideas in a very straightforward way* (Melbourne)

There was also praise for specific organisations such as NASA, CSIRO and specific institutional initiatives (including challenge-type events) and also science museums. The other area noted was government policy, especially in enabling technology spaces, public health and local councils. National Science Week was also mentioned:

> *We thought NASA and its extraordinary engagement with the public has been very influential* (Adelaide)

> *I go to Melbourne Museum fairly frequently because I love it. Anywhere in the world I got to museums* (Melbourne)

> *A piece of effective communication was a (survey on vaccination) on a public health site* (Melbourne)

> *Workshops. I've noticed a lot of the local governments areas are running sustainability-style workshops for community members* (Newcastle)

> *I like Science Week. It gives an excuse to go for gold, really just shove everything out there and have a blast for an entire week and everybody understands* (Newcastle)

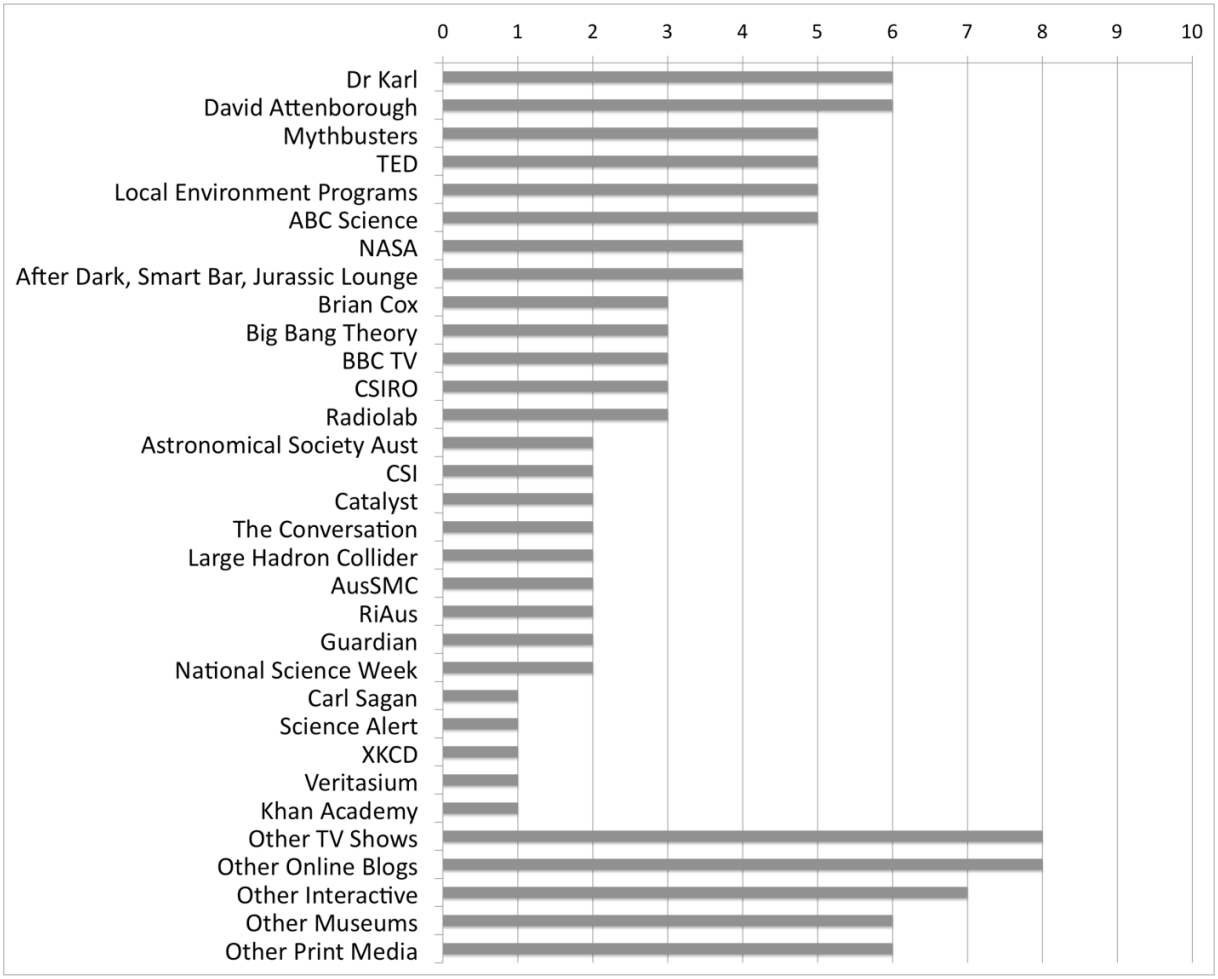
A summary of the most cited sources or good examples of science communication and engagement is shown in Figure 21.

The next three questions under this theme asked people to focus on factors for effective engagement including timing and best practices. The discussion points that emerged under the theme of effectiveness (221 quotes captured in total) are summarised in Table 7.

Table 7 Summary of discussion sub-categories on enabling effective science engagement

Sub-Categories	Summary	Number of relevant quotes
Timing	Discussion around best time to engage people in science	51
Values	Thinking about how engagement aligns with people's values and how it is relevant for them	35
Content	Thinking about the content - science, scientific process, detail	23
Target Audiences	Targeting the relevant audiences	21
Fun	Making science fun and entertaining eg science shows, TV	17
Context	Providing an overall context for the science information (link with Values)	13
Participation	Participation in activities, including citizen science	13
Passion	Using and promoting individuals with an obvious passion	11
Purpose	Having clear objectives	11
Access	Access and accessibility	7
Information	Access to trusted and useful follow-up information	6
Quality	Production values, quality of information	5
Measure	Evaluate and measure effectiveness and outcomes	5
Methods	Deliver through a range of methods	2
Network	Drawing on collaboration opportunities and networks	1

Figure 21 Indication of most commonly cited examples of good science engagement



Posed as a separate question, the issue of timing—when should people be engaged in science—was discussed extensively.

There were three key observations made by the groups regarding timing. First, that science engagement was a continual process and that it should ideally happen all the time, especially when people are interested. Second, that when engaging in research there was a balance between getting public understanding and input early, especially if there were likely to be significant impacts, and waiting until the research was firmer or peer-reviewed. Finally, it was generally agreed that science engagement should happen over a lifetime, but it was particularly important to engage early at school:

> *Personally I guess for me it's all the time* (Adelaide)
>
> *As to engagers, when they show interest. So you can communicate something, but when they actually start to show interest, then you can engage*. (Adelaide)
>
> *(If) you've discovered something or you're trying to convey to the public than probably best to do late in the piece because sometimes an in progress message comes across as a completed message, particularly in medical/biomedical sciences* (Adelaide)

Getting the timing right would also depend on the needs of the audience. Other related factors to consider were issues around accessibility—especially for gaps in regional engagement, as noted later—and the method being employed:

> *You need to engage the people where they are, and in a time and a place that they can actually deal with the information* (Brisbane)
>
> *And not geographically restricted, things with live streams and Twitter etc* (Perth)
>
> *With all the different channels and medium - Twitter, Facebook, social media, there is an opportunity to reach different types of audiences in new ways and in real time* (Perth)

The ability to understand the needs of the target audience is key to getting time, access and method right. This also requires putting the science into a broader context, and most importantly, appreciating the values that an audience brings and framing it appropriately.

Many discussions stressed that information is not sufficient for changing opinion or behaviour, and that recognising values and tailoring engagement initiatives appropriately can be more effective:

> *Why the hell would people want to learn it or know about it or engage with it if it's not relevant?* (Perth)
>
> *Values are not related to science, they're related to other issues. And no matter the type of approach or best practice of engagement that you use in that situation, being able to change values is very, very difficult* (Melbourne)
>
> *I think you can throw as many facts as you like at people but they make up their minds, not based on fact, but on emotion. That's how human beings work*. (Brisbane)
>
> *They'll feel as though the narrative has been adjusted by someone who shares their values, they become confident it's no longer a bad thing* (Canberra)
>
> *We've arrived at the point that it needs to be threaded through. Sometimes science stories are political stories. Sometimes they're economic stories. Sometimes they're technological stories. Sometimes they're legal stories* (Melbourne)
>
> *As science communicators you need to engage the community in that sense of hope and joy and future because I think that's one of the messages that doesn't actually get across in the general public.* (Newcastle)

Participation (including citizen science), interaction and getting your voice heard were ways in people could engage that were congruent with values, and focus groups recognised the contribution of non-scientists to engagement discussions:

> *I think that if people have an opportunity to be heard, their views about science and technology, and have some sense it might be considered; this makes for more effective measures* (Canberra)
>
> *Once there is something engaged, you can say: "yes, you're empowered, you can make a difference"* (Newcastle)

Another recurring theme for effective science engagement was thinking deeply about the context, specifically not just in providing science content and making follow-up information accessible:

> *Best practice would be follow-up information, if people want to find out more, where can they find it? It's not a finite process* (Adelaide)

… but also engaging people in the scientific method and scientific ways of thinking:

> *Always important to have an element of instruction. The instructing about how the process of science works* (Melbourne)
>
> *There's a gap in understanding of how that science principle works, where we do build up layers and layers of science and of evidence and then we come to a general conclusion* (Brisbane)
>
> *"What do you think the public really needs to know about science?" and the response was "A sense of uncertainty".* (Canberra)

Another set of discussions focused on the science engagement as engaging and fun, in line with one of the sub-themes emerging in the earlier definition discussion. Making it fun and led by passionate individuals were two aspects that came through:

> *Explosions was the one thing that came up, with some glee* (Adelaide)
>
> *Beyond science fiction, there's all sorts of stuff with movies and TV and popular culture* (Canberra)
>
> *And not apologising for people who are engaged in our programs and having fun* (Newcastle)
>
> *A bit of passion goes a long way* (Sydney)

The final sub-category related to being able to deliver good-quality engagement programs. The essential ingredients were to have a clear purpose (for overall policy as much as individual programs), to look for ways of evaluating the desired outcome, and to pay attention to the details and quality of the final product:

> *One of the things that makes for good science communication is a clear sense of purpose. I think I was rather disappointed in Inspiring Australia from that point of view* (Canberra)
>
> *You can have the best content in the world, but if you've got a really crappy looking website that the links don't work and it looks like a five-year-old designed it, then who's going to take it seriously? Packaging the content is very important as well* (Brisbane)
>
> *Like any good research you've got to decide what you want to measure, what it is you're after and then you have to develop a way of measuring it and see if your outcome happens* (Perth)

Finally, effective science engagement has an impact:

> *It's a curiosity and a thirst for knowledge, and it's a passion for problem solving and investigation, Once of the things I would like to see is for science engagement to leave a more lingering effect* (Canberra)

Barriers and gaps

In addition to thinking about the factors that enable effective science engagement, the focus groups were asked to think about where science engagement in Australia could improve. What are the gaps? What are the barriers to change? The specific questions offered in this section were:

7. Where are the gaps in science engagement across Australia?
    a. Are there various target groups/audiences that are being missed?
    b. Are there geographical areas that don't get opportunities?
    c. Are there different types of engagement that we're not doing?
    d. Are they science disciplines that we're not engaging people with?

8. What needs to improve in the way we engage people in science? (Could look at examples of science engagement that did not work)

9. What do you think are the barriers to effective science engagement?

The discussion points that emerged under the first theme of barriers (129 quotes captured in total) are summarised in Table 8.

Table 8 Summary of Discussion Sub-Categories on Barriers to Science Engagement

Sub-Categories	Summary	Number of relevant quotes
Brand	Preconceived ideas about what science is	30
Information & Trust	Hard to find supporting information, difficult to filter, who to trust	20
Relevance	People don't see the relevance to them	16
Resources	Resources including training and expertise	15
Audiences	Barriers in finding the right audiences for maximum impact	12
Funding	Funding, lack of money	11
Evaluation	No or limited evaluation, evaluation is difficult	11
Purpose	Not having a clear purpose	5
Publicity	Getting the messages out	5
Careers	Hard to see link to careers	4

There were two significant barriers that weren't related to the delivery of science engagement, but the broader context in which an understanding of science could be formed.

A large proportion of the discussion centred on the poor 'brand' of science. Science was perceived as being difficult. It is focused on geeks. It is a belief system. One needs to have special understanding to participate in science. All of these factors were seen as damaging perceptions when trying to engage a broad public:

> *I think we need to get rid of the taboo of science as a separate entity. The arts are a part of day-to-day life, we need to get rid of this elitist structure* (Brisbane)
>
> *When you have things like Richard Dawkins going on Q&A and having a massive punch-up, that's an association for science as a brand as well, because it's being conflated with atheism* (Canberra)
>
> *There's an ongoing barrier that science is still regarded as hard and special (Melbourne)*
>
> *But scientists are not all geeks* (Sydney)
>
> *Geek Chic has done a lot of damage* (Canberra)

The second contextual factor was the sheer breadth of information available, and how people could make sense of it, filter it for credible sources and use it to form opinions. Some of this was related to internet searches, some to the tendency of news to seek out opposing views (no matter how well supported by evidence) and some around not being able to recognise cognitive bias.

How people sought and found information, and then made decisions based on what they understood was seen as a particularly problematic issue for science and critical decision-making:

> *Where we had unengaged people involved in activities, they find it difficult to find a source they can trust* (Canberra)

> *They don't know how to filter out someone's…they're hearing different things and they don't know how to sift out the real stuff* (Brisbane)

> *Also regarding journalistic balance, they will bring in controversy on something that in science there is no controversy* (Perth)

> *They have their ideology, and they look for evidence to support their conclusions* (Sydney)

Another barrier related to context was that audiences had trouble seeing relevance, and that sometimes science communicators have difficulty taking the perspective of audiences. This reflects the flip side of the discussion that focusing on understanding audience needs and values is necessary for effective engagement:

> *But "I just don't think that science is relevant to people's lives" even though it's right in their face. I find that incredible*. (Brisbane)

> *I notice at the moment discussion is based on premise that we should figure out what the public wants and then try and deliver it to them, but I feel a lot of science communicators are thinking "What do I want the public to know, and how am I going to do that?"* (Canberra)

> *I think lack of understanding of our audience is a major problem* (Canberra)

After these contextual factors, the discussions also focused on inadequate funding and resources for effective delivery, where resources included expertise and trained specialists:

> *We just went out to rural Australia and at the end of the event people were saying "when are you coming back?" And we don't have the funding* (Canberra)

> *It's the lack of specialists. It could be in any field. Even science communication specialists, the actual lack of people that understand what they're doing or know how to effectively engage is an issue* (Adelaide)

Finally, the last set of barriers related to a lack of clear purpose and being able to evaluate the outcomes—again, a reflection of what was discussed in delivering effective engagement:

> *People are confused about what they want science communication to do, the objectives aren't very clear* (Brisbane)

> *There's not enough evaluation being implemented across the science communication community* (Canberra)

> *I would say evaluation is an internal barrier because sometimes it is hard to integrate into activities process, funding etc*. (Perth)

The discussion points that emerged under the theme of gaps (40 quotes captured in total) are summarised in Table 9.

Table 9 Summary of discussion sub-categories on gaps in science engagement

Sub-Categories	Summary	Number of relevant quotes
Mainstream Media	Mainstream media coverage	8
Regional	Regional areas	7
Young Adults	Young Adults especially in 18-35 category	7
Unengaged	Unengaged or disengaged	5
Socio-economic	Low socio-economic profile	4
Culture	Culturally diverse groups and Indigenous Australians	3
Schools	School activities outside the classroom	3
Elderly	The elderly	1
Arts	People in the arts	1
Gender	Gender divides, differences	1

Many of the gaps identified were as expected. Regional areas, young adults post-school, low socio-economic areas and culturally diverse communities (including Indigenous Australians) were noted as gaps where science engagement isn't as accessible, or isn't targeted appropriately. How to engage the unengaged, or disengaged in science, given its importance for everyday life, was also seen as important:

> *Geographical gaps as well, a big problem in Australia* (Brisbane)
>
> *The socio-economic issues like people getting to events or turning up when they're worried about what their kids are going to eat that night* (Adelaide)
>
> *I think there's less things specifically targeted at an interaction for adults, most is "We'll talk at you", "you come to a thing"* (Sydney)
>
> *I think a lot of the science engagement or communication we do is preaching to the converted, or at least preaching to the aware* (Canberra)

Effective science engagement for younger students outside school was also raised, and this was a concern that emerged quite strongly in the related open-ended survey question:

> *There's a lot of emphasis on sport after school and musical activities, but there's really nothing out there (for science after school)* (Newcastle)

In addition to under-served groups, the other gap that was most often mentioned was the level and quality of coverage in mainstream media. Attendees spoke about the lack of science coverage in mainstream newspapers and opportunities for science coverage in other popular publications:

> *Really obvious to me is that there's not articles and presentations in some media eg Women's Weekly* (Perth)'

Mechanisms for improving science engagement

The final question for the focus groups was to provide input into what type of mechanisms might provide support for more effective science engagement. They were asked:

10. Are there incentives/support mechanisms for promoting more effective science engagement?

The discussion points that emerged under the theme of mechanisms (55 quotes captured in total) are summarised in Table 10.

Table 10 Summary of discussion sub-categories on mechanisms for improving science engagement

Sub-Categories	Summary	Number of relevant quotes
Grant KPIs	Insisting on science communication outputs in research grants	20
Resources	Providing resources and support (including funding opportunities)	8
Backing Winners	Supporting proven activities with greater funding and resources, not reinventing the wheel	6
Networks	Using networks and collaborations	5
Purpose	Have clear objectives	5
Metrics	Including metrics and evaluation	4
Awards	Rewarding and recognising effective science communication	2
Entrepreneurship	Facilitating more private, entrepreneurial science communication	2
Political Action	Engaging in political action and lobbying	2
Audience Incentives	Providing financial incentives, rebates for audiences	1

The most critical factor, which also emerged from the survey analysis, was ensuring that there were requirements or indicators built into research grants that required scientists to engage the public in their work:

> *If you don't have enough peer-review publications as opposed to really good science communication…* (Brisbane)
>
> *There's not enough value for professional scientists to communicate with the public, it's all publish or perish* (Newcastle)
>
> *We've just in a massive disincentive to communicate with the public called the ERA* (Canberra)
>
> *The major research council has put no emphasis at all on communicating outcomes of research* (Canberra)

Changing grant conditions would most likely require a coordinated approach from government and related networks. The other factor that came into play in discussing a coordinated approach was to make sure a clear sense of purpose to enable this strategic approach:

> *The government can really help with having a well-funded, coordinated approach* (Brisbane)
>
> *If we want science to have a more systematic approach, do we need political action committees?* (Perth)

The strategic, coordinated approach was also echoed in terms of desirable funding initiatives:

> *If they were actually serious about it, they would put a process together, they would put out an idea, have a tender, they would want deliverables so they'd want a timeline, they'd want outcomes* (Brisbane)
>
> *We need to be more strategic, construct a longer-term vision and maybe larger sums of money - one way in which we should be going rather than smaller scale events* (Canberra)

Critical areas for improving the quantity and quality of science engagement in Australia

The following open-ended question was included in the online audit survey: **"What do you think are the critical areas where we need to improve the quantity or quality of science engagement in Australia?"**

The responses fell into three categories already discussed in the focus-group analysis section of this report—how to create more effective engagement initiatives, gaps in the engagement and mechanisms for improving science engagement. The primary differences between the focus-group discussions and the internet survey's open-ended questions were that the internet survey stressed the need for engagement in schools, and placed more emphasis on funding as a mechanism. Figure 22 provides a word cloud of the common phrases that emerged from the responses.

184 responses were received to the open-ended question on the survey. Of these, 13 were null, as respondents had provided other responses previously or noted that they needed more time to think through their responses.

Of the valid entries, 68 were related to how science engagement might be more effective, including understanding audiences' needs better and catering for those through timing, methods of engagement targeting audience involvement, reframing in terms of their values and providing the most appropriate and useful types of information.

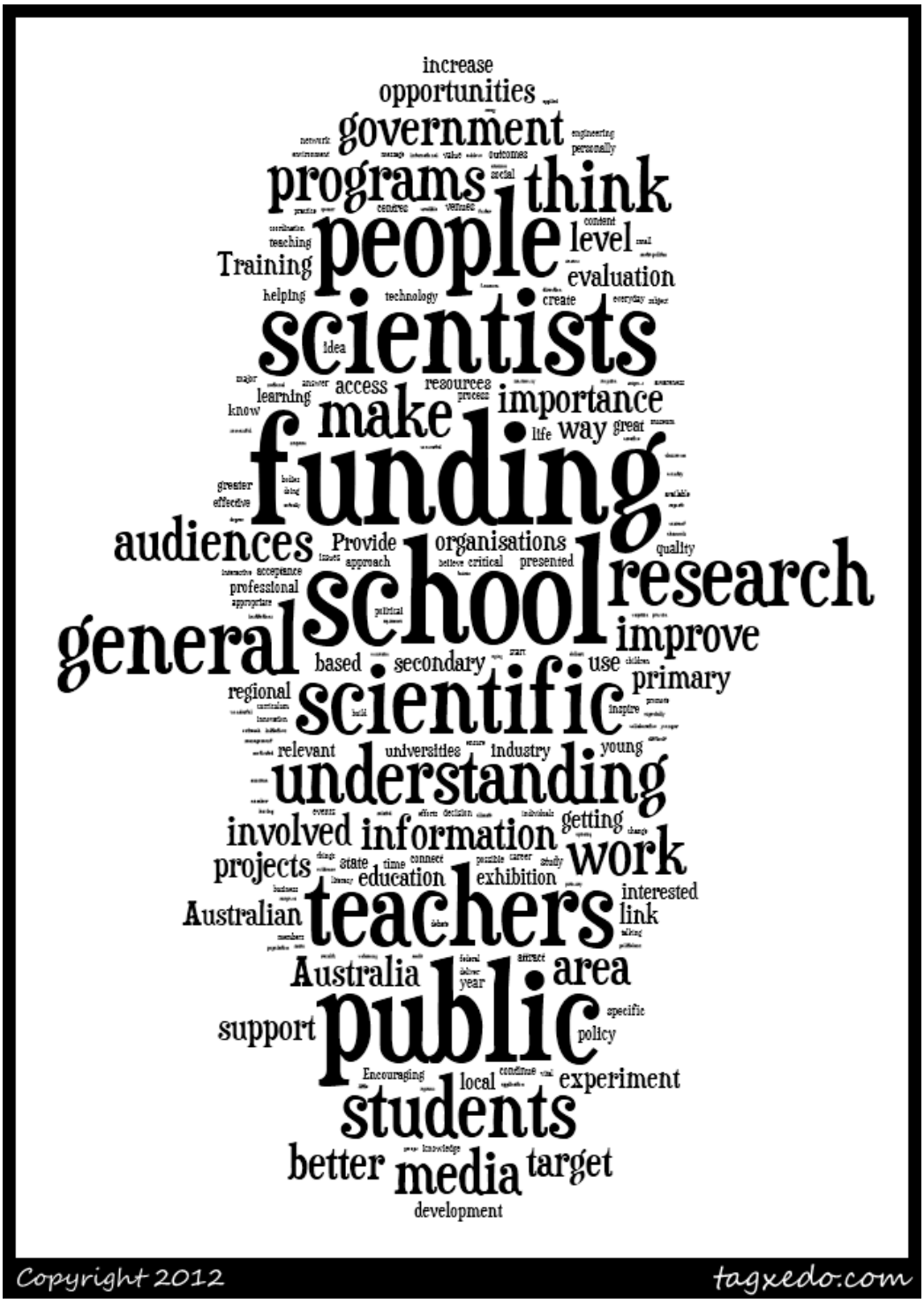
Other improvements were related to providing better follow-up information, improving the quality of delivery and collaborating with networks. Linking science engagement to careers was seen as an important factor. It should be stressed that eight of the 14 entries relating to the content of scientific literacy cited the need for understanding the scientific process and using those thinking approaches for decision-making.

Another 45 entries commented on the current gaps in science engagement, specifically around reaching regional areas, lower socio-economic areas and Indigenous communities. Other gaps were young adults, both engaged in science and unengaged. The two most common gaps cited were the level of science engagement in schools, which was seen as important for long-term science engagement over a lifetime, and the way science was represented in mainstream media.

Lastly, 58 entries addressed the types of mechanisms that might be useful in developing more effective science engagement. The most commonly cited mechanism was a need for resources—funding, training and expertise. Other entries looked at the need for supporting what was currently working, finding networks and collaborations, and better evaluation. Increasing political support and addressing current incentives for direct communication by scientists were also raised.

Overall, the most critical areas from this open-ended question seemed to relate to better science engagement at a younger age through schools and higher quality teaching, and better and more strategic funding for programs that were delivering effective engagement.

Figure 22 Tag cloud of entries from the survey in regarding to critical areas for improvement



Discussion

Gaps in audit results

This survey has collected a good representative sample of the different types of science engagement activities happening across Australia. However, this is not exhaustive and many activities are still missing. In particular, there is a need to gather activities run by state or territory governments, particularly in the eastern states, and by local governments.

Gaps in science engagement across Australia

Most of the science engagement activities in Australia appear to be ongoing, and recently started or about to start. They particularly focus on biological or environmental sciences and are less likely to focus on information and computing, mathematics or engineering sciences, which appears to be a significant gap.

Most engagement is directed to nation- or state-wide target groups predominantly made up of school-aged children or the general public, with usually more than 500 people targeted. Fewer activities were targeted at specific groups such as decision-makers, farmers, politicians and business leaders. While business was engaged in many activities, this was dominated by mining companies and less by small businesses.

We believe science engagement in Australia would benefit from a more tailored approach to science engagement that particularly seeks to understand the needs and concerns of those being targeted.

The people driving the science engagement tended to be scientists and professional science communicators, and more effort needs to be made to encourage others—such as non-government organisations, businesses and community groups—to drive science engagement.

The federal government is a the major funder of science engagement activities in Australia, and while this is very positive and may also reflect that this project was funded and promoted through Inspiring Australia, we believe a diversity of other funding sources need to be encouraged.

Definitions of 'engagement'

We define 'public engagement' in science as the "motivated affective state of individual members of publics" (Kang 2012) when interacting with scientists or at events about science.

Thus, for us, and for many of the focus group participants, public engagement goes beyond the mere one-way dissemination of information ('deficit' model) to a more participatory approach where people are affected and motivated by their participation in science.

However, like beauty, engagement can lie in the eye of the beholder.

When conducting this national audit of science engagement activities in Australia, we let the respondents define how they perceived 'engagement'. The results showed that there is a continuum of how people define engagement, from the one-way transfer of information to more interactive critical thinking and problem solving.

Theories of science communication/engagement and the nature of science engagement in Australia

For much of the history of the communication of science, scientists and more recently professional 'mediators' (called science communicators) have seen the amorphous 'public', often referred to as the 'general public' as empty vessels who needed to be filled with science knowledge (Irwin, 2006; Poulet, 2009; Trench, 2008).

The goal of science communication was, and often still is, very much directed at creating a science-literate public. With controversial scientific issues, such as climate change, there remains a belief by many that 'if only the public understood the science', they would be able to accept it and understand the need for action or policy change. And there is still a dominant assumption that science literacy is both the problem and the solution to societal debates and conflicts (Nisbet & Scheufele, 2009).

Science communication researchers have theorised this research as the 'deficit' model of science communication (Jolly & Kufmann, 2008; Trench, 2008). In this model, scientists speak with certainty, and science has centrality in the scientists–public interactions (Irwin, 2008).

The communication is one-way from scientists to the public and it assumes the public lack any valuable knowledge of their own. "Science is presented as the embodiment of truth and the task of governments (or scientists) becomes one of bringing rationality to human affairs" (Irwin, 2008).

Many of the activities collected in this audit appeared to be passive and one-way, and often related to lectures or educational experiences where people learn by watching, listening or viewing via public lectures, websites, newsletters and printed materials. This matches with most activities particularly wanting to inspire people to value scientific endeavours or consider doing science in school or as a career.

As a part of engaging the public in science there is a need for the credible one-way dissemination of the best available information. As such, the deficit model can coexist with other communication models (Trench, 2008).

In the early 2000s, there was a reaction against the deficit model, which was perceived by many to have failed—especially when science communication campaigns about contentious science issues like genetic modification failed to convince the public to support this research (Kleinman, Delborne & Anderson, 2011; Horst, 2010).

At this time, science researchers began to theorise that this engagement had not appeared to lead to more literate citizens who were engaged in science or able to participate in democratic decision-making about science's directions or its impacts on their lives (Jackson, Barbagello & Haste, 2006; Benneworth, 2009).

This lead to governments and research organisations encouraging two-way communication, where scientists and science communicators were encouraged to listen to and acknowledge public concerns and needs through a two-way dialogue about the nature of risk. This model postulated that public trust could be gained by being more open and transparent about scientific uncertainties.

It assumed that the public, who were now deemed to have some knowledge and resources of value to scientific dialogue, would respond rationally to such openness (Irwin, 2008). The dialogue model of science communication "may have become a practical necessity if public policy is to be made – and justified – in circumstances of social and technical uncertainty," (Irwin, 2008).

The audit shows that many activities are moving towards more interactive engagements with the public, particularly with the dominance of face to face interactions and their high use of social media. Most of the activities captured in the audit are not about the simple dissemination of information, although there still is a focus on increasing awareness, education and scientific literacy.

More recently, it has become clear that dialogue alone is not enough if science is to truly inform people's decision-making and behaviour choices (Williams, 2010; Benneworth, 2009). And to go even further, some have recently called for the public's values to have more influence over what science actually gets done or not in the first place (Wilsdon & Willis, 2004; Rogers-Hayden & Pidgeon, 2008).

This participatory model of science communication, which appears to have the potential to lead to the true democratisation of science, has particularly gained traction in recent years (Joly & Kaufmann, 2008; Miller, Fahy & ESConet Team, 2009).

Irwin (2008) takes the participatory model further to call for 'third order' thinking about science engagement: "third-order thinking invites us to consider what is at stake within societal decisions over science and technology and to build on the notion that different forms of expertise and understanding represent an important resource for change rather than an impediment or burden".

Third-order thinking places science–public relations in the wider context by:

- raising profound questions of scientific and political culture
- recognising that disagreement and controversy bring energy, excitement and focused attention to debates, and, as such, are an important resource
- providing more meaningful scrutiny of the prevailing modes of scientific governance
- critically evaluating current approaches to scientific governance and science communication.

Such public engagement in science will "open up fresh inter-connections between public, scientific, institutional, political and ethical visions of change in all their heterogeneity, conditionality and disagreement" (Irwin, 2008).

Others have called for the participatory models to move 'upstream' beyond just consultation and more into co-creation of science and technologies (Rogers-Hayden & Pidgeon, 2008).

Certainly most, if not all, of the science engagement activities collected by this audit are not about this level of critical thinking where the public are shaping the questions and participating in and even driving the science. There also appears to be few activities directed at individual or institutional behavioural and policy changes.

Evaluation of science engagement activities

Most evaluation of science engagement activities is done informally and in-house using feedback forms and surveys. Most people appear to judge success on the numbers of people who attended, hit on the website or provided positive feedback. There are fewer attempts to use qualitative data or to formally measure success against clear indicators of success.

A significant number of people did not know, before running their engagement activity, that it would work and relied heavily on their own or others' past experiences. There appears to be little pre-testing of tools or activities to see if they will work before being used.

Most rely on reputable scientists or organisations to make sure their science is current and credible.

Pathways for more effective science engagement

The qualitative analysis of the focus-group discussions and open-ended survey question have identified a number of ways in which science engagement could become more effective in Australia, by considering what factors make for good science engagement, the current barriers and gaps, and potential mechanisms to assist.

In reflecting on the discussions and inputs, the following observations summarise how this community of professionals engaged in communicating science see pathways for more effective engagement:

- Make sure that individual engagement programs and overarching government policies have clarity of **purpose** and ways in which the desired outcomes can be measured and **evaluated**.

- Find ways to enable security of **funding** for effective programs, especially programs that are demonstrating effectiveness over time so that they may expand nationally to **address current gaps** in the communities being addressed.
- Deliver more **entertaining and interesting** forms of engagement that meet the specific **values** and needs of target audiences.
- Make sure that science communication and engagement processes reflect and expose scientific ways of thinking and the **scientific method** to skill communities in better **evidence-based decision-making**.
- Create links and **networks** that allow scientists to engage directly with the public and **embed incentives into grants** that reward scientists for doing so.
- **Start early** and keep going—it's important to embed a lifelong love for learning and for science in a way that doesn't pigeonhole science as hard, geeky or elitist.

In many ways, it appears that the science communicators involved in the focus group discussions appreciate the theory of more participatory and consultative engagement, but are struggling to find ways to fund, resource and put these ideas into practice.

It appears that there could be a time lag, and that we are still responding to a broader system that hasn't moved away beyond the deficit model, or does not know how to cast the role of the expert scientist/science communicator in this new mode of third-order thinking.

Recommendations

Some of the following recommendations are based on taking this project further to develop an online database that can be easily updated, added to and interrogated. This will be part of Project C under the Inspiring Australia 2012–14 funding. Other recommendations are about improving the quality of science engagement in Australia.

Developing and promoting the audit database

We recommend:

1. updating the survey tool to include fewer open-ended questions and 'other' options. This will make it easier for people to add new data or update existing data in less time and requires less data. This will also involve recoding some of the data from the existing audit to suit the new format.
2. making the survey tool available via a public website so that data can be easily updated and maintained by the Australian Science Communicators
3. promoting the survey to those currently less well represented in the audit, such as local and state governments
4. making the data available to people researching science communication
5. constantly improving the visualisation bubbles and the map (to show where programs are delivered)
6. ensuring that, as part of their funding agreement, all projects funded by Inspiring Australia and its state partners complete the updated survey so that their information improves the existing database.

Improving the quality of science engagement

We recommend:

1. identifying case studies of participatory science engagement and showcasing these as 'best practice' examples on the audit website (particularly important, given that most seem to rely on past experience to inform new activities)
2. funding and resourcing science engagement activities that include testing, prototyping and piloting activities
3. encouraging and supporting science engagement activities that go for a longer time and which focus more on:
    a. specific groups rather than the general public or school children (for example, farmers or youth aged 16–18)
    b. the uptake rather than the delivery of science
    c. group problem solving
    d. consulting and sharing views about science
    e. activities that shape the science questions
    f. critical thinking and dialogue about science
    g. achieving behavioural or policy change

4. investigating why information and computing, and mathematics and engineering sciences are less involved in science engagement activities, and then identifying ways to encourage such engagement
5. identifying and promoting simple evaluation tools that can be used effectively in-house to monitor and review activities
6. promoting to research funders and organisations the need to make it a requirement for researchers to engage with non-scientific groups about their work
7. exploring links between the theory and the practice of science communication and promoting these.

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Science engagement national audit

Inspiring Australia's National Audit of Science Engagement

As part of the Inspiring Australia aims, we want to create a database of science engagement activities in Australia, understand gaps and help with creating evaluation tools.

To do this, we want a snapshot of activities/programs taking place between January 2011 and June 2013. If your engagement activity has/is happening or is funded and planned for this time period, please fill in the survey.

CLOSING DATE: SATURDAY 30 JUNE 2012

We are only asking for information that is or will be publicly available, and not for your trade secrets!

You can enter three activities, then we ask one set of general questions. If you have more than three activities, you can then enter them (and skip the general questions if you already filled them out).

We are asking you about the following categories of information:
- an overview
- who is involved
- funding, support
- the activity in more depth
- evaluation.

By participating in the survey, you go into a draw to win a case of good-quality wine or a $150 bookshop voucher.

You can enter more than one engagement activity into the survey, and will be prompted after completing the first engagement activity to enter another if you wish.

The survey should take you about 10-15 minutes per project, depending on how much you write!

If you would like more information about this survey, please contact Econnect Communication (07 3846 7111, admin@econnect.com.au, www.econnect.com.au).

By entering your data, you will receive the first report on all the data gathered.

Science engagement national audit

Overview of the activity

1. What's the name of this engagement activity?

2. Is there a website/webpage that describes the activity? Please give the URL below.

3. When did/will the activity start (month, year)?

4. When did/will it finish (month, year)?

5. What are you doing? We'd like a brief description of the actual activity.

6. What significant issues, needs or priorities is your activity addressing?

7. Please rank the outcomes your activity seeks.

	1 (high importance)	2	3	4	5 (low importance)
Inspire target groups and get them to value scientific endeavour	○	○	○	○	○
Attract increasing national and international interest in science	○	○	○	○	○
Critically engage target groups with key scientific issues	○	○	○	○	○
Encourage young people to pursue scientific studies/careers	○	○	○	○	○
Other	○	○	○	○	○
Other	○	○	○	○	○
Other	○	○	○	○	○

Please specify your 'others', top to bottom.

Science engagement national audit

8. What does your activity focus on?

	major component of activity				not present in activity
Understanding of the natural and human-made world	○	○	○	○	○
The nature of the scientific process or enterprise	○	○	○	○	○
Societal and environmental impacts and implications from science and technology	○	○	○	○	○
Personal, community and societal values related to applications of science and technology	○	○	○	○	○
Institutional priority or public policy change related to science and technology	○	○	○	○	○

Science engagement national audit

Who is involved

1. From the groups below who you may be targeting with this activity, please estimate the number of people who are (or are expected to be) involved. If you are not targeting a specific group, leave that row blank.

	Up to 20	21-50	51-200	201-500	More than 500
Politicians	○	○	○	○	○
Policymakers and advisers	○	○	○	○	○
Decision-makers	○	○	○	○	○
Farmers	○	○	○	○	○
Business leaders	○	○	○	○	○
Indigenous communities	○	○	○	○	○
School-aged children (but not necessarily in schools)	○	○	○	○	○
Metropolitan communities	○	○	○	○	○
Regional communities	○	○	○	○	○
Remote communities	○	○	○	○	○
General public	○	○	○	○	○
Other (please specify)	○	○	○	○	○
Other (please specify)	○	○	○	○	○
Other (please specify)	○	○	○	○	○

Please specify who your 'others' were, top to bottom

2. Where are the group/s you are targeting (as identified in previous question) located? Give us specifics for each location, or leave the box blank if you're not targeting anyone there.

International (which countries?)	
National (which regions/areas?)	
State/territory (which ones?)	
Regional (which regions? e.g. Corangamite CMA in Vic; Kakadu NP in NT)	
Towns/suburbs (which ones?)	

Science engagement national audit

3. Who is involved in the activity? If you can, please let us know the specific names of the organisations/departments within the groups below which are relevant to you. If a group is not involved, leave the box blank.

Business/corporation	
Tertiary education facility e.g. university, TAFE, college	
State government e.g. Department of Environment	
Federal government e.g. Department of Finance	
Local government	
Non-government organisations	
Professional scientific associations/societies	
Government funded research agency e.g. CSIRO, AIMS	
Consultancy	
Media e.g. ABC Science Unit	
Cultural organisation e.g. museum, library, art gallery, science centre	
Other (please specify)	
Other (please specify)	
Other (please specify)	

4. Is there a main agency/organisation leading the activity? If so, please specify. Note: this is who is 'running' the activity, and it may be for a client; do not list the client here.

5. Please name the main funder of the activity.

6. Please name the secondary funder of the activity (leave blank if not relevant).

7. Please name the third funder of the activity (leave blank if not relevant).

8. Please name the fourth funder of the activity (leave blank if not relevant).

Science engagement national audit

1. What are the in-kind and/or cash contributions from funders as a per cent of overall project funds (approximately)?

	Cash % of project funding	In-kind % of project funding
[Q13]		
[Q14]		
[Q15]		
[Q16]		

Comments

2. Which major fields of science are involved in the activity? Tick all that apply.

- [ ] Mathematical sciences
- [ ] Physical sciences
- [ ] Chemical sciences
- [ ] Earth sciences
- [ ] Environmental sciences
- [ ] Biological sciences
- [ ] Agricultural and veterinary sciences
- [ ] Information and computing sciences
- [ ] Engineering
- [ ] Technology
- [ ] Medical and health sciences
- [ ] Social sciences

Science engagement national audit

Engagement activity in more depth

1. Can you describe the motivation for the activity? (e.g. saw others doing it, my organisation wanted me to, the research shows this is a good thing to do, we had some spare cash, it seemed like a good idea, etc.)

2. How are your target group/s involved in the activity?

	Not part of activity		Part of activity		Major component of activity
Learning from watching, listening, viewing lectures, media and/or exhibits	○	○	○	○	○
Asking questions of experts, interactive inquiry learning in activities/exhibits	○	○	○	○	○
Consulting, sharing views and knowledge among/between participants and science experts	○	○	○	○	○
Deliberating with other participants and group problem-solving	○	○	○	○	○
Producing recommendations or reports	○	○	○	○	○

Other (please specify)

3. What tools have you used to engage?

- ☐ Social media
- ☐ Traditional media
- ☐ Art
- ☐ Music
- ☐ Website
- ☐ Face-to-face
- ☐ Phone
- ☐ Workshop
- ☐ Seminar
- ☐ Conference
- ☐ Field day
- ☐ Social event
- ☐ Exhibition
- ☐ Interactive exhibition
- ☐ Newsletter/emails
- ☐ Formal paper
- ☐ Fact sheet
- ☐ Brochure
- ☐ Briefing paper
- ☐ Establish network
- ☐ Link to network
- ☐ Link to education providers
- ☐ Peer-to-peer communication
- ☐ Survey
- ☐ Questionnaire
- ☐ Interview
- ☐ Focus group
- ☐ Consultative meeting

Other (please specify)

Science engagement national audit

4. When in the science process is the engagement activity happening?

- [ ] to get support for funding of science before it happens
- [ ] to get target group involvement in shaping the science question
- [ ] to involve them in doing the science
- [ ] to get support for funding during the science
- [ ] the engagement is about ongoing science
- [ ] the engagement is about completed science

5. Who is involved in delivering the engagement activity? If you rank any 'others', please tell us who each group is in the comment box below (in order).

	1 (high involvement)	2	3	4	5 (low involvement)
Communication professionals	○	○	○	○	○
Scientists who did or are doing the research	○	○	○	○	○
Other scientists not directly involved in the research	○	○	○	○	○
Other specialists (e.g. graphic designer, artists, actors, etc.)	○	○	○	○	○
Managers (e.g. resources, business, etc.)	○	○	○	○	○
Interpretation specialists (e.g. museum curators, science centre education officers, rangers)	○	○	○	○	○
Volunteers (other than scientists)	○	○	○	○	○
Students	○	○	○	○	○
Other (specify below)	○	○	○	○	○
Other (specify below)	○	○	○	○	○
Other (specify below)	○	○	○	○	○

Your 'other' groups, in order, top to bottom

Science engagement national audit

Evaluation

1. Did you have any evidence that your engagement activity was likely to work before starting it? If so, please describe.

2. How do you make sure of the credibility, currency and accuracy of the science involved in your engagement activity?

3. What kind of evaluation have you done or do you plan to do?

- [ ] None
- [ ] Informal
- [ ] In-house
- [ ] External
- [ ] Other

(please specify)

4. How are you evaluating/have evaluated/plan to evaluate the activity?

- [ ] Feedback forms
- [ ] Focus groups
- [ ] Surveys
- [ ] Pre-testing materials
- [ ] Media monitoring
- [ ] Web-traffic monitoring
- [ ] Interviews
- [ ] Other

(please specify)

5. If there was one thing that would tell you your engagement was successful, what would that be?

Science engagement national audit

1. What do you think are the critical areas where we need to improve the quantity or quality of science engagement in Australia? (Your answers to this question will not be linked to your case study or to your name.)

2. About you

Your name	
Your organisation	
Your position	
Your email	
Your role in the activity/ies	
Your postcode	
Your phone number	

3. May we list the following information publicly? All other demographic information will be private.

	Yes	No
Your name	◯	◯
Your organisation	◯	◯
Your position	◯	◯
Your email	◯	◯

If you answered no to any of these, is there someone else who may be willing to be listed instead? If so, name them below and give contact details.

4. Can we contact you if we want more information?

◯ Yes

◯ No

If not, is there someone else who may be willing to answer questions? If so, please name them below and give their contact details.

Science engagement national audit

5. Would you like to be in the draw for a random prize? (If you choose a prize preference, please make sure you've given us your name and phone/email above.) If you don't want to be in the draw, just leave this blank.

- ◯ Book voucher
- ◯ Red wine
- ◯ White wine

Appendix B—Promotional document

The biggest snapshot of science engagement in Australia

It's a picture as big as Australia. A flash of light illuminating how people are getting science out there. And it's the first time it's been done.

The picture shows everyone who is engaging people with any science, from anywhere, any organisation, even into the future—that's the goal.

Inspiring Australia wants to create a snapshot of all of the diverse science communication activities and programs going on between January 2011 and June 2013, and we need the help of anyone doing science engagement across the country.

People can help by filling out a survey about the science engagement that they're a part of. We'll put the results into a visual national online database that anyone can explore. The database is part of a national audit that will help us all understand:

- who are Australia's players in science engagement—internationally, nationally, regionally and locally
- where and who is missing out on science engagement
- if and how Australians respond to science engagement activities
- how people can link their activities or ideas together
- how people are evaluating their engagement activities, or not
- how we can create better tools for evaluation
- the bigger picture of science engagement in Australia—with lots of opportunity for research.

The survey and database are being created in response to the Inspiring Australia Expert Working Group report *Developing an Evidence Base for Science Engagement*. It's the first of a suite of projects tackling the report's recommendations.

As well as the survey, we will do personal interviews and a desktop review to make sure that we capture as many activities as possible.

The team comprises Jenni Metcalfe (Econnect Communication), Kristin Alford (Bridge8), and Jesse Shore and Kali Madden (Australian Science Communicators). Nancy Longnecker (UWA), Rod Lamberts (ANU) and Joan Leach (UQ) are advisors for the project. The data will help develop a national evaluation tool for science engagement activities—another initiative in response to the report's recommendations.

The audit will help science communicators to be seen as part of the big picture of science engagement in Australia and their standing with respect to the world. This Inspiring Australia initiative is supported by the Australian Government through the Department of Industry, Innovation, Science, Research & Tertiary Education in partnership with Econnect, Bridge8, ASC and UWA.

Appendix C—Moderators' guide for focus groups

econnect communication

Focus group moderator's guide

Inspiring Australia National Audit of Science Engagement

1. Introduction

Welcome to participants

Introduce moderator (name) and recorder (name if one; or recording device)

Thank participants; reiterate value to them from participating

Process of focus group discussion – like a dinner table conversation without the wine and food (though with ASC ones, it might with it!)

Role of moderator is to guide the discussion but not contribute to it or answer any questions.

Focus of discussion – critical areas where need to improve the quantity and quality of science engagement in Australia

Confidentiality of information (no attribution of names), and how it will be used – thematic analysis of the transcribed data and included in a report to IA

Let's start by introductions, please tell us who you are and how you've been involved in science engagement (if needed and group does not already know each other)

2. Main section

Discussion guided by following questions:

1. When you think of the phrase 'science engagement' what sorts of things first come to mind?
2. Is 'science engagement' the same as 'science communication'?
3. What are some of the good things happening in science engagement in Australia and overseas?
4. What do you think is the best time in to engage publics with the science and why? (may need to prompt about timing – before research starts, during research, peer reviewed only etc)
5. Are there examples of science engagement activities you see as 'best practice'? And does the timing of when engagement happens affect these examples?
6. What are the factors that make for effective science engagement?
7. Where are the gaps in science engagement across Australia? prompts:
    a. Are there various target groups/audiences that are being missed?
    b. Are there geographical areas that don't get opportunities?
    c. Are there different types of engagement that we're not doing?
    d. Are they science disciplines that we're not engaging people with?
8. What needs to improve in the way we engage people in science? (if time could look at examples of science engagement that did not work)
9. What do you think are the barriers to effective science engagement?
10. Are there incentives / support mechanisms for promoting more effective science engagement?

3. Conclusion

Thank you; Remind them of the audit survey and the opportunity to add further ideas after the focus group by emailing jenni@econnect.com.au

Econnect Communication 1 of 1