Article

Public attitudes to science: Rethinking outreach initiatives

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The public doesn't understand science. You scientists need to put more effort into communicating your work.

Today's kids leave school not knowing enough science. You teachers should teach them better.

University graduates don't even know how to write a concise scientific paper. You tutors should give them more practice before they come to work for us.

Journalists don't understand even the basics. You editors should employ someone who knows what they are talking about to write about science.

Note the familiar pattern here. A shortcoming is found and it's someone else's fault. We don't like it when we are in the firing line but we unwittingly do the same to others. In this article I argue that the type of 'deficit thinking' that underlies the above sentiments is an inappropriate way to respond to the complex issue of engaging the wider public with science. It benefits neither the people being judged nor the community that does the judging. For example, when the science community is on the receiving end, as in the first of the sentiments above, no matter how seriously they take the challenge of trying to communicate more effectively, there is a very good chance nothing much will really change if, with the best will in the world, that effort was misdirected. The challenge here is that topping up a deficit is no guarantee of a cure for whatever caused it in the first place.

Thinking further in this vein, I suspect that asking scientists to put more effort into communicating clearly with a public, most of whom are not interested, is akin to asking a relative stranger to speak more loudly to someone who is hearing-impaired – futile and perhaps very annoying. I will draw on results from the latest in a series of surveys commissioned by the Ministry of Research, Science and Technology (MoRST) to make the case that, with the best will in the world, improving communications will not necessarily work to boost public engagement with science, except perhaps with the already-engaged audience. The article begins with an outline of the survey and introduces a range of items with their basic response frequencies. It also briefly introduces a segmentation analysis that looked for patterns of associations within each individual's responses. The second part of the article then asks questions about just what it is about science we might want members of the public to engage with. The third part of the article will suggest a different avenue with the potential for making a constructive response to the challenges the survey results highlight. The paper is intended to spark discussion and a re-evaluation of the complex issues raised.

A brief outline of the MoRST survey

In early 2010, for the third time in this decade, MoRST commissioned the Nielsen Company to survey public attitudes to science (Nielsen 2010). In 2010 a dual methodology was used for the first time, with 600 participants interviewed by telephone (the traditional method) and another 600 completing the survey on-line. Since there were only small differences in response patterns between the two survey methods they will not be further commented on in this article. As in 2002 and 2005, the sample was carefully weighted on gender, age and geographic location. Somewhat more females (622) than males (578) took part. The majority of respondents (964, 80 percent) had no formal science education beyond that received while at school.

Discussion of key findings of the survey

The 2010 survey was somewhat shorter than the earlier two. Key questions were repeated to establish trend data across the decade. When the 2002 survey was designed, the first questions served the dual purpose of setting a wide set of contexts around the terms 'science and technology' in respondents' minds while also ascertaining their levels of interest in these contexts and perceptions of benefits to be gained from new developments in them (Hipkins *et al*. 2002). With minor adjustments to reflect changing research and social priorities, this context-setting item series was continued in 2010, but respondents were only asked about perceptions of benefits and not about their personal interest levels.

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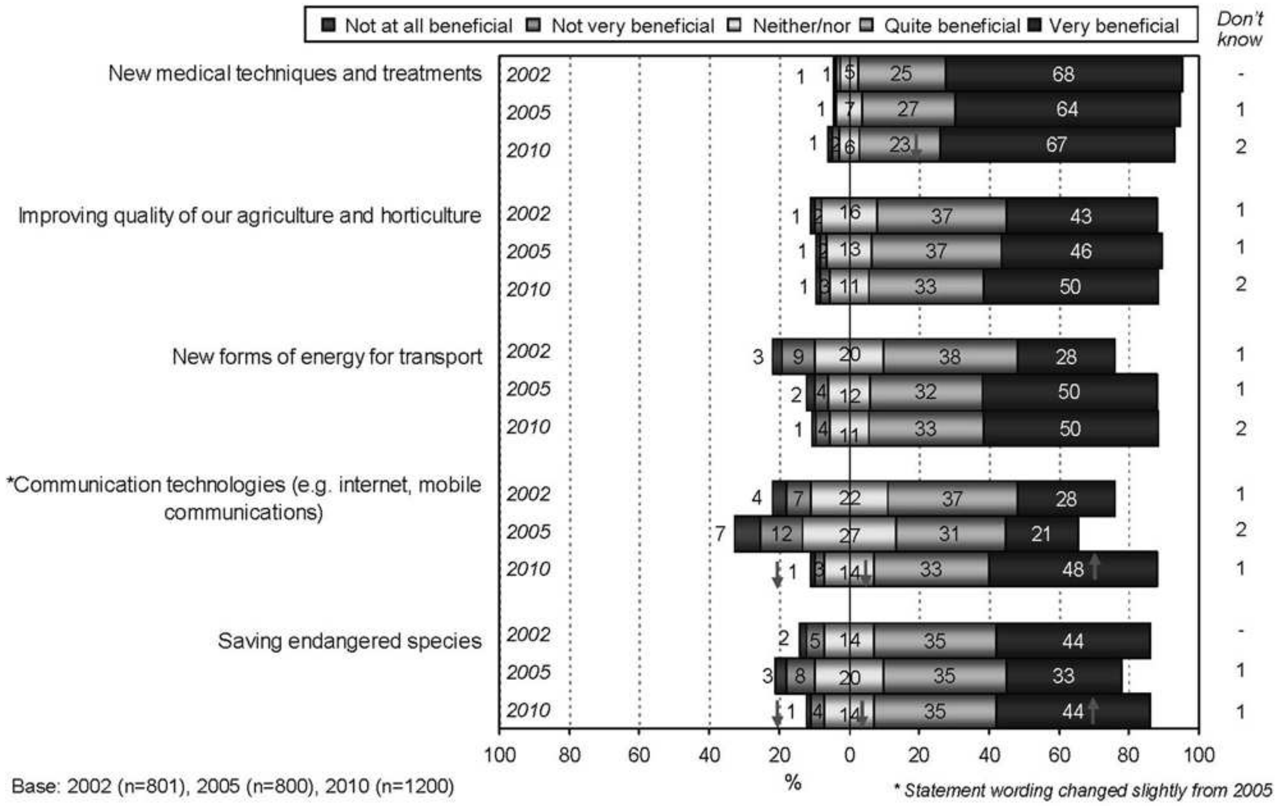
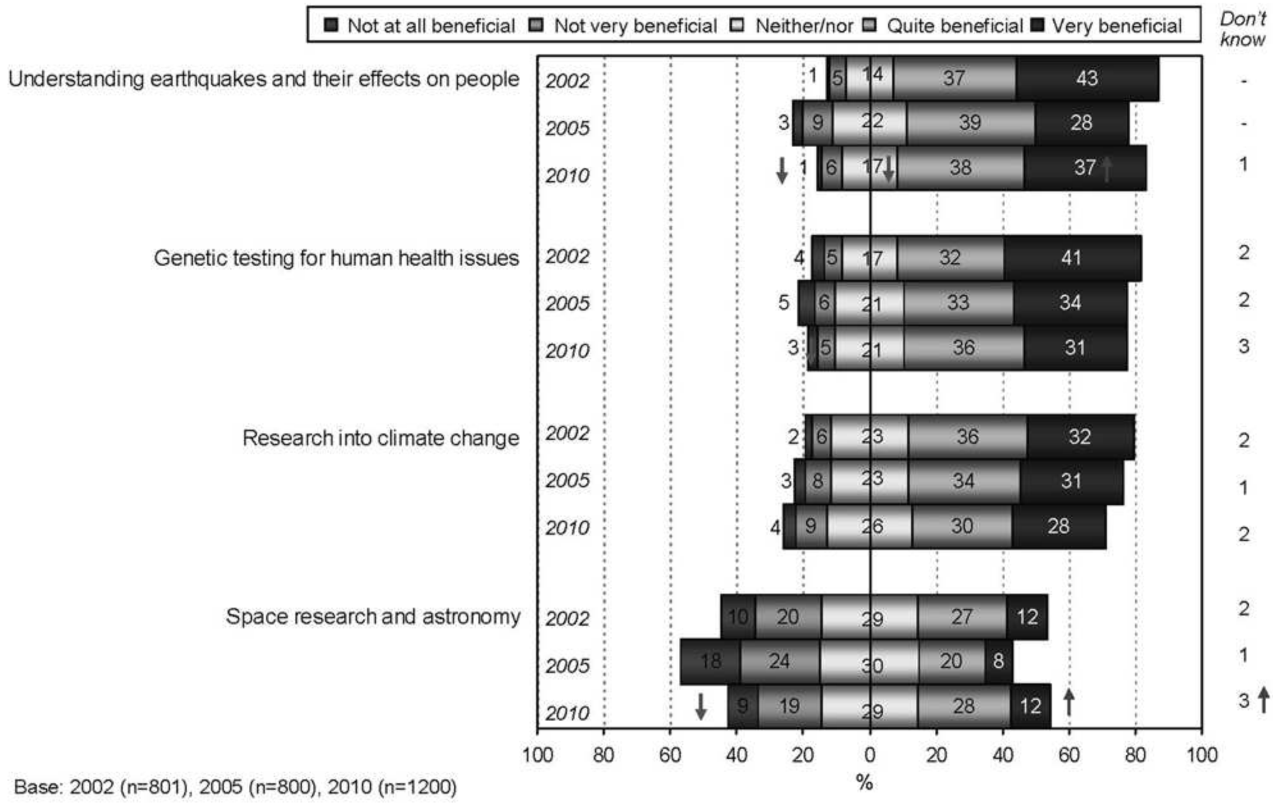




Figures 1 (upper) and 2 (lower). Benefits associated with developments in science and technology.

Figures 1 and 2 show responses to the 'perceived benefits' of nominated contexts across the three surveys. For most contexts, the series is notable for the lack of any substantive shift in perceived benefits and in the lack of change in the ranking order of the various contexts (arrows up or down denote significant shifts). Scientific research resulting in new medical techniques and treatments is almost universally seen as beneficial – no doubt most people can imagine themselves as potential recipients of such benefits, if not immediately then certainly some time in the future. Space research/astronomy was the lowest-ranked context in all three surveys, with climate change second-lowest. Arguably these two contexts would be furthest away from many respondents' direct experience and hence many people would be less aware of their potential relevance and impact. Supporting this suggestion, respondents with postgraduate qualifications (13 percent of sample), who we might expect to be widely-read, were more likely to rate these two areas as beneficial. Notable exceptions to the overall pattern were the more emphatic agreement (increase in 'very beneficial' responses) that transportation research brings benefits (first seen in 2005) and that new developments in communications technologies bring benefits (first seen in 2010). Again these changes are likely to reflect increasing encounters with changes and challenges in these areas over the last few years.

Is speculation about a relationship between benefits perceived and the motivation people might have to pay attention to science congruent with responses to other parts of the survey? Figure 3 shows responses to questions that canvassed *personal* responses to science, both in life contexts and as communicated through various media channels. Again the series is characterised by patterns that show very little difference in response patterns across the decade. The highest level of agreement is with the most passive item – 'it is important to be kept up-to-date'. (This item was added in 2010.) Three quarters of respondents agreed with the statement – but by whom and by what processes did they expect this updating to happen? Contrast the substantial majority who agreed with a need to be kept up-to-date with the lower numbers who agreed that 'science is important in *my daily life*' (emphasis added). Just over half agreed that conflicting information about science makes it hard to know what to believe, yet more than half were neutral or disagreed that science and technology are too specialised for their personal understanding. The picture building here is suggestive of a somewhat detached interest in science for around half the adult population. They generally appreciate there are benefits, they are aware of a need to keep abreast of new developments, but they lack the personal motivation, and in some cases the necessary confidence, to do so themselves.

Interpreting public attitudes to science in this way can lead to assertions that there is a need for more effort to be put into clear and accessible communication of key research findings. However, this type of response is underpinned (at least tacitly) by the deficit thinking illustrated in the introduction, where the suggestion was made that this might be futile in some cases. Do other data from the survey support this assertion? One item asked people to rate the amount of information they see and hear about science. Results were: far too much (2 percent); too much (8 percent); about the right amount (47 percent); too little (35 percent); far too little (6 percent), and don't know (2 percent). These responses suggest that over half the participants had no active desire to read or find out more about science. As might be expected, those with postgraduate qualifications were more likely to say they wanted more information, but the above analysis suggests they are more likely to be paying attention to science in the first place. More and better communication is unlikely to reach those who tend not to take an active personal interest in science. An exception might be where issues are sensationalised in the media, but this is hardly likely to be conducive to constructive conversations. So what do we know about the sense that people make of the science communications they are aware of?

Figures 4 and 5 show that most people do trust any information they can source to scientists, and also that the most trusted media outlet is TV documentaries, followed by TV news. Common sense suggests many people are more likely to see and

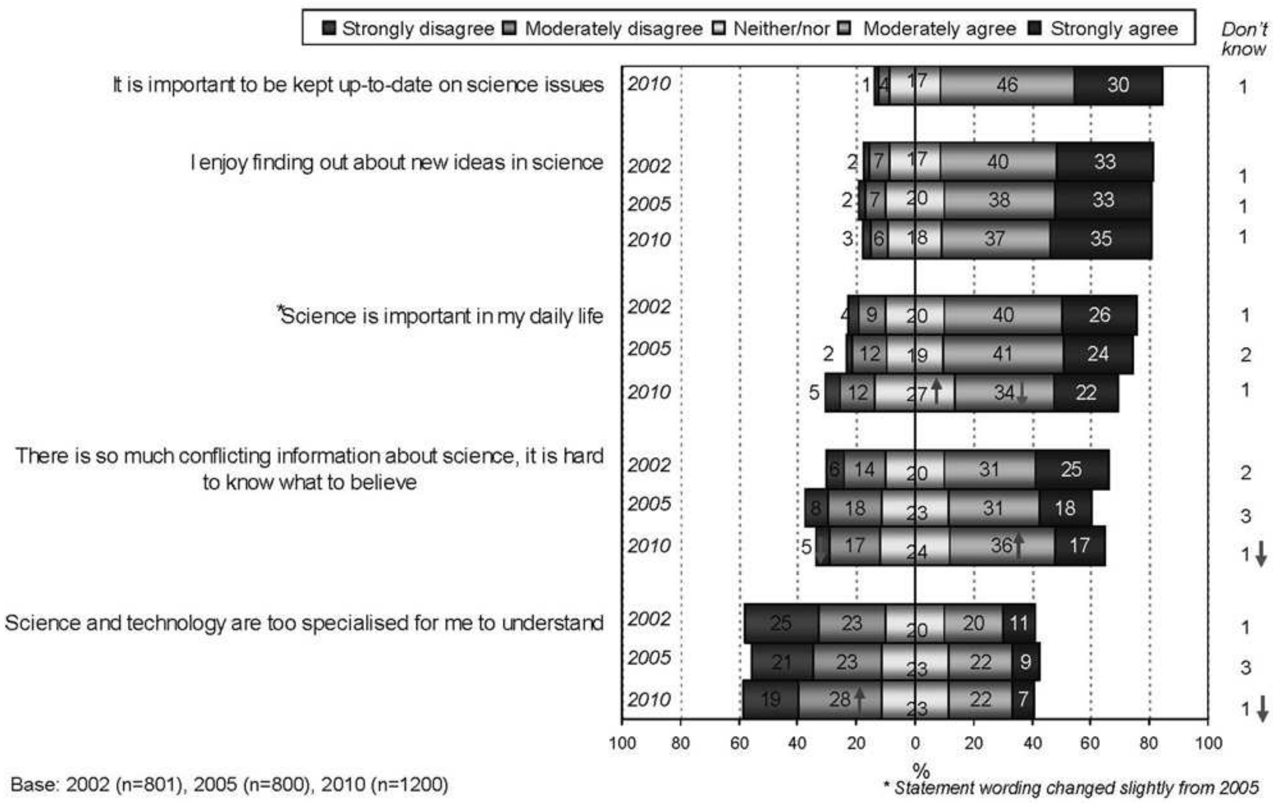
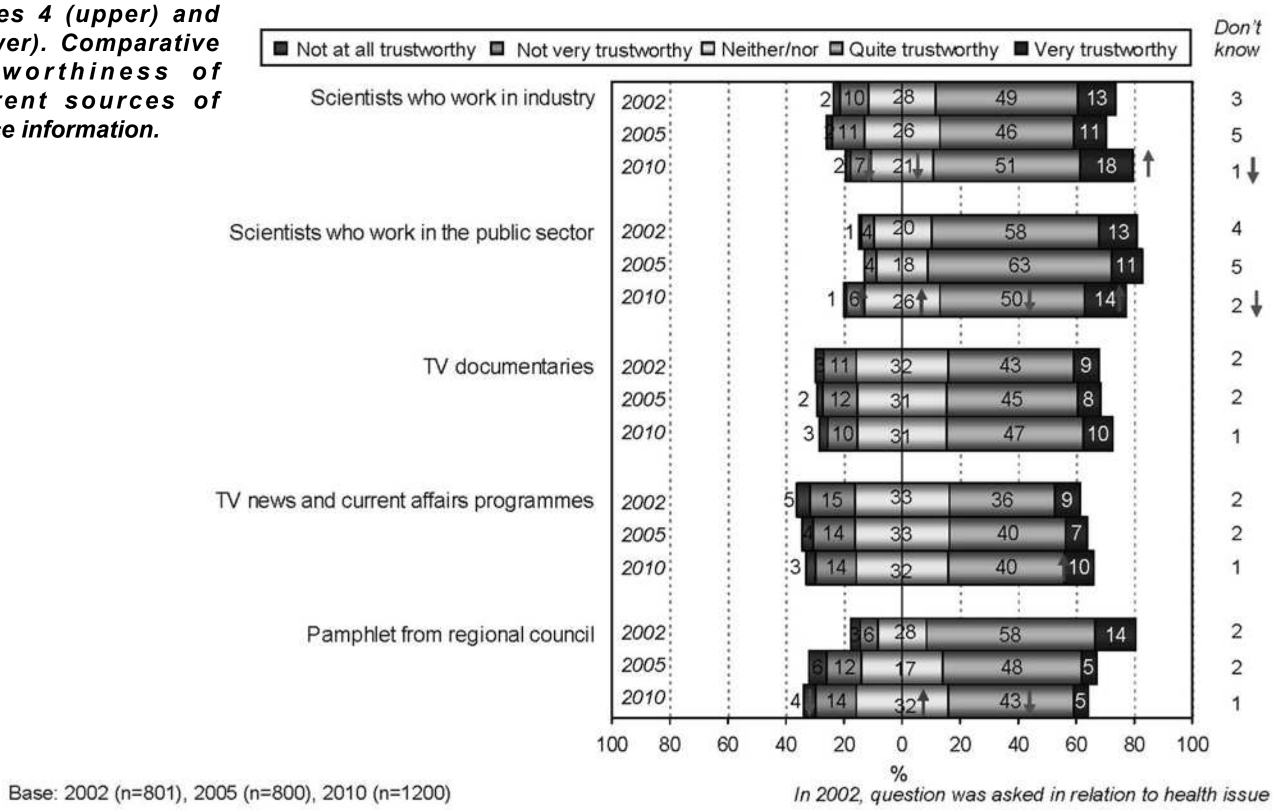


Figure 3. Attitudes towards science.

hear things about science via these media channels, especially given the lack of interest in the active pursuit of science, as documented above. Note the significant 2010 increase in perceptions that newspapers and the internet are at least 'quite trustworthy'. Respondents with no science education beyond the school level were more likely to find TV documentaries trustworthy, as were female respondents. In a decade-by-decade analysis, scepticism about the reliability of sources was likely to increase with age, across all communication channels (Hipkins 2010).

What else do we know about the group that appear to be less actively engaged? A segmentation analysis was undertaken to look for clusters of similar responses. It yielded the five clusters shown in Table 1. Full details of the characteristics of these clusters and the methodology by which they were determined can be read in the main report (ACNielson, 2010) . For the purposes of this article selected differences between the responses of the 'mainstream' group (at 44 percent of respondents it is by far the largest cluster) and the small group of 'science orientated'

Figures 4 (upper) and 5 (lower). Comparative trustworthiness of different sources of science information.



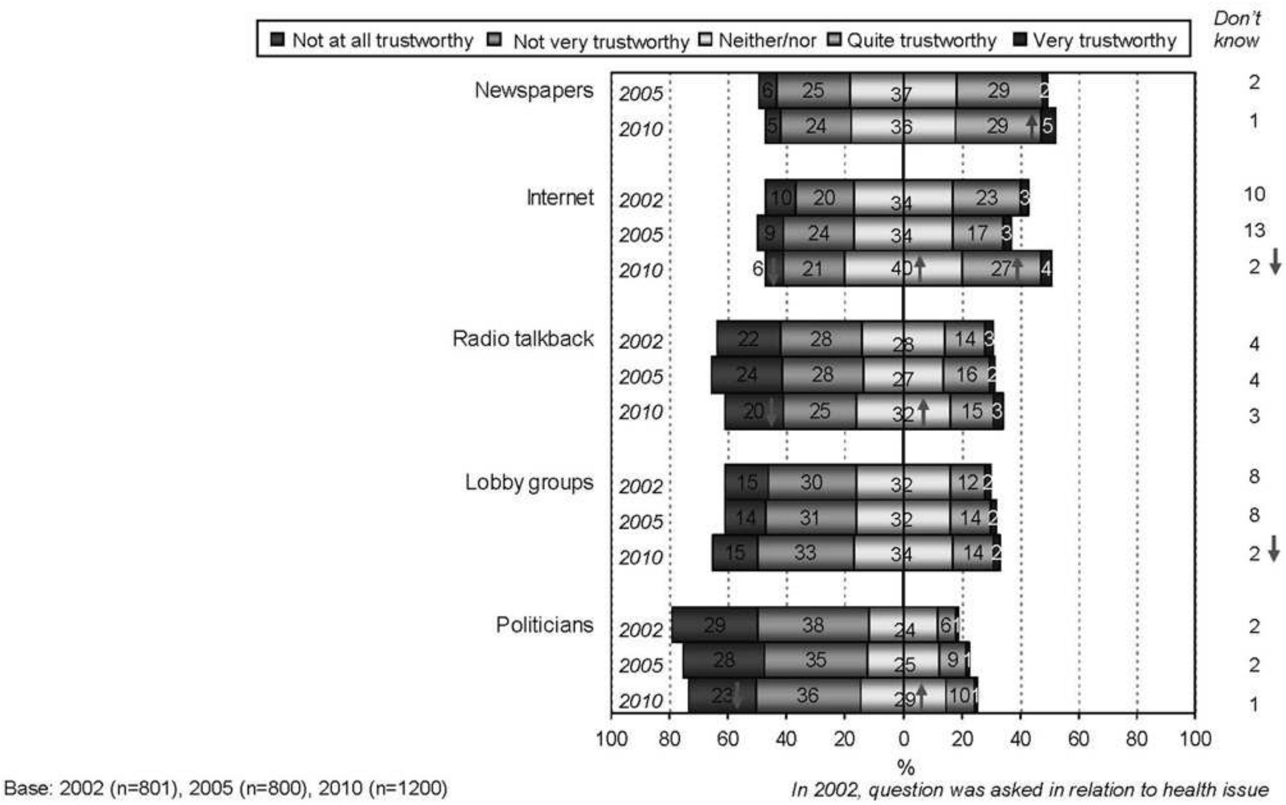


Table 1. Distribution of respondents regarding attitudes to science.

Cluster group	Percent
Mainstream	44
Science orientated	23
Science followers	13
Enthusiasts	11
Disengaged	9

(a smaller cluster at 23 percent) are described in the next section. They were chosen as groups who might be targeted as most likely to be impacted by communications initiatives. The 'science enthusiasts' (with more postgraduates and science-educated respondents) are already actively involved. The 'science followers' are mainly older people without formal qualifications who nevertheless support and follow science developments. The small 'disengaged' cluster is likely to be actively so – for example, they showed the highest disagreement of all groups in response to items related to science and the economy, which are discussed next. By contrast the two clusters explored in this article arguably sit on either side of a divide between inclining to engage or inclining to disengage. Understanding their differences could help us rethink communication strategies.

Why engage people with science?

Encouraging greater public engagement with science is generally seen to be a 'good thing' by the science community but for what *purpose*? How we answer this question is important to how we might rethink communication dilemmas and solutions. This section addresses three broad arguments for greater public engagement with science:

- To create conditions conducive to ongoing support for scientists' work.
- So people will make well-informed decisions when science findings and approaches are relevant to personal decisions.
- So people will be 'good citizens' when it comes to public decision-making about issues that have a science component (often called socio-scientific issues).

Purpose 1: Educate future scientists

In relation to the idea that a public who is aware of the benefits of science is much more likely to support public funding of research (e.g. through taxes), Figure 6 shows responses to a series of items that asked about 'science and the economy'. The pattern of responses suggests that a majority of respondents already believe science to be economically and environmentally beneficial. Three-quarters of them appreciate its potential to enhance our international competitiveness. Although 'blue skies' research is not as strongly endorsed, those who agree it should be funded are still in the majority. Note that the final item – science is out of control – is reversed. Disagreeing is a positive response and is again the view of a substantive majority.

We could take the overall response as an indication that all is well in this aspect of public engagement with science. However, differences between the largest 'mainstream' segment and the 'science orientated' segment add to the growing picture about communication challenges that are the main focus of this article. Table 2 outlines the demographic differences between these two clusters, along with differences in perceptions of the benefits of science and of its potential economic impact.

The differences here are suggestive of a *benign* lack of engagement for the mainstream group. Even though fewer respondents from the mainstream segment believe the government should fund scientific research, this is still the view of almost half of this group. Although relatively more of them believe science is out of control, it is still very much a minority view. If not actively supportive, neither are they actively opposed

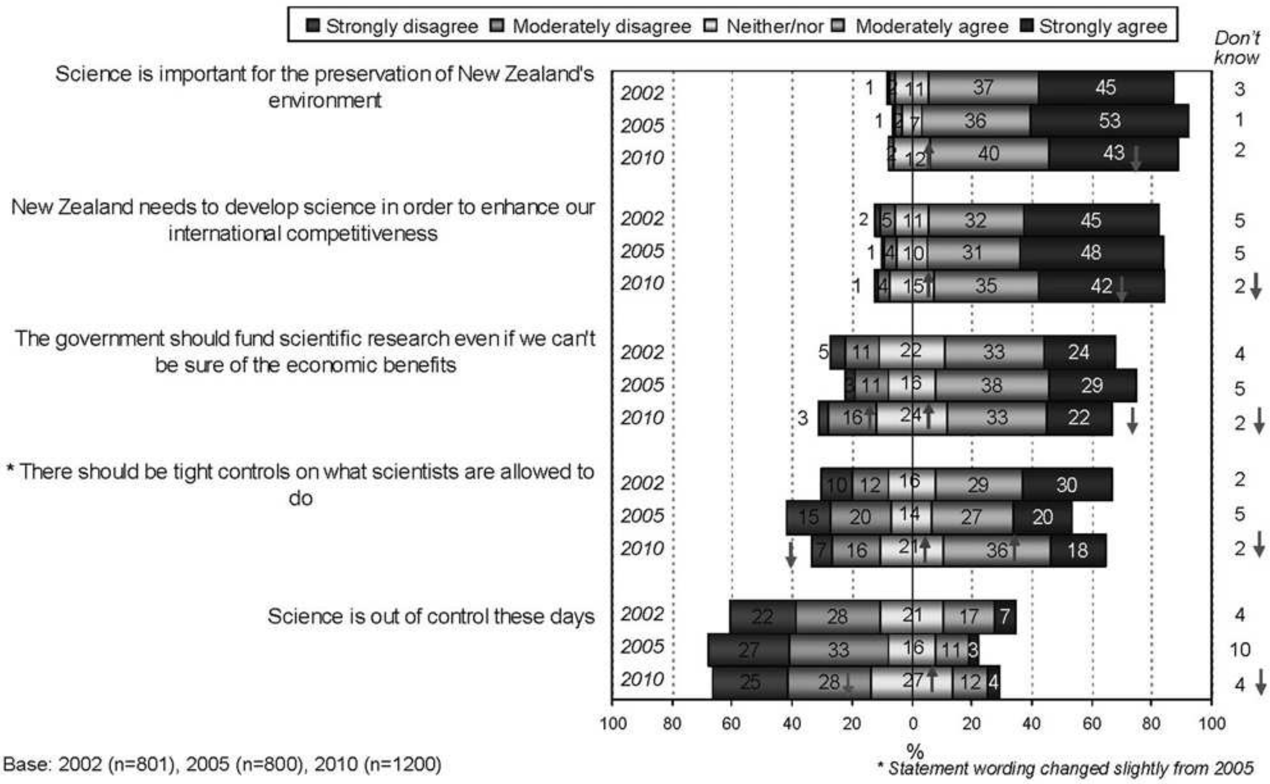


Figure 6. Relationships between science and the economy.

to science, or unaware of its potential benefits. I will come back to question of differences in perceptions of the benefits of earthquake research when I discuss the third of the reasons listed above for engaging people with science.

Purpose 2: Make good personal decisions

Table 3 shows key differences between the responses of the two clusters in relation to the second reason – to make well-informed personal decisions where science findings and approaches are implicated. Notice that differences between these two groups when considering science in relation to *their own lives* (as opposed to a more abstracted economy 'out there') are mostly of a greater magnitude than those reported in Table 2.

Less than one-third of the largest mainstream segment believe that science is important in their daily lives. They are less likely to be confident of their own abilities to source and untangle scientific information. More than half of them rely on TV journalists and producers to report such science as they may pay attention to. Those who feel they already receive too much information may simply switch off or switch channels.

Clearly there is an opportunity here to shape communications that do foreground the impact of science in daily life, but there is a snag. Relating emerging science to daily life may not be easily possible or plausible for much contemporary research. This is more obviously so for the 'blue skies' category, but it also applies to all ongoing work streams where theories and the meaning of evidence are being actively contested within the science community (which doubtless impacts on 'conflicting information' anxieties where these exist). Once new science becomes more settled, perhaps via a process of application to

Table 2. Differences in support for science in contrasting segments.

	Mainstream segment (44%)	Science-orientated segment (23%)
Profile	Female bias (49% *of all* females fall into this segment cf. 39% of males).	More likely to be male (27% of all males cf. 20% females).
	All age groups represented equally, aside from those aged 45–54.	Older age groups (55+) are under-represented.
	Unlikely to have formal science training (but includes 50% of those with a high school qualification in science).	Most likely to have undergraduate or postgraduate qualification (includes nearly half of those with formal science training).
	Higher frequency of low income earners.	Higher than average level of household income.
Perceptions of benefits	Less likely to see the benefits in space research and astronomy (31% cf. 40% all respondents).	More likely than average to perceive benefits for most areas of science named in survey, including space research and astronomy.
	Less likely to see benefits of understanding earthquakes and their effects on people (71% cf. 75%).	80% perceive benefits for understanding earthquakes and their effects on people.
Science and the economy	Less likely to agree that the government should fund scientific research even if we can't be sure of the economic benefits (43% cf. 55%).	More likely to agree the government should fund scientific research even if we can't be sure of the economic benefits (64% cf. 55%).
	Less likely to believe that New Zealand needs to develop science in order to enhance our international competitiveness (73% cf. 77%).	More likely to believe that New Zealand needs to develop science in order to enhance our international competitiveness (81%).
	More likely to think that science is out of control these days (20% cf. 16%).	Less likely to believe that science is out of control (9% cf. 16%).

Table 3. Differences in personal responses to science between contrasting segments.

	Mainstream segment (44%)	Science-orientated segment (27%)
Perceptions of personal relevance	Less likely to believe that science is important in their daily lives (30% cf. 56%).	More likely to believe science is important in daily life (82% cf. 56% average).
	Less likely to think it is important to be kept up-to-date on science issues (70% cf. 76%).	More likely to think it is important to be kept up-to-date on science issues (88% cf. 76%).
	More likely to feel they receive too much science information (10% cf. 8%).	This segment has a split view on whether they receive just the right amount of science information or too little. (4% cf. 8%).
Self-efficacy in relation to seeking information	Less likely to enjoy finding out about new ideas in science (57% cf. 73%).	More likely to enjoy finding out about new ideas (98% cf. 73%).
	More likely to believe science is too specialised to understand (39% cf. 29%).	Believe they understand science (1% say it is too specialised to understand cf. 29% average).
	More likely to believe that there is so much conflicting information, it is hard to know what to believe (59% cf. 53%).	Less likely to believe there is so much conflicting information about science, it is hard to know what to believe. (39% cf. 53%).
Trustworthiness of information sources	Most trust TV documentaries (60% cf. 57%).	Less likely to rate TV documentaries (50% cf. 57%) or other media.
	Less likely to trust public sector scientists (58% cf. 64%).	Most trusted sources are industry (71%) and public sector (69%)scientists.

new technologies, relevance to daily life is more likely to be apparent, but still not necessarily so, and by then it may no longer be the focus of scientists' science programmes. The flip side of this argument also applies. In the first round of this research we held focus group conversations, one of which was with a group of mothers of young children, held in their local kindergarten after hours (Hipkins *et al*. 2002). An science-related issue of great concern to them at the time was an outbreak of head lice (it was late summer) and the pros and cons of treatments involving strong insecticides, compared with methods intended to deprive the lice of oxygen (e.g. oiling the hair and then putting on a tight rubber cap to keep it surrounding the hair while eliminating air spaces). In this conversation they showed a strong awareness of the relevant body systems and several were active seekers of internet information on the topic. Obviously these mothers could engage with science when they had a powerful motive for doing so. The snag is that the relevant science ideas might well be long-settled and of no specific interest to communication efforts.

Purpose 3: Participate in socio-scientific discussions

Where does this leave us? Before proposing a possible reframing of the engagement/communication dilemma, I return to perceived benefits of earthquake research, placing this in the context of the third reason for seeking to engage the public in science – to be 'good citizens' when it comes to public decision-making about socio-scientific issues. In a recently published article, a US school principal with an obvious interest in science pondered the earthquake in China's Sichuan province that resulted in the death of so many children inside their collapsed school buildings (Bailey 2010). She asked if a similar tragedy could happen in the USA and, state by earthquake-prone state, summarised the evidence that indeed it could. She described legal, political and financial barriers to the retrofitting of unreinforced masonry schools in several states and made a plea for people to ask questions about the condition of the schools that their children attended, or in which they worked as teachers.

Of relevance to our discussion are the additional dimensions to engagement with science that this article illustrates. Here is a school leader who is clearly aware of earthquake research (she cites several examples) but this science knowledge on its own was not sufficient to the task she undertook. She was also able to place the scientific questions within a wider framing of social systems (legal, political – local and national, financial, and insights into reasons why others might not be paying attention). Most importantly, she thought to ask the question in the first place. This had to involve imagining a link between distant events and local possibilities, and then pursuing answers to that question. The *dispositional* components to her actions were important enablers to her use of her knowledge and skills.

A substantial majority of the mainstream segment were also aware of the benefits of earthquake research (Table 2). Following the head-lice example above, they could presumably pursue more information if they felt a need to do so, although their lack of self-efficacy could certainly be a barrier to action. The greater barrier though, might be dispositional. To make the necessary links and ask the right questions, you do need to be paying attention in the first place. To think it is worth making the effort, you need to believe your actions could make a difference. (Nancy Bailey's call for action is the clear motivater of her research and advocacy.) Where then does this line of argument leave thoughts of improving communication strategies? In my view, the dispositional dimensions highlighted here need to be fostered while we are young, and hence science communication efforts might be better directed to supporting teachers to achieve this important goal.

Catch them young…

In science, students explore how both the natural physical world and science itself work so that they can participate as critical, informed and responsible citizens in a society in which science plays a significant role (Ministry of Education 2007a, p.17).

The quote above is the one sentence 'essence statement' that justifies science's inclusion as one of eight learning areas in the New Zealand Curriculum. A few pages further on this statement is expanded to four broad purposes:

By studying science students:

- *develop an understanding of the world, built on current scientific theories;*
- *learn that science involves particular processes and ways of developing and organising knowledge and that these continue to evolve;*
- *use their current scientific knowledge and skills for problem solving and developing further knowledge;*
- *use scientific knowledge and skills to make informed decisions about the communication, application, and implications of science as these relate to their own lives and cultures and to the sustainability of the environment.* (Ministry of Education, 2007a, p.28)

All of these are relevant to the discussion above, the last bullet point directly so. Obviously some working knowledge of the 'big ideas' of science is needed to access further knowledge (bullet one). An understanding of how science 'works' (second bullet) can help with questions of conflicting information and deciding who to trust and why. This aspect is addressed in a 'nature of science' strand that is intended to weave through the more traditional disciplinary areas: living world; physical world; material world; Planet Earth and beyond. The aim in the third bullet point arguably works towards strengthening dispositions of the sort briefly indicated above. Some of the generic features of the curriculum, such as the development of 'key competencies', further reinforce the message that learning in all the learning areas is about *using* not just getting knowledge (OECD 2005).

While this particular version of the curriculum is relatively recent, these aims have been broadly held for many years now in Western nations, sometimes foregrounded and sometimes not, depending on which interest groups dominated curriculum thinking at the time (DeBoer 1991). Why, you might be asking, is there so little evidence that they have been successfully met? The prevailing attitudes to science exhibited by the largest mainstream cluster certainly suggest that if the confidence and willingness to engage with science was an aim of their schooling, it has not worked for many people. Supporting this assertion, the OECD's international assessment programme (PISA) recently reported that just 56 percent of New Zealand's 15-year-olds thought science was 'very relevant' for them (Caygill 2008).

We need to ask why so many of our young people do not see personal relevance in their school science learning, and we need to reframe their learning if school science education is to shape dispositions such that young people leave school on the way to being actively engaged with science when and where appropriate.

At the heart of the dilemma is another set of conflicting purposes – this time in *science education,* which is a discipline in its own right. In common with other 'difficult' school subjects such as mathematics (and in earlier times Greek and Latin) the science disciplines have been used as both a preparation for, and gatekeeper to, tertiary education in the sciences (Gilbert 2005). This foregrounds the purpose of educating future scientists. Laying down a foundation of knowledge on which to build tends to stress content 'coverage'. Perceived omissions on the part of schools are likely to be met with the sort of deficit criticisms illustrated in the introduction to the article. Gate-keeping that allows only the most talented to proceed requires that at least some of that content be too difficult for 'average' learners, who do tend to turn away from science as soon as they can. The message here is not that educating our future scientists is unimportant, but rather that it can conflict as a purpose with preparation for participation as 'responsible citizens in a society in which science plays a significant role' (Ministry of Education 2007b).

A widely cited discussion of science education for the 21st century pointed out that future scientists are also future citizens (Millar & Osborne 1998). This is self-evident but important. The aim of educating future citizens applies to *all* students. The aim of educating future scientists only applies to some. This logic suggests the former purpose should prevail, at least in the years before senior secondary school when wider curriculum choice opens up.

There are several ways that the science community can actively support teachers in rethinking their practice to better achieve this purpose. First and most obvious is to desist from deficit criticisms, which teachers do tend to take to heart. Learning time is limited, and teachers cannot 'cover' all the content scientists think may be desirable, while also doing justice to developing the understandings, skills and dispositions our future citizens will need. Something has to give. While they are on the receiving end of criticism, many teachers – especially those whose tacit thinking privileges the gatekeeper role of sciences – will be reluctant to fully take up the future-focused opportunities provided by New Zealand's widely acclaimed curriculum.

The second way that scientists can help is to engage constructively with conversations about the 'big ideas' that really are necessary to developing a foundation for responsible citizenship. What concepts and theories are so centrally important that not knowing them is a barrier to engagement with socio-scientific issues, or even just making good life decisions? This question is a current focus for the National Research Council in the USA and a new '21st Century Science' curriculum has engendered considerable debate in the UK. If teachers are to seriously engage with this curriculum debate (and many have not yet done so) they do need scientists' support and input. They also need fresh new materials, examples from actual science-in-progress that are accessible for students and most of all support and encouragement as they wrestle with new directions. This is the third way scientists can help, and many are already doing so – for example by contributing to the science stories documented in the MoRST-funded Science Learning Hub developed and maintained by the University of Waikato. Here is a ready-made audience with whom to engage. Maybe we will see the fruits of these new directions in science education a decade hence – but only if we pull together to make the necessary changes.

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