Knowing me, knowing you

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Abstract

To engage effectively it is important to understand audiences' values, attitudes and background knowledge. Given that researchers are increasingly expected to be responsible for public engagement, we conducted a small study into their perceptions of publics' scientific knowledge. Our data show researchers feel public engagement is important and their particular field is not difficult to understand. However, our participants appeared to rely on guesswork when estimating public knowledge and to underestimate positive public attitudes towards science. We suggest if researchers develop more accurate sense of audiences' knowledge and attitudes they will be able to engage more effectively and efficiently.

Keywords

Engagement, knowledge deficit model, science communication, public knowledge of science

Researchers are increasingly expected to be responsible for engaging public audiences with their research (Davies, 2008). While most believe that such engagement is part of their duties and supports their licence to practice (Royal Society, 2006), many are undertaking engagement activities with little or no experience, conceptual understanding or formal training (Brownell, et al., 2013). They may also face confusion about the importance that should be accorded to engagement within a research career and the value that institutions and research leaders place on engagement (STFC, 2016).

Trench (2008) describes three models of communication: first, the ‘deficit model’, communication of information to an audience perceived to be lacking knowledge or understanding; second, dialogue between researchers and publics; third, participation, in which all communities have the opportunity to communicate, discuss and be part of the outcome. How scientists view their publics will inevitably influence how they choose to engage (Casini & Neresini, 2013) but effective engagement requires two elements: a communication model that is right for the audience and activity (Weigold, 2001) and an accurate perception of the audience’s profile (Nisbet & Scheufele, 2009). More recently, Holliman and Warren (2017) argued that training and ongoing support, combined with measures that recognise and reward engagement, should be added to this list.

It is not surprising that scientists, trained to prize rationality and logic in their professional lives, believe other communities are likely to behave in a similar way (Simis et al., 2016). However, Davies (2008) showed that many scientists do not feel well-informed about the publics they interact with. Overall, the scientific community appears to have poor expectations of publics’ knowledge (Besley & Nisbet, 2011), and to be likely to assume that publics are ignorant of and not interested in science (Ahteensuu, 2012) and will be ‘put off’ by difficult-to-understand topics. These beliefs probably contribute to the prevalent view of engagement as either deficit-model transfer of information from scientists to publics (Grand et al., 2015) or founded on the belief that public levels of scientific knowledge are insufficient to enable people to understand and tackle current problems (Halliday, 2009) and they therefore need to be educated on topics of which they are ignorant (Schibeci & Williams, 2014).

Besley et al. (2015) suggest that knowing audiences’ values, needs, attitudes and understanding is essential for communication that promotes actionable change. An accurate assessment of these factors would mean scientists would frame concepts (Nisbet & Mooney, 2007) and use language (Brownell et al., 2013) appropriately for their audiences. Underestimating what an audience knows makes a scientist appear patronising, while overestimating understanding affects opportunities for engagement and discussion (Sturgis & Allum, 2004). Therefore, the aim of our study was to establish the accuracy of scientists’ perceptions of people’s scientific knowledge and attitudes to science.

We invited research scientists (defined as having at least an honours degree or currently studying at least at honours level) at the University of Western Australia to participate in a survey. We sent out 373 emailed invitations from which we recruited 40 participants (11% response rate). Nineteen participants specialised in chemistry, 16 in biology and five in physics. Most participants (28) were educated to PhD/Doctor of Science level, two had a Masters degree, one a diploma, six an Honours degree and one a BSc. Their length of experience ranged from two to 26 years.

Participants received a paper survey in three parts. The first part asked for information about their scientific specialism, engagement activities, and views on science communication.

The second section asked participants to judge levels of public scientific knowledge. Since the 1980s, the US National Science Foundation has conducted regular surveys – the Trend Factual Knowledge Questions (TFKQ) – to find out what the public knows about science (Stocklmayer & Bryant, 2012). The TFKQ survey poses a consistent set of true/false questions about scientific facts to participants from several countries. We selected 15 questions from the TFKQ dataset but rather than asking our participants to answer the actual questions, we asked them to predict what percentage of people they believed got the answer correct.

Additionally, to establish the accuracy of participants' judgement of public attitudes to science, we drew on a survey conducted by the Royal Society of Chemistry in 2015 (RSC, 2015). As this survey was originally administered only to chemists, we likewise chose only to ask those researchers who described themselves as chemists to answer this section, as the questions were highly specific to chemists and chemistry. As with the TFKQ section, we asked participants to predict the percentage of the public that agreed with each statement.

Participants' views of engagement

Participants largely believed that they had a responsibility to engage and communicate. None gave this a value of less than 4/10 and 30 of the 40 participants rated it at 8 or more. There was essentially no difference in the responses of those who had undertaken public engagement and those who hadn't.

Participants who had undertaken public engagement were asked to give examples of their activities. The four activities that appeared most often were talks/presentations,

media interviews, outreach to school-age children and writing for non-scientific audiences. This is consistent with earlier work by one of the authors of this paper (Grand, et al., 2015), which showed that talks/lectures and working with schools were both common activities and considered as exemplifying engagement by most researchers.

Some have surmised (e.g. Davies, 2008) that one of the barriers to engagement is researchers' perception that their research is likely to be too difficult for people to understand. However, our participants did not feel this; on a scale of one to ten, most participants did not feel their field was too difficult; 75% of participants rated it at 4 or less. Similarly, they did not feel concerned about how they themselves were perceived; the average score was 4.1. Their anxieties focussed more on personal issues: their major concerns were lack of time, lack of engagement skills and being unsure about the right level to pitch their engagement. Nine participants added free-text additional comments; framing, both in terms of how they should themselves present their research and how it is presented by the media, was one of their most pressing concerns, together with not being rewarded for engagement activities.

Public scientific knowledge

The bulk of the questions in our survey focussed on researchers' predictions of public scientific knowledge. We asked participants to predict what percentage of the respondents to the TFKQ survey got the answer correct. We reviewed how many participants correctly predicted the percentage of the public who got the answer on the TFKQ right, how many over-predicted and how many under-predicted. We defined a 'correct' prediction as falling within $\pm 5\%$ of the actual percentage. For example, if the actual percentage for a given question on the TFKQ was 72%, answers between 67 and 77% were considered correct.

As the Trend Factual Knowledge Questions have not been used in Australia, we used data from Japan for comparison; Thomson (2008) showed that Japan and Australia are not significantly different in terms of scientific literacy. Where data from Japan were not available, we used data from the USA results, given the similarities of culture and education between the two countries.

Very few participants made wholly accurate predictions. For nine of the 15 questions, the majority of participants overestimated the percentage that got the answer correct,

and in the other six, the majority underestimated the percentage of correct. There was no pattern to the estimates; in four of the questions, participants' estimates were very clustered but in four other questions, estimates covered the full range of percentages. Nor were there any patterns related to field of research; chemists, biologists and physicists showed an equal lack of facility.

There was no relationship between participants' levels of recent (within the previous 12 months) public engagement and their ability to estimate public knowledge correctly. For all participants, the average number of correct estimates was 1.9 (± 1.5) out of 15. For those who had undertaken recent public engagement, the average was 2 (± 1.5) but for those with no recent engagement activity, it was 1.6 (± 1.5).

Public attitudes to chemistry

Again, we reviewed how many participants correctly, over- or under-predicted the percentage responses to a series of questions about public attitudes to chemistry, to judge whether chemists had an accurate perception of public attitudes. In eight of the nine questions, a majority of participants underestimated the level of public agreement with the statement. The overall average number of correct responses was 1.2 (± 1.2).

What does this mean?

Given Nisbet and Scheufele's (2009) contention that an accurate perception of the audience's profile is essential for effective communication, our results suggest there is considerable room for improvement. Our results indicate that scientists do not have an accurate perception of publics' level of scientific knowledge but, unlike much earlier work that shows scientists expect the public to have low levels of science literacy or poor understanding of science (Brownell et al., 2013; Burchell, 2007; Burningham et al, 2007; De Boer et al., 2005), our results show no such consistency; our participants more-or-less equally under- and over-estimated public knowledge. Recent experience of public engagement did not appreciably affect scientists' ability to correctly predict public scientific knowledge.

One of our participants' concerns was their perceived lack of engagement skills. Although training is known to improve engagement skills (Schatz & Russel, 2008; Holliman & Warren, 2017) and there is a positive association between receiving training and increased confidence (Burchell et al. 2017), uptake of training opportunities is often low (Royal Society, 2006). For formal training, our results

suggest that programmes could usefully be expanded to include discussion of levels of public knowledge, as inaccurate perceptions of the specific social context, values, attitudes, roles and communication routes of different audiences (Bray, et al., 2012; Nisbet & Scheufele, 2009) limit the effectiveness of engagement. Although scientists frequently conceive of the ‘public’ as a homogenous, uninformed group (e.g. Ecklund et al., 2012; Blok et al., 2008), our results suggest they have little idea of how this ‘public’ thinks about science.

Should scientists therefore be encouraged to ‘learn’ the average scientific literacy of the populace? We would argue not. The TFKQ have been widely criticised for a variety of reasons: for their bias toward the physical sciences, focus on factual knowledge, lack of relevance to everyday life and lack of expert agreement on the ‘correct’ answer (Stocklmayer & Bryant, 2012). Measuring overall scientific literacy obscures the fact that many people have high levels of scientific literacy in specific domains that interest them (e.g. dog breeding, gardening, astronomy), rather than a general content knowledge (Falk et al., 2007). Also, as Kako-Nitta et al. (2017) demonstrated, audiences at museum-based science events have a higher cultural capital and more positive attitudes to science than the general community. Therefore, the average results of the TFKQ questions may not reflect the audiences scientists are most likely to work with.

Rather, we suggest that researchers be encouraged to think about their specific audiences. As Mahrt & Puschmann (2014) showed in the context of science blogs, almost all bloggers believe they write for the ‘general public’, yet Kouper (2010) showed that their topics and the language they use are rarely appropriate for a lay audience. Instead of trying to predict their audience’s current level of knowledge, researchers could directly ask its members what interests them; something which can be neglected. Peterman and Young (2015) showed that while scientists working at festivals are good at avoiding jargon and using real-world examples, fewer than half asked visitors about their own interests. Researchers intending to engage in the digital sphere can be encouraged to draw on regular surveys of digital media use (e.g. Ofcom, 2017; Sensis, 2016; World Internet Project, 2016) to identify the tools and media currently favoured by audiences of different ages, locations and objectives, or to conduct strategic surveys of their audience (Matthews & Wallis, 2015).

The work of Illingworth (2017) and Landrum & Hallman (2017) suggests researchers might base their planning on an adaptation of Kipling's '5 Ws and an H': *why* they want this engagement to happen – what its aims and objectives are; *who* they are engaging with – schoolchildren, indigenous communities, retired people, etc.; *how* and *where* they will conduct the engagement; and *when* in the research cycle the engagement is happening. Finally, through appropriate evaluation, we can understand *what* happened; considering the audiences' emotional and intellectual engagement (Illingworth, 2017) enables researchers to understand whether they have achieved their objectives and so plot a route to improvement (Burchell, et al 2017).

The results from the RSC questions showed a strong discrepancy between what chemists thought public attitudes to chemistry would be compared to what they actually were. Chemists formed the largest single disciplinary grouping among our participants (n=19, out of 40 respondents). Thus, although these results come from a sub-sample, given this preponderance and the consistency of results among researchers from different fields shown in the other sections of the survey, we judge that the results from chemists can fairly be extended to the group as a whole. Chemists seemed mostly to be unaware of the overwhelmingly positive public attitudes to their science and to them. Fear of public backlash – or as one participant wrote, [concerns about] 'violent deranged individuals of the public targeting me or my company' – causes relevant and justified distress for researchers (Lundy, 2005) but if people's positivity towards chemistry can rationally be extended to science as a whole, the element of reluctance to engage that is based on concerns about negative public attitudes seems unreasonable.

Including evidence of the actual levels of public support and trust in science and scientists in engagement training could mean half the engagement battle would be won. Removing the need to convince researchers, research leaders and institutions of the value of engagement would allow the energy that might otherwise be devoted to defending science (Dudo & Besley, 2016), and demonstrating scientists' trustworthiness, to be used elsewhere, perhaps in enabling scientists to better understand their field and its overall relevance (Pearson et al., 1997), or designing more complex and subtle engagement that moves them away from the deficit model. It would also offer scientists a frame within which they could present their work in a way that accurately responds to publics' interests and needs, which would in turn

improve the confidence scientists have in their engagement (Gunter et al., 1999).

Although our results showed very little difference in accuracy of perception between scientists who had recently undertaken public engagement and those who had not, we acknowledge that our research did not allow us to explore the subtleties of this distinction. We allowed participants to self-define 'public engagement', which means we did not take the types of engagement they undertook into account in our analysis. In future research, it would be interesting to explore the relationship between orders of engagement (Irwin, 2008) and accuracy of perception; perhaps those who typically engage in first-order communication, which does not support high levels of discussion or interaction with audiences, have more inaccurate perceptions than those who typically engage in third-order communication, with high levels of interactivity and dialogue.

Overall our results suggests that scientists are largely unaware of how much the public knows about science and for the most part rely on guesswork when estimating levels of public knowledge. Scientists are also unaware of the qualities of public attitudes to science and scientists. Improving the accuracy of scientists' perceptions – through training or the opening up of data – could help strengthen the lines of communication between the scientific and public communities and increase the effectiveness and value-for-input of their engagement.

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