Science and Technology Committee

Oral evidence: Science communication, HC 162

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Written evidence from witnesses:

- Science Media Centre
- Professor Louise Archer and Dr Julie Moote, ASPIRES 2 Project, King's College London
- British Science Association
- Wellcome Trust
- Science Communication Unit, Imperial College London

Watch the meeting

Members present: Nicola Blackwood (Chair); Victoria Borwick; Carol Monaghan

Questions 62-128

Witnesses: **David Shukman**, Science Editor, BBC News, **Deborah Cohen**, Head of Radio Science, BBC, and **Fiona Fox**, Chief Executive, Science Media Centre, gave evidence.

> ***Alex Burch***: Hello, everyone. It is my very great pleasure to welcome you all to the Commons Select Committee for Science and Technology, looking at public understanding of and engagement with science.
>
> I am Alex Burch. I am head of visitor experience, learning and outreach here at the Natural History Museum. It feels particularly appropriate to be hosting this meeting here today, where every day our scientists investigate contemporary science issues of global significance and every year we invite 5 million people through our doors, including a quarter of a million schoolchildren, to engage with and be inspired by the science of nature.
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> It also falls to me to make the health and safety announcement. There are no planned fire drills. If there is an alarm, I ask that you exit by the entrance where you came in. A member of staff will take you to the meeting point.

Q62 Chair: I open by thanking the Natural History Museum for hosting us today. One of the key priorities of the Science and Technology Committee is to make sure that we raise

awareness of science and technology. One of the ways we think we should do that is by making sure that we do not stay bunkered in the Houses of Parliament, and that occasionally we leave the building. We are very grateful to those who are willing to host us, even though we are politicians.

This is the second session of our science communication inquiry. There are a number of organisations that are responsible for communicating science. Museums, like the one we are in, are key among those, as are the witnesses who are sitting before us. We are very grateful to you for coming to give evidence to us today. We will begin questioning you in a second, but I would like to start with a baseline question for Fiona Fox. What do you think is the real public perception of science, and how have the media influenced that perception?

Fiona Fox: Public perception of science is pretty good. If you look at all the public opinion polls, scientists, particularly independent scientists, score very highly in terms of public trust. The public also see scientists on case-by-case issues. I have been leading in our centre on issues like human-animal hybrid embryos, mitochondrial donation—known by some in the media as baby with three parents—and all the interest that there has been in the last year or so in human genome editing.

The public response has been incredible. I invite you to look back at some of the media coverage. This is the most controversial kind of science. It is cutting edge and is really pushing at the edges of our regulation, and we now have questions about the 14-day rule for studying embryos, yet the media coverage has been excellent and the public response has been very supportive. We want our scientists to keep advancing and understanding. If that pushes at the regulatory limits, we would like to debate that and to be able to do so. In fact, we find that on those issues the public are very permissive.

I think it depends. My worry area is the way the media handle conflicts in science. We have seen that very much over the last few days, in some of the big stories about dietary advice. We have had it with statins, with sugar and, recently, with the report about dietary fats. That is the problem area for most people. My husband really annoys me by saying, "What on earth am I meant to believe? Is red wine good for me? Is it bad for me? You lot change your mind every day." Having come into science 10 years ago, I know that we do not change our mind every day. There are new studies, which are done in different ways. Different hypotheses are tested, and there are very good reasons why different studies come to different conclusions.

I worry when a minority group of experts claims to have overturned everything we have ever known about the safety of statins or, like last week, everything we have ever known about dietary fats. All of that is gone. Those claims are given a lot of prominence in the media, when actually the studies are quite weak. My challenge to the public engagement people is on how we arm the public to be able to work out which scientific experts are credible and which evidence base is credible. That is absolutely critical.

Q63 Chair: David Shukman, I understand that your post is as science editor at the BBC and that it was created in response to a review in 2011. Can you explain to us a little bit about what your role is? How do you work to ensure accuracy and impartiality of BBC science coverage, and how effective do you think you are?

David Shukman: The role is primarily to be a journalist—a reporter trying to make sense of some interesting science for the main news programmes. That is the majority of the job. Part of it is to try to encourage collaboration, within the BBC, between the different parts of BBC science. When he did the review, Steve Jones identified that there were different departments covering science within the BBC, but they were not talking to one another. That has been a major part of what we have tried to put right—notably, because we are now all in the same building, new Broadcasting House, and previously we were scattered between other buildings.

There is another role. Having the editor title does not give you executive authority, but it gives you a bit of influence with news editors, to be able to go to them and say, "This is really important. You should really big it up. What you've read in the paper this morning has been misreported. You should avoid it with a bargepole." The role is perhaps not as originally envisaged by Steve Jones in his review, that there would be a sort of director of BBC science, with power to influence and direct every bit of science output. The BBC decided that that would be impractical—how would you ever keep across what every single programme was doing, all the time?—so they reconfigured it to be a broadcaster on a par, in theory, with the business editor, the politics editor and all the rest, to show that the BBC takes science seriously.

I have noticed that, if you go to the key editors, you can say, "Look, you really ought to take this particular thing seriously." An example recently was the discovery of gravitational waves. A lot of people, including quite a few producers, wanted to run away from that—"What on earth is a gravitational wave? It's all a bit complicated"—but I was able to go to the editor of the 6 o'clock and the 10 o'clock news and say, "No, this is a really big moment, and these are the reasons why we should lead with it," and we did. That is one example. There are others where I have not been so successful, but I flag that one up as an example of the job working; an editor can go to the people running programmes and say, "This is a major moment in science. We should take it seriously."

Q64 Chair: What about the representation of role models in non-science programming? We have a serious problem with the recruitment of young people to STEM subjects. In particular, we have a shortage of digital skills and a shortage of engineers. I cannot remember the last time we had an inspirational engineer in "EastEnders", for example. Do you see that as part of your role or perhaps Deborah Cohen's role? What are you doing to push science role models into your non-science programming?

David Shukman: I cannot claim to have any role in that, apart from being encouraging whenever I get the chance. In news, I have a personal crusade to try to get young women scientists on air, whenever possible.

Deborah Cohen: I am not sure that I have that much influence either. I look after programmes, particularly on Radio 4 and on the World Service, with a bit on Radio 3 as well. I am part of a team; I am an editor in another grouping. I spend a lot of time talking to my colleagues who look after programmes like "Start the Week", "In Our Time" and "Saturday Live". A lot have built programmes on Radio 4, and they have understood that people are very interested in science.

I hope that my team has had some kind of influence on those programmes. For example, a couple of weeks ago, "Start the Week" was all about genetics. I do not think you would have heard that a few years ago. "In Our Time" is very popular, particularly with young audiences and students. About one in four of those programmes looks at the history of science. For example, last week there was one about the history of penicillin. It did the history side. A programme that we do called "Inside Science", which is about contemporary science, looked at how we might be able to solve the problem of antimicrobial resistance to antibiotics. That is the kind of influence we have. Every time we meet someone else in the BBC, we try to enthuse about what we do. I hope they pick up on it.

Q65 Chair: Which parts of the BBC do you think are sub-optimal in performance on this so far? Which of them need to pick up their game? I think we need some role models in our contemporary drama—for example, young women going to do engineering from unexpected backgrounds, to say that anybody can do this. That would be brilliant. What do you think should be happening?

Deborah Cohen: It is very hard for us to influence everybody making programmes for the BBC.

Q66 Chair: I am just putting ideas.

Deborah Cohen: You are right. I am a bit closer to radio drama than I am to television drama. Radio does more science-based dramas. We are going to have a big season about Mars that, hopefully, will inspire people. Space is a very good way of inspiring people into science.

Fiona Fox: I am sorry, but all our focus is on news. Certainly the SMC is very focused on news. I would not underestimate what happens in the middle of a crisis. For example, when Fukushima happened, we put hundreds and hundreds of engineers, scientists and radiation experts on to "Sky News on the Hour", every hour, and on to BBC News 24. Estelle Morris, a former Education Minister, as I am sure you guys remember, said very publicly once that she learned more about radiation from the talking heads during Fukushima than she ever learned at school.

I have a 17-year-old son. When Fukushima is happening and there is no other story in town, or during the floods last year, I hope to see scientists and engineers in the news, being the solution. No offence to anyone in the room, but sometimes politicians will be in the news during times like floods for different reasons, to promote different political ideas. Generally, the bit that the scientists and engineers do is come out and say, "This is the solution," or, more importantly, "Dredging is not the simple solution. It might sound easy. It might be simple, and we can all hang on to it, but actually it's more complicated than that." I would not underestimate it. News is performing very well in terms of putting great experts out there when people really care and are really worried about crises.

Deborah Cohen: Could I add one more point about inspiring young women into science? We do a series on Radio 4 called "The Life Scientific", which goes out at 9 am. It is remarkably popular; it is one series that has really cut through. I have made a conscious

gesture that, in each series, half of the scientists are women. We have had quite a few women—I am just thinking through them—from engineering and the physical sciences, not just from the biological sciences.

Chair: Fantastic! Thank you very much.

Q67 Victoria Borwick: I am delighted that the Chair decided to come to my constituency; thank you very much indeed. Could I go back to some of the comments you made earlier, Fiona? Could you give us a bit more flavour of the role of the Science Media Centre, your funding, how you were set up and how you envisage working? Could you do a bit of scene setting for people who might not have heard about you before?

Fiona Fox: Yes, no problem. The Science Media Centre was set up in 2002. Basically, it was set up by the scientific community because so many things were going wrong at that time. Think back to 1999-2000, when we had the GM furore. GM was introduced to the British public under headlines like "Frankenstein crops kill" and "You may find genes in your tomatoes," with pictures of Tony Blair as Frankenstein. There was MMR at the time. The animal rights extremists completely dominated the media. Most scientists who did animal research did not speak about it. Things were not good. There was talk of a frontline between the scientific community and the mass media.

We were the product of a House of Lords report. Former Science Minister David Sainsbury set it up and Patrick Jenkin chaired it. It took evidence from scientists, who all bemoaned the media and said that they were undermining public trust in science. Steve Connor, Tim Radford and other top science journalists gave evidence. I do not know whether you did, David.

David Shukman: It was before my time.

Fiona Fox: Basically, they said, "The scientists are not good at this. They are not rolling their sleeves up, getting on to the pitch and playing the game. They come out once a year from their ivory towers and hand out science on tablets of stone." We were set up to fix that. Our role is to improve the quality of science that reaches the mass media, by increasing the number of scientists prepared to engage effectively with the media and by making it easier for people like David throughout the news media to access really good scientists.

There are many different groups that have to have their say. Prior to 2002, the one group that was not engaging in these huge debates was the scientific community. We were hearing from campaign groups, politicians and newspaper editors, but we were not hearing from them. If the British public say no to GM crops, having heard all the evidence, that is absolutely fine—we live in a democracy—but with some lovely, honourable exceptions, the vast majority of plant scientists in world-class institutions like the John Innes Centre, Rothamsted Research and Oxford University told me that at the time they just ran in the opposite direction. They did not engage in that row. I am not sure whether we will ever know, but I think that the British public, the politicians and the supermarkets said no to GM having not heard from the best experts. All we want to do is to ensure that on fracking, synthetic biology, human genome editing and climate change, policy makers and

the public have easy access to very good-quality scientists, not that they should dominate the debate or that they should win arguments.

Q68 Victoria Borwick: To cut through that, how do you engage with that broader range of views, including media outlets that may misrepresent science? You talked about your relationship with the BBC, but there are others.

Fiona Fox: We work with every single national news media outlet in the UK. There is not a single newspaper, radio programme or television channel that does not use our services. We are proactive. When a story breaks—for example, on flooding, volcanic ash, Ebola or Zika—they will get in their inbox 10 experts from our database: "Here is their mobile number. She is not available for the next three hours, but she is available in an airport for three hours. You can speak to her there. Here are their credentials." Very top-quality experts will be in your inbox the minute the crisis has broken.

Q69 Victoria Borwick: Do you see yourselves as impartial? Obviously, you are funded by corporate bodies at the moment. How do you ensure impartiality?

Fiona Fox: We are funded by 109 different funders. If you ask me which bit of my job I hate, it is raising funds, but the system we have chosen is to ask almost everybody with an interest in good science to give us small donations of £2,000 or £3,000. We take money from universities and Government, but there is an upper limit of 5%. No one is allowed to give us more than 5% of our running costs. We are completely independent from our funders. I imagine that, if you looked down the list, you would see that we have annoyed almost all of them—Government, most definitely—in our time, because we are independent from them. Our editorial decisions are made by ourselves, our board of trustees and our advisory body.

Q70 Victoria Borwick: How do you avoid being seen as either political or, in particular, corporate?

Fiona Fox: You asked whether we are impartial. We are not pro any scientific or institutional agenda—we are not pro-GM or pro-synthetic biology—but we are pro-science, unashamedly pro-science, as Susan Greenfield said when she opened us. We are pro the scientific method. Where there is scientific consensus—around climate change, GM and the safety of statins—we reflect that. Therefore, we will be called pro-GM and pro-statins.

Q71 Victoria Borwick: I did not think that there was one side on any of those three topics.

Fiona Fox: There is very strong scientific consensus on those three topics. On other topics, such as HRT, bees and pesticides, and cannabis—I am sure I could go through a long list—there is no one side in science. Of course, there are lots of sides in society, but we are the Science Media Centre. That is very important. We have been asked by journalists, "You need to find an anti-GM scientist." We say, "Our criteria are that they must publish in peer-reviewed journals, they must work for respected institutions and they

must have reached a certain level in their scientific career. Please, we would love to have an anti-GM scientist. Find us one." They do not exist in mainstream science.

For us to search the country for a climate sceptic or an anti-GM scientist, without the credentials that we need to recruit, would be false balance, exactly what we accuse the media of sometimes—putting scientists on a programme and giving equal weight to their views, when one is a maverick who does not publish in peer-reviewed journals and the other represents the vast weight of the evidence. Very importantly, if tomorrow a randomised control trial was published that showed dangerous side-effects of statins or that overturned the consensus, we would bite their hand off; we would give anything to run that press briefing. The issue is where the weight of evidence lies. That is a really important job.

Victoria Borwick: Thank you. I am sure I will come back with more questions later.

Q72 Carol Monaghan: What are the challenges, both to scientists and to reporters, of reporting science and scientific matters to the general public?

David Shukman: The first is to get clarity. For an awful lot of people in our audiences, there is a fear barrier—a lack of comprehension. They are put off by science. The overriding priority in our reporting is to make things as clear as possible. We have to be very careful about the choice of language, very ingenious with our use of graphics and very clever with the way we explain things. We go to immense lengths to make that point.

There is always a debate. I mentioned gravitational waves. When the Higgs boson came along, the instinctive reaction was, "That is a bit too difficult for the 6 o'clock news. When you get your two-minute slot, are you really going to explain the Higgs boson?" My answer is, "Absolutely. We must definitely try." I desperately want science to be part of the mainstream news process and not a weird oddity that you stick on somewhere very late at night; it should be part of the main news process. That means that the obligation is on us really to work at finding ways of making these things clearer. They are very difficult. You will not get everybody on board. The phrase I would use to describe the process is "make it accessible." The accusation is that we dumb down. I have heard that from scientists—in striving to fit it into two minutes, you will have to dumb down. I rather resent the phrase. If the obligation is to reach as many people as possible, you have to find ways of doing that.

That is one overriding point. Another is that we are surrounded all the time, and bombarded, by supposed science. One of the most critical things is to try to get producers, fellow journalists and others to understand the difference between what looks like science and what really is science. Our inboxes are filled with PR firms purporting to have done some research—a survey—that shows that apples cure cancer. It is amazing, I am afraid, how many newspapers will pick that up, so the first thing we try to instil across the BBC newsroom is that the way to look for real science, as opposed to pretend science, is to ask, "Has it gone through peer review? Has it been published in a recognised journal? Is the sample size large?"

A colleague of mine, Pallab Ghosh, said, "Watch out for the claimed cure for cancer on the basis of two mice being studied over a long weekend." We need to apply some

common-sense rules. Is this a 10-year study involving 10,000 people, done by very reputable organisations, who then submitted their work to peer review and had it published? Those are some of the guiding principles in how we try to approach our science reporting.

Deborah Cohen: I agree. I would add a couple of other issues we come across. One is statistics: how you translate a lot of science, which is expressed in numbers, into words, which we have to do. The BBC has a programme called "More or Less", which does a very good job of explaining statistics to the general public. The other thing is the expertise that resides within the production teams. I happen to have a science degree, but I studied a long time ago. I have quite a stable team of producers and presenters, who know their stuff. They are not all science graduates, but they have worked in the field long enough to be very confident with the material.

Q73 Carol Monaghan: Are scientists good communicators? Simon Singh told us that "communication is hard" and should be left to communication experts. Do you agree?

Deborah Cohen: It is a mixture. Some scientists are fantastic communicators; some are not. Some people like doing it, but some people you cannot persuade into a radio studio, or even to talk to you on the phone. It is probably the same in all walks of life. Maybe there are slightly fewer scientists who like to talk about their work. There is a mixture of people. Some people are very good at talking about their own work. Some people are very good at talking about other people's work. A lot of scientists do not like to talk about other people's work, because they feel that they are not experts in that field.

David Shukman: There has been a welcome improvement. When I first started reporting on science in 2003, it could be quite a struggle to find people even to agree to give up the time required to come to a studio, or to go filming with us or whatever it was. It was quite difficult. Even if you persuaded someone to give an interview, they would often be very concerned about what their peers would think. I picked up that there was this feeling, which has diminished in science, that, if you are on telly all the time, somehow you are not a proper scientist. Over the last decade, that has changed. In particular, the younger scientists who are coming up have grown up not just with telly and radio, but with online and social media as routes to explaining science, and they enjoy it. There is a very welcome change in that.

It is a struggle. We are often accused of focusing on quite a narrow band of contributors. I plead partially guilty to that. One reason for it is that, if you are in a hurry and you have three or four hours to get a piece ready for the news that evening, you cannot waste time chasing around for someone who, in the end, may not be very good at explaining it. I go back to my absolute priority, which is to make it clear. That is why certain people pop up a lot; you know that they can explain it very clearly.

Fiona Fox: There is a very critical role for science communicators, but I could not disagree more with that comment. It would be tragic if we replaced scientists with science communicators on all issues. David makes the point that for a clip on the BBC 10 o'clock news, you need a really good communicator, but when there is a really controversial, complex issue, David attends lots of our briefings—not with a camera—just to understand

better what on earth is going on three days after Fukushima, a week after the floods started or when there is conflicting evidence on statins.

At that moment, what you need is deep, deep expertise. The reason why I love my job is that I see 20 journalists in a room, who have been sent by their editors to ask all the tough questions, and quite often there is nothing that the experts cannot answer. On the first or second day back after Christmas, we ran a briefing on the flooding. There were five top experts, from the Centre for Ecology and Hydrology and elsewhere. There was nothing that they did not know, on every single question. That was not great communication skills—it was very deep expertise.

I said it in my evidence, and I really want to say it again: we are blessed in the UK that we have specialist journalists. That does not happen any more in Australia or New Zealand. My equivalent in New Zealand was the last standing science correspondent in the New Zealand press. Now he runs the SMC New Zealand. They do not have science journalists, but we still do. The *Daily Mail* has four specialist science reporters. The BBC has hundreds.

Deborah Cohen: I wouldn't go that far.

Fiona Fox: There are a lot.

David Shukman: We have lots of programmes.

Fiona Fox: You have Andy Williams. There are a lot of programmes. It is a good thing; don't be defensive. They are specialists and they are very clever. They do not have a lot of time—they might write five articles a day—but they have time to come to the Science Media Centre for one hour to listen to that expertise.

I really think that it depends. The reason that I stay in science—I was not in science at all as a media officer—is that I really enjoy meeting a group of people who care about the truth, who have integrity and who test their opinions and hypotheses, rather than just saying them. That is what makes them great communicators. They know what they are talking about, generally.

Q74 Carol Monaghan: I, too, have a 17-year-old. As interesting as the science programme on the radio at 9 o'clock is, 17-year-olds are not listening to radio. To what extent are new media—internet blogs and things like that—playing a role in communicating science? Are they helping or hindering?

Deborah Cohen: The BBC is moving into this area—teenagers, as you said. The problem that the BBC always has is getting to the 16 to 24-year-olds—in fact, the 16 to 30-year-olds. Social media is where young people live these days, isn't it? The BBC is moving into this, but there is a huge amount of work to be done by us in that area. To answer your second question, I think it is helping.

David Shukman: There are a couple of challenges. One is that a lot of the material that pops up on, in particular, Facebook, Twitter and Instagram will, by definition, be brief. I worry that that makes it difficult to explain things, to give the context and explain the different issues that might be at stake on something. It will be harder to make sure that

something like a one-minute video that pops up and is shared really captures the nuance of an important bit of science.

The other thing that is a challenge—there is nothing we can do about it; we have to ride with it and find some way of dealing with it—is that, when you have a looming big announcement from some scientific institution, inevitably some bits and pieces will pop up on Twitter. I am slightly old-fashioned, probably, but before you broadcast, I think it is worth hanging on to see what the results are actually showing.

For example, recently there was an interesting discovery at the large Hadron collider—a mysterious bump in the data. No one quite knows what it is. There is a bit of that on social media already. For the 6 o'clock news, is it right to hold off until we know what they have found and have had a proper chance to analyse it? Yes. Can I foresee a time when there is so much buzz on Twitter about something that we feel obliged to do something? That will probably come along. If you want to anchor your science reporting in results that have been scrutinised through the processes of peer review and publication, which are not infallible, obviously, but give you a couple of barriers against things being wrong, that is challenged by the rise of social media.

Q75 Chair: Surely it is possible to capture audiences, to pique interest and to draw people into more technical and complex explanations on other platforms. That is the role that social media can and do already play in science education. We should all be trying to extend and expand that. We are not against that, are we?

David Shukman: No, obviously not.

Chair: Just checking.

David Shukman: Tim Peake tweeting from the international space station is obviously hugely engaging. We are hugely supportive of that.

Chair: We have all been following, and retweeting.

Q76 Victoria Borwick: I would like to go back briefly to something the Chair said earlier about science, technology and engineering, particularly when you were talking about your programming and engaging younger people with potential job opportunities—things like the making of Crossrail, the complexity of the tunnelling and young people being seen to have decision-making roles in the maths and engineering required. Having seen that sort of programme, how can you draw in how those people got those jobs? I have always been slightly concerned that many of them have not been through our British education system.

It goes back to what my colleagues, particularly the Chair, said about making young people interested in engineering. There are thousands of jobs in real-time solutions to what is going on underneath our streets at the moment. How do you think you have a role in communicating that part of engineering, science and discovery? Tunnelling has changed, all because of technological and scientific advances. All sorts of things have changed in a practical way.

David Shukman: There is great awareness in the newsroom of whether the fact that you have science correspondents, a science editor and a science team somehow means that you are ignoring engineering. We are aware of that. It is not always easy, but there is definite interest in trying to explain an engineering marvel. I keep going back to gravitational waves. A key part of our coverage of that was not just Einstein or the scientists who analysed the results, but the engineers who built the amazing detectors. The word "marvel" was used quite a bit that day. That is justified. Explaining how someone got to a position where they were making decisions about how to build some engineering marvel is difficult in news, just because the items are so short. It would probably be easier through "The Life Scientific", for example, to find a way of teasing out someone's journey to being an engineer who makes key decisions.

Deborah Cohen: We have done that on a couple of occasions. We did an interview with Robert Mair, who was involved with Crossrail; we did his life scientific. Our TV colleagues who make programmes have done a lot in this world. There is currently a series about how airports work, which is all about engineering. The issue is how we get to young people, who, as we know, do not sit and watch television these days.

Q77 Victoria Borwick: Don't you think that at the moment that is possibly because we're going for the sort of person who has really made it? Wouldn't it be fantastic to have the person who drove the machine and threaded the eye of the needle, the tunnelling, and to talk about the maths concerned? Maybe there are other people. I am really taken by the point the Chair made earlier about making sure that we explain to the next generation what opportunities there are in science, technology, engineering and the whole range of subjects.

Deborah Cohen: There is a problem, and you are right; we need to show more stages of the process. The BBC will be doing a lot, and has already done quite a lot, with the micro:bit, which is a project for the year 7 and year 8 cohort and will now be available to everybody to buy. Hopefully, we will continue making programmes about it. The "Make It Digital" season will continue on that. I agree; I am sure there is more that we can do on that.

Q78 Chair: David, I want to go back to your comments in answer to Carol Monaghan's question about the challenge of communicating science. You said that the first point was to use clarity to overcome barriers of fear and knowledge, to make sure that science was not niche, but was in the mainstream, and to make sure that you were weeding out the bad science. One allegation often levelled at the BBC is that there are problems with the due impartiality guidelines, with quite narrow opinions being elevated because of that. Do you think that is improving now, because of the 2012 changes, or is it still something where there needs to be improvement?

David Shukman: It is improving, with exceptions. It is a big organisation, with lots of outlets. After the review, BBC News ran a series of courses that everybody in news had to do. At its heart, the key thing was to explain scientific method, to help people understand the difference between what looks like science and what really is science, and to be able to form judgments about the due weight that should be allocated in covering a topic. That has filtered through—no question.

You still have a challenge, because in broadcasting there is often the binary approach, of two guests. There, the emphasis is on making sure that the presenters are briefed to be able to explain in their introduction and their questions where the weight of evidence lies—where the consensus on a topic is in science—so that the listener definitely gets it that, of the two contributors, one represents a minority view and the other the majority view.

Q79 Chair: What is your view on this, Fiona?

Fiona Fox: I absolutely agree. It has been transformed within the BBC. Jonathan Baker, who is now chair of the Science Media Centre, ran courses for every single general news journalist and editor to talk about what Steve Jones called "intelligent" balance. It is not saying that we do not want sceptics on the airwaves; of course Lord Lawson has a place on the airwaves. A few years ago a new study was being published in *Nature*. It was a climate study that had taken seven years, and there were 200 scientists from across Europe. On that day, I remember somebody—I think it was 5 Live—saying, "Right, can we have one of your guys and a scientist who disagrees?" I thought, "Oh, my God. There are hundreds of scientists involved, and it took seven years. Could you not just let one of the authors explain for a few minutes what they did and then have the debate between the pros and antis next week?"

Of course there should be debate. Science is not the only answer to climate change; there are other issues. The "Today" programme has been absolutely brilliant—until the last week, for some reason. I am thinking about the debate yesterday on cholesterol. We had a study yesterday—an absolutely classic example—and woke up to headlines like "Bad cholesterol helps you live longer" and "High cholesterol does not cause heart disease, new research finds, so treating with statins is a waste of time."

As Evan Harris, formerly of your camp, says, extraordinary claims need extraordinary evidence. If this is true, it overturns everything we have ever known. I am not saying that it is not true, but it was an observational study, so it is not very strong evidence. People who do observational studies, who are good scientists, point out that there are lots of confounders, and we already have very good trials. We issued comments from five scientists, all saying, "But we have the gold standard—randomised control trials, which say that actually cholesterol is linked to the risk of heart disease in older people," yet in the debate yesterday morning, which some of you may have listened to, I do not know how on earth my mum or my friends, who are not in science, were meant to work out who was telling the truth on that or where the weight of evidence lies. It was an extraordinary claim.

There is something there about the issue of signposting. How does the BBC signpost when there is a scientist? I do not think it is always true. If it is Susan Jebb, who represents better nutrition, versus Jamie Oliver, we can all tell—he is a celebrity chef who has his views. If it is a climate scientist like Brian Hoskins from Grantham versus Lord Lawson, we know that the latter is a politician. It is when two scientists are put on a programme, making extraordinary claims that everything that we ever knew is wrong, that there needs to be signposting. I remember one BBC editor saying, "What do you want us to do, Fiona—put a jingle over the maverick?" I admit it is hard. We do not want jingles on the "Today" programme, but we should at least keep trying. The science on the "Today"

programme is excellent. If you listened yesterday, you will know that there was a big package on Cambridge and scientists' views on Brexit.

Q80 Chair: What about other media outlets, compared with the BBC? The BBC has a specific issue with the guidelines, and we have had a lot of media coverage of those guidelines, but what about other outlets? How are they performing at the moment?

Fiona Fox: News editors and general newsrooms are wedded to balance. I do not think that is a problem. The headlines that I read out are a problem because of their prominence, but within those articles, experts we had proactively provided were urging readers to treat the findings with caution and pointing out that big, better trials have been done that show the opposite. I do not see that the BBC got this right and everyone else got it wrong. Again, I go back to our wonderful specialists, who do care. In my inbox, I have hundreds of emails, which I will never be able to publish, from science specialists saying, "Thank you. This helped me to knock it down. My editor wanted to put it on the front page." When you go to journalism school, if there is such a thing as a journalistic training any more, you are told to have objectivity and balance.

Q81 Chair: In the cases where it goes wrong and everybody is told, "It's all right. Go and eat four eggs for breakfast every day. It doesn't matter what happens to your cholesterol. You will not get a heart attack" and—

Fiona Fox: Eat lots of fat.

Chair: If you discover that a headline has gone out that potentially gives the wrong scientific information or the wrong impression, how do you go about putting it right?

Fiona Fox: We get in there before the headlines. We are very privileged in that we have early access to all the top 12 or 15 journals—the journals for which there are press officers. If a study is coming out in the media on the Monday, we will look at it on the Friday. We proactively go to our database, to the wonderful scientists I talked about, and ask them to read it and give a mini media peer review, to say to the journalist, "Beautifully designed study, but not as strong as this," or "This conflicts with what we previously knew," or "Not a very good study at all." Then you hope that the journalist will either include lots of those caveats, so that at least the wider public get a measured report—I want to emphasise that that happens a lot—or, as often happens, that they will argue with their editors: "We should not run this story. We certainly should not put it on the front page. We should put it on page 9." Increasingly, I notice that in the *Daily Mail* and others, the standfirst—the three little points under the headline—will say, "Leading scientists urged caution. Study only done in mice. Would need to be replicated in humans in show an effect."

I am feeling fairly positive. The people sitting behind me, who will give evidence to you later, do public engagement. We must arm the public—arm ourselves—with understanding of how to read an article. If it was only a small study done in two mice over the weekend, I will dismiss it and not give up my little glass of red wine a night, but if it was a huge randomised control trial, done by good research institutes, I will take it a bit more seriously. I do not know whether they still do it, but the Wellcome Trust used to

have a lovely project that trained teacher trainers. I went to do a little talk for them. They would then go into the classroom as teachers and encourage their children to read the media critically.

Q82 Chair: What if the story has already gone out and has gone to broadcast? When you realise that that has happened, do you schedule something to put it right?

Deborah Cohen: I can answer from my perspective. Often we do. I have the luxury of having specialist programmes. We always ask for comments from listeners. If we have got things wrong, people write in and say, "There is another answer to this. Why did you get it wrong?" We are very open about that. Sometimes when there is a big story in the media generally, like the statins, we may analyse it further within our programmes, where we can have a longer, five, six or seven-minute discussion about why you get to these sorts of things. We are in a slightly different position. We may not have the same listeners, it is true to say. However, we try. We hope that we get it right.

David Shukman: I cannot comment on the particulars of the story that Fiona mentioned. In general, if there is a factual inaccuracy, it will be corrected. If it is a question of judgment, there may be an internal debate about whether the item should be revisited at some later date, in an effort to correct an impression.

Q83 Victoria Borwick: I have a couple of final questions. Mr Shukman, earlier you talked about the complexity. How important is the use of language in communicating science? You have heard about what happens when it goes wrong—when people do not think of the other side—and the errors we have had. Over the last 10 days, we have been told that we can all now eat eggs, fat and cholesterol, that we can throw statins in the bin, and the rest of it.

Chair: To be fair, this is not about health advice.

Victoria Borwick: It was amazing when we had the chief medical officer say that she was not drinking so much red wine. That was a tremendously powerful message. A lot of people said, "I have given up drinking my red wine." The language is so important. As the voice that we all hear, how do you use your language and put it over clearly?

David Shukman: The priority is to be accurate, I suppose, and make sure that whatever language you use conveys the science correctly. It is absolutely crucial that we translate what the scientists are saying into plain English.

Q84 Victoria Borwick: How do you avoid the jargon?

David Shukman: I have done interviews in which I have begged scientists not to use certain words that mean nothing beyond their field. It is a constant struggle. More difficult are concepts. The word uncertainty means one thing to a scientist and something different outside the world of science. Then they have terms like error bars. Among scientists, they will just talk about error bars, but you cannot go on the news and talk about error bars. We have to try to find ways of conveying what scientists mean by uncertainty, confidence levels and error bars. Finding ways of turning that into English is a challenge, particularly

when you have a percentage confidence level in a result that itself is not cast-iron. The classic is the Intergovernmental Panel on Climate Change saying that it is 90% confident that most recent warming is man-made. You have two quite interesting and difficult concepts in that one sentence. We have to work hard at finding ways that resonate with the audiences.

Chair: Carol has the final question.

Q85 Carol Monaghan: What are the risks of communicating scientific uncertainty, Fiona? You mentioned GM, climate change and fracking. Where do we draw the line between scientific and political reporting? I do not know whether anybody would like to take that.

Fiona Fox: This is a tricky one. All I would say is that at the Science Media Centre—not everyone agrees with us; I am sure that people who give evidence later might disagree—we have never, ever encouraged a scientist to gloss over slightly the uncertainties on climate change, statins or GM in order to win an argument. We do not even think that scientists should be trying to win arguments. They should be the bit that allows you—policy makers, politicians, the public and journalists—to have the debate, informed by the best evidence.

There was a row—Climategate proved us right—when people were so under the cosh from the sceptics that there were emails flying around saying, "We shouldn't be emphasising the uncertainties in our knowledge, because that is what the sceptics are doing. They are saying that it is uncertain and that there is a scientific divide, and you are just giving them ammunition." Our view at the Science Media Centre was the exact opposite. If there are uncertainties, you must admit that there are uncertainties and gaps in our knowledge. You should go and do the research to fill them. That is the story of science. You should never gloss over the uncertainties and pretend.

As was said earlier, no self-respecting scientist will ever sit here and say, "GM is safe. Synthetic biology is safe. A vaccine is safe." They just do not talk like that. If the public hear scientists on the "Today" programme and throughout the media saying, "We in the scientific community will not tell you that a vaccine is safe, but I vaccinated my child"—Victoria Borwick spoke about the very powerful messages given by Sally Davies—they reflect that. People reflect it back to me. Some of my friends say, "Scientists are like that. They will never tell you for definite." I am very much in favour.

The politicisation of stories is a very difficult issue. I want to use my one little opportunity to get something in here about Government scientists. You will have heard us give evidence on that before to this Committee. I am really upset, as I see that this Government's huge commitment to public engagement, GO-Science and the wonderful chief scientists is in very big contradiction to the fact that Government scientists are heavily restricted. I am referring to the research-active scientists who are employed in Government institutes. The reason they are not allowed to speak freely is that it is assumed that they would be politicised. If they spoke on badgers, GM, flooding, animal research, bees and pesticides or ash dieback, the journalists—that means David Shukman—would say, "You are a Government adviser. You are in conflict with Government policy," which would embarrass Ministers. Actually, a lot of those scientists are wonderful. They have

done their research for 30 or 40 years. They are very able to talk to David about the evidence on ash dieback or badgers and to avoid being drawn into the politics.

I would love it if the Committee had one sentence in its report, just to nudge on that, because we have had absolutely no success with it. The biggest failure of the SMC is in trying to persuade the Government to liberate more of their own researchers, who are sometimes the best researchers available. If there were loads of others, I would not mind. However, on certain issues, the very best, to whom everybody points us, work in Government research institutes. We cannot get at them.

Q86 Carol Monaghan: Academic freedom.

Fiona Fox: Academic freedom, yes—even for Government researchers.

Chair: Thank you for your evidence today. It has been very helpful in progressing our understanding of this inquiry. We will have to move on. We have slightly gone over our time, because it has been so interesting.

Examination of Witnesses

Witnesses: **Professor Louise Archer**, Professor of Sociology of Education and Chair of the Centre for Research in Education in Science, Technology and Mathematics, King's College London, **Imran Khan**, Chief Executive, British Science Association, and **Katherine Mathieson**, Director of Programmes, British Science Association, gave evidence.

Q87 Chair: I welcome the panel to the Committee. You will have heard the evidence from our previous witnesses, so I want to dive straight in. There was a five-year study, called the ASPIRES project, which looked at a student cohort and tried to understand what would interest them in STEM subjects. It found that many existing communication strategies are missing the point, but that lack of interest in science is not the key factor in driving student choices. I will start with you, Professor Archer. What are young people's attitudes to science? Why are we missing the point in our communication strategies? What do we need to change to try to drive up STEM choices? Why is interest dropping off at the crucial moment?

Professor Archer: The ASPIRES project is a 10-year study. We are tracking the same cohort from the end of primary, aged 10, up to 18. It is still going on; they are 17 at the moment. We have used a large-scale survey, over 30,000 students to date, just to give you a sense of the scale.

Looking across that age span, it was quite striking and surprising to us how high the students' interest in science was. In primary school, you would expect over 70% to say things like, "I find science interesting." Even up to the GCSE years—when, to be honest, it is quite hard to maintain interest across the board, because it is hard work—you still got very high levels of interest, around 60%, which is significant. In our view, it is not that students do not find science interesting. The wealth of very engaging media, for example, around science is partly to do with that. Obviously schools can take a bit of credit as well, for making their science interesting. It is not all doom and gloom.

Our research suggests that that is not enough to make someone think, "Yes, this is for me. I can continue." There are a lot of other factors against them. There is how much science capital, as we call it, they have. There is the structure of education. I know this Committee is not looking at education, but if we want to understand where young people spend a lot of their time and what shapes their views of science, education is very powerful. They are getting very strong messages from quite an early age that only the very brainiest continue with science. We have a structure in our education system in England that is set up, basically, to weed people out from about 13, which we feel is perhaps a little young if you want more to continue.

There are lots of factors, but one of the main ones is the fact that they have quite low science capital. They have low understanding of the wider value of science and do not see it as leading to a whole range of careers. It is not seen as an enabling subject, although many of us within science education would see it as an enabling subject. That is something to be worked on. Of course, there are also the views of the culture of science, which is still very much seen as quite white, male and middle-class. That still needs to be worked on.

Q88 Chair: Picking up those points, Imran Khan, what are some of the ways we can address that, both through the education system and through communicating science as an enabling subject, not just for the geeks? What do you think? How do we start doing that?

Imran Khan: There is so much interesting content that you could take from Professor Archer's work and apply elsewhere. If we were to try to sum up what the British Science Association does in a nutshell, it would be promoting science not just for scientists. The lesson from the work of the ASPIRES project is that we have to get away from the idea in education, and throughout the rest of public life, that interest in science is appropriate only for the brainiest, the nerdiest and the geeks. We need to open it up and say, "Whether or not you are a scientist and whether or not you have training in science, engineering or any of the other STEM fields, you should be able to have access to science and critique it, challenge it, enjoy it and champion it—all those things."

We have a barrier to connection with science that does not exist in other fields. In areas like art, music, politics or sport, it is not seen that only the professional classes have a right to access, yet sometimes we feel that with science, if you do not have a degree in science at bachelor's level, you do not have a right to get involved. This Committee is a fantastic example of the fact that you do not need to be a scientist to enjoy science and access and critique it. Katherine, do you want to say a bit about the CREST programme?

Katherine Mathieson: We run a programme called CREST awards, which gives young people an opportunity to do their own science research and technology projects. Over 30,000 11 to 19-year-olds take part every year. We find that it really changes their perception, not only of what science is like, but of their own potential identity as a scientist, which backs up the findings of Louise and her colleagues.

A couple of years ago, we did a fairly light-touch evaluation and got students to draw a picture of a scientist before they started. They all drew Einstein; they drew a white male with crazy hair. Afterwards, they drew all kinds of people—people like themselves, people they had seen around them and people they had worked with to do their own research projects. There is a very powerful effect of enabling students to participate in real science

that leads them to change their attitudes to what scientists are like and how they could connect to science, either as a scientist or just by having a lifelong engagement with science in some other way.

Q89 Chair: It is very interesting that the perception in an 11 to 14-year-old's mind of what a scientist is like is still Einstein. We have not updated. We hear a lot about the need to have young female scientists in the media to change the perception among young people—or perhaps the public generally—of what a scientist is. Is this an evidence-based attitude-change mechanism, or do people just think that it will help?

Professor Archer: I do not think that we have definitive evidence on whether changing that would or would not help, but it is fairly clear from our evidence that there are still widespread stereotypes around who is a scientist. Depending on the methodology, people will give you different things. In our research, young people and their parents are very much aware of people like Brian Cox as scientists. There are noticeable efforts to shift some of those stereotypes, but the young people in our studies mention programmes like "The Big Bang Theory" a lot. Underneath it, there is still the idea that whether he is geeky or more trendy, or used to be in a band and has cool hair, scientists are still very brainy and are generally white, male and middle-class. There is still more that could be done to challenge that.

Exactly as Imran said, the key is not just changing who the figureheads are, but the real democratisation of science—the idea that anyone can have a voice in science. A sister study to our work, called Enterprising Science, has been working with schools and teachers to help young people see that you do not have to be a specialist. Anyone can engage with science, anyone can know about it and anyone can use science to improve their life. We are interested not just in positioning young people as consumers of science messages that come down from on high—not just telling them the science—but in letting them find ways to be the scientists and do the science themselves, in a broader range of ways.

Q90 Chair: If young people see scientists as Einstein and quite separated from themselves, both in terms of centuries and in terms of class and ethnicity, do they also see them as separated in terms of language? Are there specific words and phrases they identify scientists as—geeks, for example?

Professor Archer: We have done a lot of research in classrooms looking at the way in which students think you have to talk and behave to be seen as a good science student. There is very much the idea that doing science is associated with talking science, using very specific terminology. We are interested in how you can break that down a bit. That is not to say that you get rid of scientific concepts or any terminology per se. It is just that it can be more accessible. As the previous witnesses said, there are ways of making science more accessible and understandable that do not rely on lots of jargon and trying to convey a very abstract, elite notion of science that suggests that science is only about that sort of language.

Imran Khan: To pick up on the role models question, a bit of research done by the Wellcome Trust, last year or the year before, talked about the fact that, even if you are

getting 30-something exciting scientists and engineers from diverse backgrounds, if the people you are trying to influence are 12, 13 or 14-year-olds, it is probably still too late. You need to get people who are on the sorts of media that people of that age are using—not TV, not newspapers and not radio. They also need to be much closer in age to the kind of people you are trying to influence. That is not going to be a Nobel prize-winning scientist, or even someone who is on their first or second postdoc; it is going to be someone who is starting out on their career and still grappling with a lot of the same issues as the students. I am sure it cannot hurt to get more young female scientists on TV, for instance, but I do not think that that is the entire answer.

Professor Archer: There is also value in having people on TV, or wherever it is, who use science but are not scientists, to help reinforce the message that science is transferable and useful for any job. There are all sorts of skills in science—problem solving, handling data and observation—that are useful in any job. If we stop relying only on scientists to communicate science, that could be helpful, too.

Imran Khan: And breaking the link that says, "By studying science, you are setting yourself a career in science." That can be off-putting.

Q91 Chair: I want to pick up on David Shukman's concern when we raised this with the first panel. We said, "Carol's 17-year-old son is accessing his information on blogs, Twitter and social media platforms." David's response was, "Yes, but I am concerned that I cannot communicate gravitational waves in 140 characters. How do I make sure that I am not losing the depth of information that I need to communicate to get my information properly out there, in my attempt to overcome the fear and knowledge barrier and get into the mainstream?"

Imran Khan: It is not an easy question. I have a few responses to it. Yes, you might be trying to limit yourself to 140 characters, but over the course of a few days, you might be exchanging those 140 characters directly with the scientist who did the research. That is a level of depth that you might not get through traditional media.

The other link that I would make with the previous session is around how you communicate uncertainty and the idea that scientists can come into conflict with one another. The challenge that we have is that until perhaps 10 or 20 years ago, when the mainstream media could be almost a gatekeeper between science and the public, it was relatively straightforward to say, "Now that we have confirmed consensus on topic A or topic B, we can put that out there and tell the public that a certain compound is safe or not safe." Now that there is not that gatekeeping role—at least, not one that is robust among younger audiences—we have to be comfortable with the idea that people are going to hear about different scientific claims and hear directly from scientists.

That is actually an opportunity. It is an opportunity to say that we can have a generation of people who are more comfortable with the process and motivations behind science and the uncertainties that are always inherent in science. Rather than looking at a study and saying, "Red wine is good for you or bad for you," they will instantly be able to recognise that they should look at what is behind it—perhaps even the error bars—and understand the context of the research.

Q92 Chair: That requires us to teach sufficient critical engagement in our schools and on other platforms.

Imran Khan: Teaching, yes, but it is also about exposing people to the realities of science; Katherine mentioned CREST. The realities of science are not producing a shiny research paper, with absolutely no uncertainties in it. It is a messy, human subject, where people change their minds in the course of the research. My absolute favourite bit of coverage in science in the past few years was when we had the story about faster-than-light neutrinos. There was all that speculation about whether the neutrinos were travelling faster than the speed of light. The researchers had not got to the bottom of it by the time they wanted to go to the media, so they published it saying, "Maybe this is true." A week or two later, they found out that it was a faulty conclusion.

The truth is that that kind of stuff happens in science all the time. You come to a weird conclusion and find out what the real answer was, but normally the process happens behind closed doors. With the neutrino story, it happened in full view of the public. People got to see that perhaps scientists were saying, "What if Einstein was wrong? Would time travel be real?" There was a great story about Jim Al-Khalili saying that he would eat his shorts if it was true. That was an example of the public getting to see what really goes on in science behind the scenes—behind the curtain—and really enjoying and loving it. Although social media have their challenges, they allow that process to happen a lot more.

Chair: We experience that in politics a lot.

Q93 Carol Monaghan: Katherine, it is interesting that you talked about perceptions of who is a scientist. In my previous life I was a science teacher and when I had a new first-year class in front of me I would do the very exercise you talked about. It was amazing to be standing there as a female scientist—a physicist—and having them still draw the Einstein picture. Role models are one thing, but I suppose that media perceptions and the perceptions people have throughout life have to change. We spoke a bit about that with the previous panel. Anyway, I digress. Imran Khan, could you tell me a little about British science week and what it aims to achieve?

Imran Khan: Sure. I will put it into context by talking about the aims of the British Science Association, and our view that we want to promote science as a fundamental part of culture and society. When we say culture, we do not mean culture with a capital C—the high arts, literature and everything—but a set of activities and things we do in society, ranging from politics to commerce, science and everything else. Our view is that often science is seen as something just for scientists. That is a problem for a whole range of reasons, including the benefit of science itself.

We have a range of programmes and engagement in education and other areas to try to bridge the gap between science and the people we would like to have access to it but do not. British science week is our set of activities that say to people, "If you've never accessed science before, if science is one of those things that scares you or puts you off, here's your opportunity to get involved." We have a series of activities working with local community groups and schools, and through the media, launching big campaigns like citizen science projects where no experience whatsoever is required to take the first step

from being someone who is not receptive to science and not interested in it to at least being interested and receptive.

Katherine Mathieson: We have an audience model that classifies people based on their behaviours around science: people who engage with a lot of science and go to events and that sort of thing, people who don't, and people who work in science. We evaluate all our programmes by the degree to which they move people between those categories. If somebody has not previously been very active around science, do they go to more events? Do they watch more science on the telly? Do they take part in science in a way that is credible and feasible for their own lives?

Q94 Carol Monaghan: The Glasgow Science Centre is a wonderful resource. My children love to go there and will spend an entire day there. Their scientific knowledge does not necessarily increase throughout the day. They have a fabulous time, but is it fair to say that events like British science week or a science centre, or the Science Museum next door, attract a wider audience but dilute the science in order to do that?

Imran Khan: I do not know whether they dilute it, but if they do, is it much of a problem? I come back to Louise's work. If we are just focused on transmitting scientific knowledge, that is one aim, but we are doing more than that; we are trying to get people to be enthusiastic about science and feel that science is part of their identity, so that when they see scientific advances being made they are instantly curious about them.

We want people to be able to say when they go into their careers, whether or not they are scientists, "I can use that bit of scientific research in the business I am in," or "I can start a company based on that, even if I've not been a scientist myself." If the experience your kids are having at Glasgow Science Centre leaves them with a lifelong curiosity and interest in science, I would be quite relaxed with them perhaps not knowing the difference between the inner and outer mantle, or whatever particular bit of scientific knowledge they might encounter.

Q95 Carol Monaghan: My point is that they do not necessarily see it as any different from a day at the play-park. They go in, they play, they have a great time and they leave. How has science benefited there?

Professor Archer: There are theories of learning that suggest that play is a very important part of learning, and theories that suggest that before what you might call more formal or identifiable learning can take place you need engagement and a sense of identification and comfort with it. Therefore, particularly for some groups, what we see as play and fun can be important to allow later more formalised learning to take place.

Q96 Carol Monaghan: I am assuming that through British science week you hope to achieve something similar, in that you spark some sort of interest that may permeate to other fields.

Katherine Mathieson: That is exactly right. We hope that the people who take part in British science week will go on to take part in other kinds of activities, both formal

learning ones and others to do with public engagement. One of the things we do for science week is to run a series of grants for community and school organisations so that they can put on events during science week.

We get fantastic feedback from the organisers of those events. Perhaps they work for community organisations and do not normally do any science; they are a bit intimidated by it and do not think science is for them. We give them a fairly small amount of money—a few hundred pounds—and say, "Put on your first science event." They come back and say, "We saw the effect we could have on the people we work with regularly and we're going to do more science events." That is a positive result for us, because it is about getting science done in places where it is not normally done, as Louise said at the beginning.

Carol Monaghan: For the record, I should say that Glasgow Science Museum is brilliant and it is great at engaging young people in science.

Q97 Victoria Borwick: Can I take us back to cultural capital and science capital? How do you think we should be using it better? There has been discussion in the academic literature as to whether that is the right term, or a useful term. Do you have any views?

Professor Archer: The notion of science capital is a way of bringing together—holding—all the science-related resources you might have: your interest and understanding of science, whether you know people in science-related jobs, whether you do sciency stuff, like going to the Glasgow Science Centre at the weekend, and that sort of thing. Our research shows that the more science capital you have for children and young people, the more likely those students are to plan to continue with it in future and to see themselves as a science person, to have what we call a science identity. We think that is particularly powerful and important. In the Enterprising Science project, we have taken the idea of science capital and said, "What can we do on the ground?" We are working in schools, because that is where most young people are, and we think that will have the greatest potential impact at scale.

We have been working with teachers. They teach their regular curriculum, but they do it through what we call a science capital lens. We are not doing special lessons or taking them away from regular learning. They try to see where the lesson can connect to the different dimensions of science capital we have picked out in our other statistical analyses. We are also working predominantly with students in disadvantaged communities and schools, trying to connect the science they are learning in the curriculum with their personal lives. It is very contextualised, but it is trying to work with what students bring with them, so that everybody has something to contribute. They might be looking at molecules and gases, so they may relate it to what they cooked at home last night, or what they see in their everyday lives.

For a lot of the students we are particularly interested in—the ones who are furthest away from science—the teachers we have worked with during this academic year have found this very powerful. They report to us that students are saying more in class—the students who typically never have anything to say. Some of it is about breaking that down. You do not have to know the right answer. Everyone has something to contribute. It is shifting their attitudes to helping them see that science is everywhere in everyday life. If you talk to a scientist or someone with a science background, we know it is everywhere. We can

see it, but the majority of the population do not see it, so it is helping them to make those links and showing them that they can use science, they can become community science experts and it can help them now and in the future. It makes links to future careers.

Last week, I was in a class in an inner London school. A student put up his hand and said, "But sir, I want to be an actor in the future. Why is this science class any use to me?" The teacher turned it round by saying to the whole class, "For two minutes think about what we have learned this year that could be useful for an actor." They came up with about nine different things. They got really excited. For students who are a long way from science, that connection can be very powerful. Our teachers are very happy with it so far. They say that even for their year 10 bottom-set science, which is a difficult place to be at the best of times, it is engaging them better, so we are seeing some potential there.

Q98 Victoria Borwick: It sounds very encouraging. What about engaging with the wider public? We have heard that exciting things are going on in schools. Mr Khan, what about public engagement? How can we carry forward that enthusiasm?

Imran Khan: It is a very broad question. To start with, there are a number of reasons why you might want to do public engagement. We have talked about some of them, in terms of inspiring and educating young people with a view to getting them into a career in science, but there is a whole range of other reasons. We might just want them to be science-literate or science-comfortable members of the general public who can participate in a social debate about science. There is the idea that, in the same way that art, music and sport enrich us, science enriches us as well. There is the economic argument.

There is also the argument that it improves science, that science can be better when it is done through engagement with the public. That could be through getting better research questions; if scientists have to communicate with the public, it could make them better at communicating with each other. There is a whole set of motivations. Each has different methods by which we might try to make them come true. In the case of improving science and making science better, that type of public engagement might be through science, or it might be public dialogue between scientists and communities who may be affected by their research. If it is about policy decisions, that might call for a different type of public engagement. We could think about media engagement, including social media, as a variety of public engagement. There is a whole spectrum of different types of public engagement, and the outcome you are looking for will shape the work that takes place.

Katherine Mathieson: The science capital findings have been helpful to us in thinking about the way in which we do public engagement, and what its goals should be. It has helped us to rethink what should be the age of the young people we focus our attention on, and where we should be looking for outcomes in terms of people's identity or their behaviours around science, rather than just their knowledge of it. The work Louise and her colleagues are doing will continue to yield practical ways we can improve our work.

Q99 Victoria Borwick: We have heard what has been happening with children, but then they go home to lifestyles that may not understand. Possibly we are missing a trick there.

Katherine Mathieson: One of the things we have started to do for British science week in the past year is to focus more of our time and attention on events that take place in family settings. Families with quite young children will come to an event that is good for the children, but we also want it to be good for the grown-ups. Therefore, we want it to engage the older siblings and adults in that family setting, to encourage all of them to consider their own relationship with science, not just fun with sand and mortar for the children.

Victoria Borwick: Fortunately, we are in a constituency that I believe has the best scientific museums in the world.

Carol Monaghan: You have not been to Glasgow.

Chair: Or Oxford.

Q100 Victoria Borwick: That is why I am making this very partisan representation for Kensington this morning. Obviously, all the museums around here do quite a lot of science weeks. We heard about some of the evening events happening later on—for example, European evenings—not just for children but for families. We have Imperial, the Science Museum and the museum here. A fantastic amount is going on. How do you feel that contributes to the whole public engagement? Is it a good way of engaging children and families and keeping that interest, or is it better to say, "Forget all that open stuff; let's go back to teaching science in schools"?

Professor Archer: It has to be seen as part of an ecosystem and looked at in the round. No single sector or institution can do it all on their own. It is such a big and complex issue that it is vitally important we recognise the roles all the organisations can play. There is scope for better linking-up among the thousands of organisations working in the field. That is good because it is a huge problem; it needs diversity of mechanisms and formats. In one of our other projects, which is funded by the Wellcome Trust and the National Science Foundation, we are very interested in the notion of pathways. How do we construct pathways for youth, particularly for those who do not traditionally engage with STEM, between all the different provisions, linking across schools and out of school as well?

Imran Khan: One of the most exciting things that has been happening in this part of town, and indeed across the UK, has been the effort museums and other centres have been making to bring in people who would never have gone to that type of institution before. Here in Kensington there are the science lates and the natural history lates, which take place in this institution. They bring in a crowd of young people who are not necessarily even going for the science or the natural history, but by virtue of being in this space they have a fun time and are exposed to that. Another example of what happens here is the fantastic photography exhibitions. We had Otherworlds recently, and there is the wild life photographer of the year, which happens every year. That brings in a crowd of people who perhaps would not normally have high science capital but they come in and take part. You see that happening at science centres up and down the country.

Q101 Carol Monaghan: Should the Government be doing more to increase public engagement in policy making in areas that are critically dependent on the underlying science? I am thinking of health and environment.

Imran Khan: To be fair, the Government are already doing a huge amount. They have rightly been focusing on supporting the infrastructure of science engagement and leaving the engagement itself to either the scientists or the institutions closest to the action. Over the past few years, during a time of difficulty for public finances, I and other people in our sector are very grateful for the continuing support we have had.

When it comes to policy making, it is a tricky area. As was alluded to in the previous session, you get to a certain point where you can be perceived to be moving from communication engagement to lobbying. Anyone involved in it always has to be mindful of that. You often see best practice and the most exciting stuff—you touched on this in your previous session with NERC—in upstream engagement. At the moment we are doing a bit of work with Genomics England, for instance. Genomics England and the Department of Health more broadly, as well as people across the industry, see genomic medicine as a big thing coming down the track that will revolutionise healthcare and the way people see their own health and their own data. At the moment, it is not quite clear how that is going to play out. What they are doing with us and other actors is to ask about the questions people are asking about things like insurance and potential whole genome sequencing at birth. How can we get in there now and understand which policy levers we will have to pull, which things we will need to communicate and which things we will need to research over the next five years or so, to put in place a scheme to ensure that transition goes relatively smoothly? I think that is working really well.

Q102 Carol Monaghan: You talked earlier about citizen science projects. One that I was quite involved in while teaching was about the discovery of exoplanets. Suddenly, people all over the UK were finding exoplanets. It was a fabulous piece of public engagement. Could events like science week or science museums engage in debating science issues on the Government's policy-making agenda, or is there a risk that that would seem too closely linked to the Government?

Imran Khan: Could you give me an example of the kind of thing you are thinking of?

Q103 Carol Monaghan: If the Government are looking at GM crops, for example, can we have a public debate on GM crops actually feeding into Government policy making?

Imran Khan: Absolutely. I would love that to be the case. As was alluded to in the previous session, there is sometimes the feeling, "What would the public know? How can they take part in this debate?" All the evidence is that when you empower the public to take part in a debate, they often do so very intelligently. We touched on the example of the Human Fertilisation and Embryology Bill and the changes to the ethical and regulatory landscape around experiments on embryos.

When that was first mooted there was a yuck-factor response and the idea that scientists were playing God. Once we got into a debate with the public—the Human Fertilisation and Embryology Authority was a great example of an institution that engaged the public

on a very live policy issue—all sectors of society, from people who were affected by the research to religious groups who had a view, said, "Let's all talk about this together," and use it as a way to influence legislation going through the Houses of Parliament. That worked really well, and we ended up with legislation that by and large was accepted by most parts of society.

Q104 Carol Monaghan: Could that engagement be promoted by the science centres?

Katherine Mathieson: The short answer is that I think it can. The Government will always need to consult and have dialogue with public audiences about their own policy-making timetables. It is perfectly fine to work with other partners, such as science centres and science museums. A whole range of organisations can help to facilitate that dialogue. There is also a demand from the public to talk about policy issues that are not allied to a particular policy-making timetable. We have a network of volunteer branches across the UK that put on events for the public. They reached over 60,000 members of the public in the first three months of this year alone. They have events that are often in areas of science policy that the public are interested in, not things that are particularly attached to a piece of legislation but things that the public want to debate and discuss. There is a lot of latent demand for discussion of these kinds of topics.

Professor Archer: What we are really talking about is active citizenship, which is surely what we want from citizens. I would draw it back even further; it is also a key component of what science education should be about, so that we are producing young people who grow up to become adults who are able to take part in these sorts of debates.

Carol Monaghan: Just to give a little plug, part of the new Scottish curriculum talks about responsible citizens. That is one of the key pillars of our curriculum.

Chair: I thank all of you for the evidence you have given us. It has been very helpful, and our discussion on public engagement moves us very neatly to our final panel.

Examination of Witnesses

Witnesses: **Dr Matthew Hickman,** Programme Manager, Informal Science Learning, Wellcome Trust, and **Dr Stephen Webster,** Director, Science Communication Unit, Imperial College London, gave evidence.

Q105 Chair: Dr Webster and Dr Hickman, thank you very much for coming to give evidence today. I have seen you sitting there patiently listening to the evidence that came before you. We have had some star turns, so no pressure whatsoever, but we are expecting you to outperform them. You heard right at the end some discussion about public engagement. There has been discussion recently about review of the REF and the role public engagement plays within that. We have been talking mainly about families and primary and secondary school students until now, but what role do you think research councils could play in facilitating effective science communication? How well do you think the REF is doing? Do you think the councils are doing enough? Could they be doing more?

Dr Webster: Research councils can have a huge impact on science communication, partly through funding academic research into science communication and how audiences find projects. A lot of academic work is already being done, but that is an important part of the science communication sector, so it is something research councils can help with.

Research councils are terribly important for setting the culture of science within universities. What is it like to be a scientist? One of the things we might discuss a bit in this session is what it is like to be a scientist, and how easy is it to do science communication. We have talked a lot about the need to be communicative and about scientists getting involved. One of the things I am finding, coming up on the inside track, as it were, on science communication over the last three or four years, is scientists feeling especially busier and busier, locked into a hyper-cycle of pressure to publish.

In one sense, we are terrified out of our wits by the near-death experience of the research excellence framework, the White Paper coming up and an endless feeling that you have to compete. There is a belief that universities do best when they compete against one another. All of those are things that research councils, soon to become the research council, need to get to grips with, because the more we can lower the tone and calm down, the more communicative scientists are going to be. There are some very interesting contradictions about wanting scientists to communicate and, at the same time, wanting them to win. That would be my main point about research councils. Can you please think about research culture within your institutes, so that scientists are part of an edifying zone of work where talking to the public, and even talking to each other, is seen as normal?

Q106 Chair: That is an interesting point. Dr Hickman, do you think public engagement should be part of the measurement of the impact of the REF, or do you think it undermines the whole process?

Dr Hickman: Thank you for the opportunity to give evidence today. It is absolutely important that part of the REF should be a recognition of public engagement and what it adds to being a scientist. We have heard that it can improve the quality of science. For those on the receiving end of public engagement, it is important to be able to see the face of science, and not have a middle person in the way—recognising it in the REF and embedding it within our expectations of what it is to be a scientist. Not all scientists will be great communicators. I do not think we should be saying that everybody who does scientific research should also be putting out the message, but we should recognise that public engagement has myriad activities people can get involved in, whether public-facing or otherwise. For it to be recognised in the REF and embedded within it would be a good step.

Q107 Chair: The REF is being reviewed. We have TEF coming down the line, along with a number of other things in the White Paper. What recommendations would you have for science communication and public engagement within the different reforms that are in the pipeline? Where do you think improvements can be made?

Dr Webster: The REF can make a difference, and so can the TEF. It is good that scientists are beginning to feel that part of their professional identity could be science communication. To some extent, being a research scientist is quite a narrow professional,

highly specialised life, so it is very understandable that for some scientists—probably, as Matt says, not all—science communication can be part of what you do. It is important in terms of promotion and how the institutions see you that, if you are involved in science communication, it is valued. That is something the REF can make happen. It is happening within the REF. Every time we go through another cycle, it is broadening. How we judge the success of both science and scientists is probably being broadened, and that is a matter the REF can help with.

Dr Hickman: I would endorse that. Progression and recognition tend to be focused on academic output, and, sometimes, when individuals spend more time doing science communication, it may not be recognised as favourably within institutions as it could or should be.

Q108 Chair: Are there any risks or cons to having science communication within the mix and in the funding pool that goes to universities? Do you think that at any point it will be used to divert money away from research? Do you think people will fear that it diverts money from research? Do you think there will be any point at which it will trigger undesirable behaviour, such as scientists perhaps overselling work, using language that is inappropriate or trying to use public engagement tactics that are not appropriate? What are the possible scenarios that you think it would be a good idea for us to try to predict and circumvent?

Dr Webster: That is a very good question, because academics are very smart people and are very good at gaming the system. You might say we can think of all the good things about science communication, but we also might develop the seven deadly sins of science communication, of which vanity would be one.

Chair: I have a piece of paper.

Dr Webster: Arrogance would be another. You need common sense. We do not want science communication, which we see as such a rich, diverse and growing field, to become bureaucratised box-ticking; we do not want academics simply to say, "Okay, we'll do that as well." It requires a common-sense approach. It means you have to be very careful about suggesting it is compulsory, and you have to allow quite a lot of time for it to develop in an organic way. You want to be very careful about suggesting, especially to research scientists, "This is another thing you have to do in order to progress in your career." You want it to be something that helps your science as well.

There are many arguments that becoming communicative and allowing yourself to be interested in what different sorts of publics think about your work can inform your work and your research. There is lots of evidence about that; for example, in the clinical field, you will know that patient involvement in clinical trials is something many organisations are looking at—the Academy of Medical Sciences, for one. If you are a clinical scientist interested in transforming your research, talking to patients and finding out what they want from a research project—longer life, higher quality of life—can be a very important aspect of being with the public. You do not want to make it a one size fits all. You want to encourage universities to impact on their scientific identities a bit, but you do not want to managerialise it too much.

Q109 Chair: The art of communicating your science and research to your peers has always been part of the scientific learning process. Is the art of communicating science to the wider community becoming a greater part of the research process now, or are we not quite there yet?

Dr Webster: I have very contradictory views about that. I often meet PhD students who have been told when they go to a conference what they can and cannot talk about in terms of their work. There is a sense in which, on the one hand, scientists are being encouraged to talk to the public more, which suggests that science is becoming more communicative. There is more emphasis on dealing with the public in your work. There is also a sense in which science is becoming less communicative, because as it gets more involved in intellectual property, as it becomes more competitive and as getting grants becomes more difficult, sharing ideas becomes less obviously something you should do if you want to be successful. If you do not share ideas and talk to colleagues, you are getting less good at communication, and that will impact on how you feel about the public too. I see different trends at the moment in that regard.

Dr Hickman: I am optimistic that there is a culture shift. Doctoral training centres actively encourage new PhD students to do public engagement as part of their learning. If that is done at ground level, hopefully it will filter through increasingly as people progress through their careers, and it will become more embedded, which is a good thing.

Q110 Victoria Borwick: To carry on with the Chair's theme on communication, following on Dr Hickman's last point, how do we encourage scientists to be better at being effective communicators? Obviously, scientists have to talk to journalists and journalists have to communicate, so how do we develop or improve that?

Dr Hickman: The first observation is that there are many opportunities for public engagement. University scientists are not short of those opportunities, but often they may require support when they are beginning on that path, starting to do broader public engagement activity.

Most good universities these days will have a centre for public engagement, or something like that, which provides training and upskills their researchers to communicate clearly and think about the messages they want to convey. The Science Media Centre does an excellent job thinking of the specific audience of the media. There are many different publics. Schools are a very popular target audience for scientists to engage with, and many universities provide training for their scientists to think about how they can communicate and engage most effectively with different audiences.

Q111 Victoria Borwick: We had a debate earlier when the BBC was here about the lack of time devoted to each of the topics. How do you get something down to a digestible bite for a non-expert audience, while reducing complexity or not over-simplifying it? How does one use different media to engage with different audiences?

Dr Hickman: The use of different media is to be welcomed. It is important for science engagement to go to the audience and not expect the audience to come to them. If we know that the audience is using things like online media, it provides an opportunity to

leverage that media and think creatively about how to do it. One of the huge strengths of science communication in the UK is its diversity of practice and its richness.

Simon Singh obviously believes that science communicators should be the people in charge of the message. I would disagree. Scientists should be in charge of the message, but they should be supported by people who understand what good engagement and good communication look like. Those people are very creative, and they can support scientists to use the new media in exciting new ways to engage audiences effectively.

Q112 Victoria Borwick: As you have confirmed, there is training and a way of engaging. That is reassuring. Moving on to public engagement, we have academic engagement, behavioural engagement and ways of reaching out to people. This is all part of how we are going to make science more readily accessible. Obviously, we have cognitive engagement and nudges to change behaviours, to change the way people react to information and help them through a decision-making process. Would you like to talk about any of the other communication that you feel is useful or valuable, or ways we should be doing things?

Dr Webster: We have heard in both sessions about a wide range of ways when it comes to communication. I am suspicious about "nudge" because it seems very simplistic. There cannot be a single trick that will solve the problem of communication.

Q113 Victoria Borwick: What about changing behaviour?

Dr Webster: I think it is too simple, and it can, in effect, be dishonest, because what you are really trying to enable through science communication is a better relationship between science and society, if you can put them apart for a bit. I think the better relationship depends on honesty. The problem with nudge is that it can be looking for a trick in order to get something done. It is worth remembering when we talk about science communication that the word communication has the same root as community, commune and communal, suggesting that it is not trying to get something from here to there, or to get this done; it is something we are all in together. That is why we always talk about the huge range of social media and people trying many different things, whether it is in a pub or a science centre. I do not think one would want to restrict it, but nudge is an attempt to restrict it. It is a kind of fantasy that, if we can just find the right way of doing it, we will solve the climate change problem or the GM problem. It is never like that.

There was a very interesting comment by the Department for Business, Innovation and Skills in its 2010 report about widening participation. It said we should go where the audiences "naturally congregate". That might have meant schools, pubs, clubs or anything, but it is also a metaphor, isn't it, for trying to find out what people are already interested in? If they are interested in fracking, engage them on that issue; if they are interested in horses or bees, get involved in that. People are communicating science all the time already. What we need to do as science communicators is find out where it is happening and join in.

Q114 Victoria Borwick: People took health messages to football matches, didn't they, because that was where people were gathering and they might not be having a particularly healthy diet there?

Dr Webster: Yes.

Dr Hickman: Science communication should not be science advocacy. I absolutely endorse what Stephen said. It is about enabling people to have the discussion aware of all the issues and evidence on the table. There are useful points to employ behaviour change. For example, we are aware of the challenge in teaching science in primary schools and we are very much in favour of changing primary school teachers' behaviour to do more science and get that into the curriculum. It is already in the curriculum, but I am referring to its being taught. That is not to say we want to suggest to the public what they should be thinking and that they should think GM is okay, but "Here are the facts about GM. You are welcome to disagree with them."

Dr Webster: Can I give an example of that? Next week I am running a café scientifique on air pollution in City Academy, Hackney. Air pollution is a big issue in Hackney; there is a big road running through it. Parents there would not normally be thinking about science, but we will have an asthma and air pollution expert there, as well as parents and teachers. I think that going there physically is one way of approaching what you raise.

Q115 Victoria Borwick: Do you think there is evidence to show that public engagement on science matters makes a difference?

Dr Hickman: Which matters and makes a difference to what exactly?

Q116 Victoria Borwick: How people regard science, whether they take it seriously and whether it makes them change what they do as a result of that information, and have a greater understanding of how science affects all our lives. As you suggest, it is a broad question and I apologise for that, but the sense of public engagement is really what we are thinking about.

Dr Hickman: There is a growing evidence base around the fact that science engagement can impact on learning about science. Most of that evidence base comes from the US. It is something we are currently working on in the UK. We have a funding programme, alluded to earlier by Professor Archer, with the National Science Foundation based in the US, to build that evidence base. It is incredibly difficult to draw a straight line between interaction and outcome. It is unlikely that a two-hour visit even to this fantastic institution will lead to somebody choosing a scientific career. As Louise said, the notion of pathways and having a healthy ecosystem that can support public engagement and opportunities to engage with science in all sorts of different places seems to be where the evidence is heading.

Q117 Victoria Borwick: I have been quite encouraged this morning about education in schools. We have a teacher on our own panel. My concern is that when people take that into their broader lives, how do we get those who possibly have not previously engaged with science to think about why it might be important and relevant? As you say, at the point they

come to GCSEs, they say, "Do I want to go into science, engineering and technical subjects? Why is that a good idea?" My final question is about keeping up that momentum and engaging people who would not traditionally have thought about science in their general lives.

Dr Hickman: We have said it a few times. It is about going to them and being in communities. For example, we are currently working with the Prince's Trust to upskill staff competence. They themselves had a fairly negative view. That may be overstating it, but they were not keen on science. Their school experience of science had perhaps put them off. They did it because they had to, but at the end of the training we did, they were delighted and said, "We see that science does matter; it's enjoyable, engaging and we can do this," and it built their confidence. They are now going out and working with the young people they engage with.

Q118 Victoria Borwick: Do you think that helps people make their own decisions about sorting through the jargon? We heard this morning about the conflicts—different reporting of facts, fiction and nudge. In a way, people have to be able to make a value judgment. They can do that only from their own experience, and I think it is about making people understand what they are being told.

Dr Hickman: We are still evaluating that programme, or seeing how it affects the young people who are ultimately on the receiving end of it, but we are looking to build the evidence base around how it affects people's understanding and learning about science, and around what good science communication looks like.

Q119 Victoria Borwick: How will you judge its success?

Dr Hickman: We would have to look at what comes back to us. Part of the question we would put out to the community is: what does success look like? One of the priority areas of our funding looks at measurement of outcomes. It is a good question. It is one that we are aware of and it is one we would like an answer to ourselves.

Q120 Victoria Borwick: At the end of it, would you judge success as whether people could listen to both sides of a GM argument, or some other argument, and make a decision? Some other examples have been given this morning.

Dr Webster: Who would decide what success is? Your question raises a very interesting idea. When you do science communication in the way we have been getting at, which is quite local and responding to people's problems, how does that fit with the way we tend to see science, which is that it is one thing? We have talked about the method of science, and we know that scientists find it quite easy to be fairly unitary and say, "This is the answer." That comes naturally after a science education, whereas what you are raising is about how you judge a café scientifique.

In my work I hear it said quite a lot that science communication is partly about getting more scientists, or about encouraging people into science. Then I look at the figures and I begin to wonder how many scientists we actually want. For example, a 2010 figure from

the Royal Society was recently republished in 2014 by the Nuffield Council on Bioethics; 5% of PhD students get permanent academic work in the end. If we said that only 5% of trainee teachers become teachers, or only 5% of lawyer students become lawyers, we would be astonished, but it is very clear that scientific education does not produce scientists; it produces many other kinds of people.

Then the question is whether science education is good. Is it directed at producing scientists, or does the science people learn help them in their wider lives? Again, we have been going on about that. My experience of undergraduate and secondary science education—I was a school teacher—is that it is improving in some cases, but in many regards it is organised as though you are going to become a scientist. That is an issue, because you are not.

Chair: We are about to move on to informal learning. We heard in our first session from NERC that one of their criteria for success in the Boaty McBoatface competition was that many of the 24 million who engaged in it in the first place had carried on to learn about polar research later. Not everything has to be about formal learning.

Q121 Carol Monaghan: To follow straight on from Victoria's line of questioning, we have talked a lot this morning about informal learning and things like science museums, cafés scientifiques and the like. Has any evaluation or study been made of how these activities translate to either uptake or further engagement?

Dr Hickman: As I said, it is very difficult to draw the line between specific participation in an event or activity and subsequent uptake of a scientific career.

Q122 Carol Monaghan: For example, I am thinking of something as simple as an evaluation sheet that says, "Are you here for the first time, or have you been to several of these? Is this something you are now engaging with?"

Dr Hickman: Many evaluations would probably ask that sort of question. What the overall response would be, I am afraid I cannot tell you. We may be able to find out. The British Science Association has a collection of evaluation literature—the collective memory of the science communication sector—where evaluations can be deposited to explore those sorts of things. We have correlational evidence around activity and outcomes, but I would be cautious about ascribing cause at the moment.

Dr Webster: The Wellcome Trust insists when it funds public engagement work that there is a thorough evaluation and it is budgeted for from the beginning. The question is what you are evaluating. Supposing I go to the theatre, I do not want to fill out a questionnaire when I leave to find out how I have been changed, nor do I want to be asked in a year's time whether it made a difference. We are evaluated to bits. If it is a question of how science public engagement should be evaluated, what are we after? If we want to find out whether people are becoming scientists, that is one thing; if we want to find out whether you have learned, that is quite difficult, as Matt suggests, and it might kill the beast. It is like the Italian joke: can you fit four elephants into a Fiat Cinquecento? Yes, you can: two at the front and two at the back. But you are missing the point that the elephants are big and the car is small.

Q123 Carol Monaghan: Dr Webster, my next question is perhaps best directed to you. Informal science learning probably contrasts with a more traditional type of science learning that takes place in many schools, probably not all. Is there a way we can align the two approaches better? We are hitting them from different angles.

Dr Webster: Definitely. Your curriculum for excellence in Scotland is a good start. When you read the background material for that, it talks about a broad understanding of science and society. Also in there is the idea of talking, of oracy. As you know, I run a masters course. We train 50 students at Imperial College to become science communicators. The main thing that happens at the beginning is that they are allowed to talk. They all say, "We've never talked before. When you study your science degree, you are not talking." We know why; there is a lot to learn and all those facts are terrifying. It is improving. Lots of science departments are trying to get it right, but that would be the link. Can we make formal education in science less formal? Can we get children talking about science, about their mums and about illness in the family? Louise Archer mentioned some of that.

I was a school science teacher. It is difficult for a science teacher and for science faculty to be communicative in that way because you were never educated in that way yourself. If we can move towards a sense where science education is informal—a bit—the two fields will align and you will have more communicative people. I joke to my students that, if they had been educated properly, they would not need to do a masters in science communication; they would already have those skills.

Q124 Carol Monaghan: Glasgow Science Centre—another plug for it—has developed chunks of the curriculum that can tie in with schools, which then allows pupils to do some formal learning and then informal learning. Probably the experience they can get at the science centre will be far more exciting than what can be offered in the classroom. Is that something we should be looking at more widely across the UK, or is it already happening?

Dr Hickman: We published a review of informal science study in 2012. One of the things we identified was that schools were the gatekeepers for young people. Every young person is to be found in school at some point, and the informal science learning community, therefore, hugely values the opportunities schools offer in terms of accessing that audience. Schools are perhaps less aware of those opportunities than would be ideal.

Some schools will take advantage of it. Glasgow Science Centre will do a fantastic job of marketing to its local schools and they will take advantage of the opportunity to go and enrich. There is an interesting question about what that role is and whether it is simply to deliver the curriculum in a different setting, which is a perfectly fine thing to do—it will probably give students a different experience—or whether there is a more affective element to it, about normalising the science, putting it into context and putting a bit more flesh on the bone. Science in school can too often be a body of facts that is to be memorised and regurgitated specifically for an exam, rather than a more holistic view of it. I think that is where the informal science sector can add value.

Dr Webster: To get that kind of sensitivity to different people and groups, you need to relax the regime—in other words, the league tables, SATs, tests and university league tables. If you are very regimented, it is hard to deal with individual differences, with

groups and with change, because you are hammering away trying to deliver what has to be done for the bottom line. There is a sense in which the kind of managerialised education system we have cuts against what we are talking about. On the other hand, there are lots of examples of good practice where informal learning links up with schools. The Wellcome Trust funds plenty of scientific groups who go into schools and do good work.

Dr Hickman: We can see that. Key stage 4 is the most time-pressured period of a student's learning experience. Science centres struggle to access key stage 4 audiences more than any other. Post-16, there is a little more time to go outside. Key stage 2 is probably their biggest audience. Where accountability is so high, and there is so much pressure to deliver the curriculum, that is where schools become most inward-facing, for want of a better phrase.

Q125 Carol Monaghan: There should be a more relaxed curriculum, with more opportunity to explore areas of interest.

Dr Hickman: I would love to see that.

Carol Monaghan: Just like we have in Scotland.

Dr Webster: Exactly.

Q126 Chair: Dr Webster, when you opened, you raised a number of concerns about pressures especially on young scientists trying to establish their careers, in particular the pressure to publish. That is raised with the Committee on a fairly regular basis. Is there a way to maximise the value of publishing? We hear concerns about the way in which journals are really for a select audience; journals are for scientists. Do you think there would be value in journals producing maybe non-specialist publications that would disseminate some of the work for the general public? Would that be a way to make sure that the fruits of a young scientist's work are getting out to a wider audience? Are there routes to this?

Dr Webster: Yes, there are. The open science movement, which I am sure you have been following, suggests that scientists can put more material into journals, and journals have the space, because they are online and free, for a different sort of writing about this work. It is not easy to write well about science if you have been very specialist for a long time, but it is a skill that many scientists, perhaps many young ones, would enjoy. If journals can do that, it would be a good thing. Whether they can manage it is another question, but what you say is interesting.

There was a European meeting recently about open science. That meeting was piggy-backed on to a discussion about research integrity—about research culture. The link had been made that you can liberate your publishing milieu and make it quicker and more open, with open access for everybody, but if research culture is still very much locked into pressure to publish, fear about promotion and worry about grants, you can be as open as you like but it will not improve science communication.

Q127 Chair: What is your view, Dr Hickman?

Dr Hickman: As I am sure you are aware, Wellcome hugely supports open access. It is a requirement that any scientific research we fund is published open access. That in itself is a positive step. Regardless of the complexity of the original research publication, the democratisation of science is to be encouraged. It is an interesting idea; it is the capacity to translate something and make it accessible. The question for me would be: what is the specific value-add of doing it that way rather than going through the mainstream media? Why is it advantageous for the journal to be doing it, rather than providing a detailed press release that the media can pick up on?

Q128 Victoria Borwick: We listened earlier to what the Science Media Centre said. They choose the people they write about because they have been peer reviewed and they have reached a certain level of attainment and various other points. From what you have just said, it strikes me that there might be people who do not follow that particular route. Are we missing anything by focusing on the point that that is obviously where the pool of correct information lives, given what you have just said about open source research? In so many other fields, things are coming online digitally. We were fortunate enough to be at Google DeepMind a week ago. There are all sorts of strategic things coming along from all over the world. If we are getting our information only from the Science Media Centre, are we missing a trick?

Dr Webster: My unit did some research that informed the BBC Trust. We did a content analysis. One of the striking things was how many of the news stories the BBC was reporting came from press releases from institutions—between 60% and 70%. That is not a surprise, because journalists are very busy and universities are putting a lot of resource into sending out their stories. There is another question about whether that is public engagement, vanity or widening participation. It is all a bit mixed up, but to get in contact with other people you have to be able to look around and not just take what is coming out of the universities. That would probably involve science communicators being sufficiently relaxed to go and talk to the anti-fracking movement or patient groups. If you look around, you see a very broad church when you stop yourself looking at the professionalised communication channels.

Victoria Borwick: That is a very interesting point. It reminds us to be alert.

Chair: Thank you both very much. We have come to the end of our session. This has been fascinating for us, and very helpful in progressing our inquiry. This is the second of our evidence sessions, but not the last. We have another one coming up in a few weeks' time, and we are still open to written submissions. If anyone here would like to submit written evidence, or knows somebody they think could contribute to our inquiry, we would very much welcome that contribution. We have already had over 100 submissions, so we are going to have some fun wading through all that evidence and working out how to collate it into something that is an exemplar of science communication.

In closing, I repeat my thanks to the Natural History Museum for hosting us today, in particular Alex Burch and John Jackson, who have gone out of their way to make sure that this could happen. They have been extremely helpful to us. I re-emphasise the fact that the Science and Technology Committee shares the commitment of the witnesses who have spoken today. We, too, believe that science should not be niche; it should be mainstream and

accessible, not just for the public but for politicians like myself who are not scientists and need to understand it, because science underpins so many of the policy decisions we are making today. Before I close the session, I re-emphasise that nobody on this Committee is in any way qualified to give advice on cholesterol intake. With that, I close the session. Please enjoy your day.