IOP Institute of Physics

Submission to the House of Commons Science and Technology Select Committee inquiry on science communication

Introduction

1. The Institute of Physics (IOP) is a leading scientific society. We are a charitable organisation with a worldwide membership of more than 50,000, working together to advance physics education, research and application. We engage with policymakers and the general public to develop awareness and understanding of the value of physics and, through IOP Publishing, we are world leaders in professional scientific communications.

2. The IOP welcomes the opportunity to respond to the Committee's inquiry into science communication. Effective science communication and public engagement are of huge importance, enhancing both the public's ability to understand science and think analytically, and encouraging young people to become the scientists and innovators of the future.

3. The IOP undertakes a range of public engagement and science communication work towards these ends, through our activities in schools, with public lectures and through our policy work. The IOP through our education work focus on improving young people's progression in science and focus our outreach work more generally on building 'science capital' amongst the general population.

4. Through our education work, we run programmes such as the Stimulating Physics Network[1] and Improving Gender Balance[2] which aim to improve the progression of students in physics and counter gender biases by working with teachers in schools on communication and subject knowledge. Building on this work, we have investigated students' subject choice and engagement with science. In 2015, for example, we published *Opening Doors*[3], a good practice guide exploring methods to counter gender stereotyping in schools, based on previous reports including *It's Different for Girls*[4] and *Closing Doors*[5].

5. Our outreach work focuses on the key audiences of families, adults (especially parents) and the 'under-served'. Our work with the former two groups concerns improving the image and understanding of science within families, which may in turn increase the chances of that family exploring scientific careers for their children. Our work through projects such as 'physics in the field'[6] aims to reach such audiences by either approaching them in environments where they may not be expecting to engage with science, such as festivals and community events. We are also

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[1] Institute of Physics (IOP) - *Stimulating Physics Network*: *http*://www.iop.org/education/teacher/support/stimulating_physics/page_41515.html
[2] Institute of Physics (IOP) - *Improving Gender Balance*: http://www.iop.org/education/teacher/support/girls_physics/improving-gender-balance/page_63795.html
[3] Institute of Physics (IOP) - *Opening Doors* (2015): http://www.iop.org/publications/iop/2015/file_66429.pdf
[4] Institute of Physics (IOP) - *It's Different for Girls* (2012): https://www.iop.org/education/teacher/support/girls_physics/file_58196.pdf
[5] Institute of Physics (IOP) - *Closing Doors* (2013): http://www.iop.org/publications/iop/2013/file_62083.pdf
[6] Institute of Physics (IOP) - *Physics in the Field*: http://www.iop.org/activity/outreach/activity/page_39560.html

pioneering cross-disciplinary collaborations using arts, sport or heritage as a 'hook' by which to engage new audiences with physics. In so doing, we position physics not only as something that is studied in school or an area in which one can have a rewarding career, but also as part of our culture.

6. The main points we make in response to the inquiry are that:

    - There is a need for an integrated approach to science communication and public engagement across policy areas and all areas of work, in government, academia, and the media, in order to build science capital among families. Science should be seen as part of our culture every bit as much as sport and art.

    - Studies report that attitudes to science have, in general, become more positive over the past 30 years. However, though most people are 'positive' about science, they feel they lack a personal connection to or understanding of science.

    - There are significant differences in attitudes to science between ages, genders, and social grades. Those designing and performing science communication and public engagement activities should ensure they are aware of this in their work.

    - Problems in engaging young people are subject-specific, rather than for all STEM subjects equally. The challenges of low participation and progression, particularly for girls, affect physics, computing, engineering and maths (in varying degrees of intensity) more than other subjects.

    - Many students, depending on their background, consistently receive a number of negative messages which reinforce their decision to not pursue science. A long term strategy of engagement with young people, rather than one-off events, is needed to challenge perceptions and convince more students that they are welcome in the world of science.

    - Science currently enjoys a welcome high profile in the media – but broadcasters and science communication more generally should broaden the range of careers and individuals that are represented in science-related activities.

    - Science communication should avoid the primacy of experts in lab coats and promote the primacy of curiosity (and reasoning) and methods rather than knowledge. The transferable skills of studying STEM subjects should be emphasised.

    - The Government should support and promote efforts to capture better data on what does and does not work in public engagement, and ensure that those organisations which receive funding for public engagement work provide evidence and evaluation.

The trends in attitudes to science, and public engagement with science.

7. Science and science stories are frequently in the news, from the discoveries of gravitational waves and the Higgs boson to the landing of the Philae probe on a comet. Studies of public attitudes to science in the UK have revealed three common themes: attitudes to science have, in general, become more positive over the past 30 years; most people are positive about science (and specific subject areas) but most also feel a lack of personal connection or understanding themselves; and there are significant differences in attitudes between ages, genders, social grades. Regular

surveys include the *Public Attitudes to Science* survey (and its precursors)[7], commissioned by the Department of Business, Innovation and Skills (BIS) as well as surveys by organisations including the Wellcome Trust[8], NESTA[9], the Royal Society of Chemistry (RSC)[10] and the Institute of Physics (IOP)[11].

8. Most people have a positive view of science: 81 percent of people agreed that science will make people's lives easier and 55 percent think that the benefits of science outweigh any harmful effects.[12] In 2014, 72 percent of respondents think it important to know about science compared to just 57 percent in 1988. When it comes to specific areas of research, IOP research finds that 78 percent of people believe physics makes an important contribution to society and that 50 percent of people are interested in physics.[13] Interest and appreciation are similarly high in medical research and chemistry according to Wellcome Trust and RSC research.

9. Despite an appreciation of science, the public generally express a lack of understanding, a feeling of being uninformed and passive attitude when it comes to getting involved and engaging directly with science.[14] BIS find that 55 percent of people do not feel informed about science. RSC and IOP research also find that a large number of people have a lack of confidence, understanding or connection to chemistry and physics, despite a majority believing both make a positive contribution to society. This is perhaps summed up in the attitude that people are interested in science but that "it is not for me". [15]

10. Studies reveal significant differences in attitudes between ages, genders, social grades:

    - Across almost all studies, men tend to have a higher level of interest, or hold a more positive view of science and innovation than women. NESTA find that 44 percent of men were excited about new innovations compared to only 32 percent of women. Gendered differences are also found in attitudes to specific subjects. Whereas the IOP and RSC find more men interested in physics and chemistry, the Wellcome Trust find more women interested in medical research than men. NESTA ultimately finds that "men and women differ on the intrinsic value of innovation, with women tending to focus more

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[7] Department for Business, Innovation and Skills (BIS) - *Public Attitudes to Science 2014* (2014): https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/348830/bis-14-p111-public-attitudes-to-science-2014-main.pdf

[8] Wellcome Trust - *Wellcome Trust Monitor Report Wave 3* (2016): http://www.wellcome.ac.uk/stellent/groups/corporatesite/@msh_grants/documents/web_document/wtp060282.pdf

[9] NESTA - *Innovation Population* (2014): https://www.nesta.org.uk/sites/default/files/innovation_population_wv.pdf

[10] Royal Society of Chemistry - *Public attitudes to chemistry* (2015): http://www.rsc.org/globalassets/04-campaigning-outreach/campaigning/public-attitudes-to-chemistry/public-attitudes-to-chemistry-research-report.pdf?id=8495

[11] Institute of Physics (IOP) - *Public Perceptions of Physics* (2008): https://www.iop.org/publications/iop/2007/file_39534.pdf

[12] BIS (2014)

[13] 50 percent of those surveyed disagreed or strongly disagreed with the question "I am not interested in physics and don't see why I should be".

[14] BIS (2014), Wellcome Trust (2016)

[15] British Science Association - *'Science is not just for scientists' urge leaders of the British Science Association* (2016): http://www.britishscienceassociation.org/news/science-is-not-just-for-scientists

on the practical benefits of innovation, while men are more likely to be excited by new ideas regardless of concrete outcomes."

- People from higher social grades (ABC1) appear to be less resistant to the risk of change associated with science[16], feel more informed[17] and are more interested in science[18]. This effect is also found with regards to chemistry and physics in the RSC and IOP's research. NESTA even find that there are geographical differences in attitudes, particularly when it comes to the areas of science of highest interest to people – with Londoners in particular having a higher than average interest in science relating to communication, transport and space exploration.

- NESTA find large differences in attitudes to science between the youngest and oldest age groups, on areas such as their own ability to understand science and the pace of change associated with science. Notably, 52 percent of 18-34 year olds are excited about new innovations compared to 30 percent of over 55s.[19] This is important as it is in families that science capital[20] is best nurtured. If parents have a lack of understanding or interest in science, it is more likely that their children will share this attitude.

11. As such, those designing and performing science communication and public engagement activities should ensure that they review the existing research and are aware of the possible nuances that may influence different audiences and demographics in different ways to ensure they are most effective. To support this there is a need for an integrated approach to science communication and public engagement across policy areas and all areas of work, in politics, academia, the media and elsewhere, in order to build science capital among families. In physics for example, there is a need to target specific topics at specific audiences – such as using climate change, renewable energy, big data and digital skills (social media, apps, coding) as "useful hooks on which physicists' work can be hung" and "to emphasise potential benefits to individuals and/or society of physics research and how applications relate to everyday life".[21] There is a possible gender component here too, as BIS find that people are more likely to attend science-related and cultural activities with their mother than their father, suggesting a heighted role for women in families in science learning.

12. Science should be seen as part of our culture as much as sport and art. Existing interests, such as arts, heritage or sport can be used as an entry point for engaging families with lower science capital through interdisciplinary collaborations. BIS finds that 67 percent of people have undertaken a science-related leisure or cultural activity and the Wellcome Trust that 51 percent of the public have made a visit to a science-related attraction or event in the past twelve months. However, while 20 percent of adults visited a science museum or science centre in the last 12 months, 33 percent visited a history museum, and 30 percent visited an art gallery. The Government should ensure that science is not just confined to departments focusing on education and business and that it is instead integrated across all its work

[16] NESTA (2014)
[17] BIS (2014)
[18] Wellcome Trust (2016)
[19] NESTA (2014)
[20] Science capital refers to science-related qualifications, understanding, knowledge (about science and 'how it works'), interest and social contacts (e.g. knowing someone who works in a science-related job) (ASPIRES)
[21] IOP (2008)

wherever possible. This includes, for example, ensuring that public engagement with science and science activities are integrated into the implementation of the Government's culture white paper.[22]

The balance of effort needed to increase public engagement in science by 'new audiences' and by the 'already interested'.

13. The British Science Association (BSA), rather than looking at audiences as binary – 'already interested' or 'new audiences' - have developed a model which places audiences on a spectrum through the 'disinterested' (sic) to the 'engaged' and the 'expert' (see figure 1).[23] Most people will, rather than lying at one end, sit somewhere in the middle. This approach allows practitioners to see themselves as moving individuals through the spectrum through more and more engagement (or perhaps trying to stop them moving in the opposite direction). Both 'expert' and 'engaged' are considered as valid endpoints to this journey. Of course, there may be cause to add a further extreme to the left, for those who are actively resistant to science – those that NESTA calls "innovation sceptics". As such, the balance of effort should perhaps take more account of the complex relationship people will likely have with science and focus on building science capital across the board – understanding that young people and families will sit at different points on this spectrum and require different methods to move them along it.

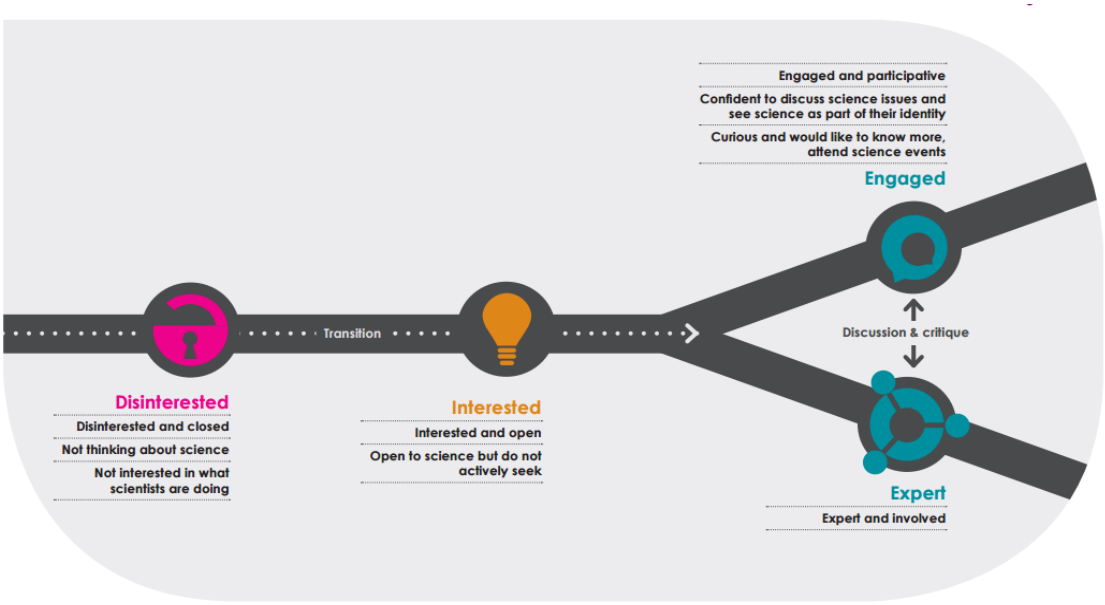

Figure 1

Any further steps needed by the media and broadcasters to improve the quality, accessibility and balance of their science coverage; and science coverage in broadcasters' programme-making.

14. Science, and physics in particular, is currently enjoying a high profile in the media - from extensive coverage of new discoveries to biopics of people like Alan Turing and

[22] Department of Culture, Media and Sport - *The Culture White Paper* (2016): https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/509942/DCMS_The_Culture_White_Paper__1_.pdf

[23] British Science Association (BSA) - *Our New Audience Map*: http://www.britishscienceassociation.org/News/new-audience-map

Stephen Hawking and the popularity of shows such as the Big Bang Theory. However, particularly but not exclusively in the broadcast media, much of this exposure is still perpetuating a white, male, "nerdy" stereotype. Also perpetuated is the idea that science is synonymous with scientists – and that scientists are clever people in white coats – rather than that science is part of a range of different careers and occupations. This image of physics and scientists is problematic. Although additional coverage of science in the media is itself to be welcomed, the continued communication of this image is likely to reinforce the idea for many individuals that science is inaccessible or not for them.

15. The media generally plays a huge role in the way that science is communicated and understood by the general public. Among young people, internet news sites, and social media, are increasingly used to receive information on science – with 55 percent of 16-24 year olds receiving such information online compared to 31 percent of all adults.[24] However, nearly 60 percent of people report television as one of their most regular source of information on science, and nearly a quarter cite print newspapers.[25] As such, it is concerning that that only 28 percent of people report that they believe what they read in science reporting is mostly or always true.[26]

16. There is a role for physics, physicists, and scientists more generally in increasing this public trust in science reporting; surveys suggest that nearly 60 percent of people want to hear from scientists.[27] However routes and recognition of public engagement and communication in science can be a challenge for scientists.

The communications strategies being taken to encourage young people to study STEM subjects in higher and further education, and to encourage those people towards STEM careers.

17. There is huge demand by employers for students with STEM skills. Estimates suggest 40,000 more STEM graduates are likely to be required every year to meet expected demand.[28] As such, there is a real need to ensure that more students are taking STEM subjects. However huge numbers of students continue to drop STEM subjects at the first opportunity, with a greater decrease in numbers in some demographics than others, particularly girls, students from lower socio-economic backgrounds and students from certain ethnic minority backgrounds. In many cases, the problem is an intersectional one, with individuals being members of more than one discrete and negatively affected group, increasing the challenges needing to be overcome.

18. The issues and barriers tend to be subject-specific, rather than for all STEM subjects equally. For girls in particular, the challenges of low participation and progression affect physics, computing, engineering and maths (in varying degrees of intensity) more than other subjects. In recent years, girls have made up the majority of students taking biology, psychology and chemistry, for example.[29] It is important to

[24] BIS (2014)
[25] BIS (2014)
[26] BIS (2014)
[27] BIS (2014)
[28] Social Market Foundation - *In the Balance: The STEM human capital crunch* (2013): http://www.smf.co.uk/wp-content/uploads/2013/03/Publication-In-The-Balance-The-STEM-human-capital-crunch.pdf
[29] JCQ data

make this distinction in any work to engage young people in science so as to best identify and focus efforts on where actual problems exist.

19. Many students, depending on their background and who they are, receive a number of negative messages which reinforce their decision to not pursue science. Some students receive the message that "science is not for you". This is reinforced in everything from the language that is used in the classroom[30] to the way that scientists and science is represented on television, to the kinds of people they see in positions of influence in science. Related to this is the often communicated message that "science is too hard" and that science is "perfect" – needing experts to understand it. Physics in particular suffers from a perception of being "too hard", and this message is unfortunately reinforced by the selection processes operated by some schools in which higher grades may often be needed to progress.[31]

20. Science communication needs to start early. Students' earliest years are very influential in shaping their impression of science and in building science capital. As such, it is important that primary school teachers are effective science communicators. Providers of initial teacher training should support primary teachers to enable them to be confident enough to include more technology and physical sciences content in their teaching in the classroom and in so doing become stronger advocates for STEM. Providers of initial teacher training and continuing professional development should facilitate unconscious bias training to enable teachers to avoid using language which may reinforce gender stereotypes.

21. A long term strategy of engagement with young people is needed to challenge perceptions and convince more students that they are welcome in the world of science. One-off events and activities are welcome but have limited influence on young people's decisions on their future. Programmes which emphasise continued engagement, and in particular look to help build science capital with teachers, parents and other influencers, are far more successful in changing aspirations than a focus on on-off visits and role models 'parachuted' into classrooms.[32] Evidence suggests that most students enjoy science in schools[33] but the issue is actually about identity; thus in engaging new audiences, we need to focus more on developing science capital.

22. There are different routes into science and different roles needed (for example, there is a huge undersupply of technicians[34]). Science communication should avoid the primacy of experts in lab coats and promote the primacy of curiosity (and reasoning) and methods rather than knowledge. The transferable skills of studying STEM subjects should be emphasised. Physics in particular is a sought after enabling subject in universities and beyond, and this should be a clear message to parents when helping their children make their subject choices. It is difficult for parents and young people to imagine physics-related careers, but in fact it is strongly physics-

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[30] IOP (2015)

[31] IOP analysis shows that there are more schools with no entrants for A-level physics who received below an A grade for GCSE physics than for many other subjects. Further discussion can be found here: http://www.iopblog.org/the-effects-of-grading-on-choice/

[32] Institute of Physics (IOP) - *Raising Aspirations in Physics* (2014): http://www.iop.org/publications/iop/2014/file_64466.pdf

[33] Wellcome Trust - *Exploring young people's views on science education* (2011): http://www.wellcome.ac.uk/stellent/groups/corporatesite/@msh_peda/documents/web_document/wtvm052732.pdf

[34] Engineering UK - *The state of engineering* (2015): http://www.engineeringuk.com/EngineeringUK2015/EngUK_Report_2015_Interactive.pdf

related sectors (e.g. computing, IT and engineering) which are growing, with more and more vacancies.[35]

The strategies and actions being taken by Government to foster public engagement and trust of science more widely, and high quality reporting of science in the media.

23. The Government does not currently have a strategy to support public engagement or promote better reporting of science in the media, though previous UK governments have produced strategies and advice.[36]

24. There is currently little data on best practice in public engagement and much evidence is gathered by inference and hearsay, with little monitoring and evaluation of projects. IOP research has found that longer term engagement with young people leads to greater impact on progression in STEM[37], but there is little longitudinal data with larger datasets to strengthen this finding. The UPMAP project has made a start at this.[38] In addition, subtly different strategies may be necessary to reach people from different backgrounds, demographics and geographies. There are increasing efforts to improve monitoring and evaluation, particularly of individual projects. For example, the National Forum for Public Engagement in STEM[39] is leading work to embed this across the sector to better identify outcomes and impacts appropriately. The Wellcome Trust have launched Science Learning+[40] detailing the impact of informal science learning. The BSA "Collective Memory" database of project evaluations, which seeks to "contribute to the collective memory of what works in public engagement with science"[41] is little used across the sector and is far from comprehensive.

25. Often, organisations running projects that start to show promising results quickly find that after initial funding, they are left to continue on their own, whereas new and innovative but often untried and untested schemes continue to receive initial funding. When projects are proving their effectiveness, this is not the time to cut them off and leave them to fend for themselves but to help them expand to better promote successful and sustainable public engagement initiatives. Moreover, there is often reluctance amongst grant-holders to admit to funders when outreach projects do not achieve the desired outcomes, much less share this publically. The Government should support and promote efforts such as the above to capture better data on what does and does not work in public engagement, and ensure that those organisations which receive funding for public engagement work provide evidence and evaluation. This information can then be pooled to inform best practice, and to decide which projects merit continued funding.

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[35] The Telegraph - *Here are the workers most in demand in the UK* (2015): http://www.telegraph.co.uk/finance/jobs/11602670/Here-are-the-workers-most-in-demand-in-the-UK.html

[36] Department for Innovation, Universities and Skills - *A vision for Science and Society* (2008): https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/36747/49-08-S_b.pdf

[37] IOP (2014)

[38] King's College London - *UPMAP (Understanding Participation rates in post-16 Mathematics and Physics)*: http://www.kcl.ac.uk/sspp/departments/education/research/cppr/Research/pastproj/TISME/Research-Projects/UPMAP.aspx

[39] National Co-ordinating Centre for Public Engagement - *National Form for Public Engagement in STEM*: http://www.publicengagement.ac.uk/work-with-us/current-projects/national-forum-public-engagement-stem

[40] Wellcome Trust - *Science Learning+*: http://www.wellcome.ac.uk/Funding/Public-engagement/Funding-schemes/Science-Learning/index.htm

[41] British Science Association (BSA) - *Collective Memory*: http://collectivememory.britishscienceassociation.org/

26. There is a need to explore how science communication and public engagement are recognised in academic circles. Science communication not only helps to enthuse a future generation of scientists, but also improve the communication skills of the scientists that facilitate such sessions. A majority of people think that scientists should be rewarded for performing science communication and public engagement.[42] And many scientists believe that science communication should be integrated into their jobs and not remain peripheral.[43] The European Commission's Science 2.0 consultation identified a need to "develop researcher reward schemes that reflect this (new) approach".[44] However, science communication is not recognised currently as an important and valuable use of academics' time, with surveys showing just over 10 percent agreeing that outreach is seen as a good for their career.[45] There is little accreditation and professionalization of science communication roles, or recognised career progression.

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[42] BIS (2014)

[43] People Science and Policy Ltd. - *Reward and Recognition of Public Engagement: Report for the Science for All Expert Group* (2009):
http://webarchive.nationalarchives.gov.uk/20120708131021/http://interactive.bis.gov.uk/scienceandsociety/site/all/files/2010/02/Reward-and-recognition-FINAL1.pdf

[44] European Commission - *Background Document: Public Consultation 'Science 2.0': Science in Transition*:
http://ec.europa.eu/research/consultations/science-2.0/background.pdf

[45] Illingworth, S.M.; Roop, H.A. - *Developing Key Skills as a Science Communicator: Case Studies of Two Scientist-Led Outreach Programmes*. (Geosciences 2015, 5, 2-14).