

Researchers: share your passion for science!

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The promotion of the public understanding of science has many positive impacts on society, including expanding the reach of science to a broader range of individuals and having a favourable impact on the economy. It also results in many benefits for researchers involved, including the development of their communication skills and improvement in the quality of their research. Despite increased awareness of the importance of public engagement (PE), the involvement of researchers has only slightly increased in the last 10 years. Time constraints, lack of opportunity and lack of funding are the main barriers preventing their participation. We propose that joining an existing PE programme can be a good way for scientists to overcome these barriers. We list specific examples of established activities that are easy for researchers to get involved in, allowing them to share their enthusiasm for science.

The need for more researchers to be involved in the public engagement in science

Public engagement (PE) in science by researchers is an important and worthwhile endeavour, providing a link between research institutions and the general public. PE benefits science, individuals, institutions, the economy and society in a myriad of ways, including strengthening the link between scientific research and the public, enriching the skill set of researchers, and leading to a scientifically informed society — one better equipped to democratically decide on science-based matters [1,2]. In addition, as the majority of research in the UK and Ireland is publically funded, there is a social responsibility on scientists to make an effort to engage with and inform the tax-paying public on their activities [2,3].

Despite the obvious benefits of PE in science to many different aspects of our society, and the fact that the majority of scientists acknowledge the moral duty of participating in PE activities [4,5], it is often difficult to convince scientists to take part. The comparison of a recent survey commissioned by a consortium of UK researchers (2015) with results of a Royal Society survey (2006) indicates that, although more researchers consider it important to find time for PE, the proportion of Science Technology Engineering and Mathematics (STEM) researchers involved has not increased much across this timespan [4,6].

Having members of the research community involved in PE activities could help overcome public trust deficits in science and scientists. Indeed, recent surveys found that only 52% of the UK population believes that what it hears about science is generally true [7] and, in Ireland, only 22% of people have ‘a lot’ of trust in the advice given by the scientific community [8]. In addition, just over a third of the UK public think that scientists adjust their findings as it suits them [7], indicating a lack of understanding in how scientists work.

However, despite half of people feeling uninformed about science [7–9], the public in both Ireland and the UK acknowledges the contributions that science gives to economy and culture, and agrees on its importance for economic growth as well as the future [7–10]. The UK public believes that science matters more than politics, arts or religion. Both publics state that they have an interest in science [4,8,9]. In addition, there is an obvious appetite to learn more about science and for more interaction with the scientists themselves. In the same 2014 UK Public Attitudes to Science survey [7], 58% of people feel scientists put too little effort into informing the public about their work and 68% would

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like scientists to spend more time discussing the social and ethical implications of their work with the general public. In Ireland, 71% of the population would like to see scientists listening more to what ordinary people think [8].

In the 2015 Wellcome Trust monitor survey [9], 63% of people stated that they were interested in hearing directly from scientists about the research they are conducting, with the top three areas of interest being ‘Latest findings from scientific research’, ‘Scientific research that is relevant to me’ and ‘How scientific research is done these days’. A large fraction of the interested public still values traditional media (television, newspapers and radio) as their preferred way of hearing from scientists. However, many forms of communication mentioned included hearing directly from scientists in both passive and active manners. These non-traditional ways of interaction included reading blogs or websites, attending (31%) and asking questions (14%) at a lecture/debate, attending a laboratory open day (19%) or a festival (14%) and connecting through social media (18%) or discussion forums (10%) [9].

The public benefits from meeting with scientists

It is clear that there is a public appetite for interactions with research scientists working in the field. The benefits of these interactions for the public go beyond a simple exchange of information about science topics.

First, meeting real scientists allows access to scientific role models, representatives of a career that many will not be familiar with, while making the public realise that researchers are real people who are accessible and similar to other adults. This is particularly important for younger groups to break stereotypes of science as ‘only for the brainy’, ‘not for girls’ or limited in career range [11]. Even short discussions between young people and scientists have been shown to alter the perceptions of scientists as ‘boring’ and ‘nerdy’ to ‘normal’ and ‘interesting’ [12]. Interactions with early-stage career scientists in particular, closer in age to children and teenagers, might inspire the next generation of scientists. Additionally, face-to-face communication between families and scientists at science festivals can develop a connection to locally occurring research [13] and educate on how local research benefits society.

Secondly, scientists are practitioners of a special evidence-based way of gathering information. PE that involves interaction between scientists and the public can facilitate understanding of how science works and how theories are proven using a scientific approach [14]. Likewise, PE at a dialogue level can allow for exchanges of cultures and thinking, allowing the scientist to understand how the public come to their own conclusions and what aspects of science are relevant to them [5]. Therefore, scientists are best placed to engage in this back and forth dialogue with the public about how science works, enabling citizens to apply scientific thinking to decision-making.

Thirdly, there is the credibility aspect of a scientist working in the field, who can provide authenticity and expertise on a specific subject when interacting with the public. This is evidenced by the public trusting scientists more than journalists to provide accurate information [7]. Moreover, the public values face-to-face engagement with expert scientists and being able to question practising scientists as opposed to being fed information [14,15].

Finally, and importantly, the enthusiasm and passion that a researcher has for his/her research subject will be apparent, helping persuade the public of its value. This is key to increased public participation, as has been seen in the science education field, where it has been established that teacher enthusiasm in the subject is a key factor in learning and engagement [16].

The many benefits of PE for researchers

PE in science by researchers not only benefits the public, it can also provide a wealth of benefits for the researchers themselves. These benefits contribute both to researchers’ professional and personal development. Such benefits, often overlooked by researchers, are well described and illustrated in several case studies published by Research Councils UK [17].

The most obvious gain from taking part in PE is the development of communication skills. Breaking down research into simple language that is understandable to a lay audience is a difficult task, but a vital one to master [18], and is increasingly important when applying for research funding (see below). Scientific communication is a learning process. Repeated engagement with a lay public will improve a researcher’s ability, leading to confidence in communicating with many types of audience, whether scientific peers, students, the media or the general public.

Communication skills often overlap with research skills and therefore, the development of these skills will impact on many aspects of a researcher's work, including grant application writing and communicating with research stakeholders or funders who might not always have scientific training [4,5,19,20].

Scientists involved in PE activities have also reported direct benefits to their own research through an increased understanding of the value of their research in a non-academic setting. Clarification of project thinking and viewing their research from a different perspective, often a broader perspective, can feed back positively on research design and aims [4,5].

A common theme in many studies that look at the motivation of scientists involved in PE is personal satisfaction and fulfilment. Scientists enjoy interacting and connecting with the public, and many report gaining a renewed sense of identity in their role as researchers [4,5,3,21].

At a certain level, being involved in PE can impact positively on a scientist's reputation. Being a good communicator, being mentioned in the media, and in some cases becoming the go-to specialist for media, can all impact positively on research and career enhancement [4,17,22]. However, this is balanced by many qualitative studies that suggest a negative impact of PE on career progression in institutions that lack recognition or reward of PE activities [5,21,23,24]. Nevertheless, researchers' participation will become increasingly rewarded by impacting either directly or indirectly on their scientific careers, since institutions and research funders are increasingly recognising the significance of PE.

Public engagement is becoming part of the researcher's role!

In fact, the idea of PE as an important and professional endeavour, part of the work of higher education and other research institutes, has strengthened since the early 2000s (Figure 1). In the UK, this culminated in the establishment of the National Coordinating Centre for Public Engagement (NCCPE) in 2008, the signing of the Concordat for Engaging the Public with Research in 2010 as well as the addition of impact agendas in the 2014 Research Excellence Framework and in the Research Councils UK funding bid requirements (Figure 1).

In Ireland, where research is predominantly conducted in higher education institutions, engagement goals have been integrated into the National Strategy for Higher Education to 2030 [25], and Irish education institutions have committed to civic and community engagement when signing the Campus Engage Charter [26] (Figure 1). Science Foundation Ireland, the national foundation for investment in scientific and engineering research, has dedicated funding to support one of its four primary objectives of having the most engaged and scientifically informed public globally [27] (Figure 1). Clearly, there is a shift towards PE becoming an integral part of higher education and research institutions' mandates.

As outlined above, universities, research institutes and funders have formally committed to PE, and researchers are now expected to engage with the public as part of their research duty. Many research funding applications in the UK and Ireland require a plan for public engagement activities, often as part of an impact statement, and agencies allow budgeting for such activities. In some cases, lay members of the public are part of the funding process. For example, Parkinson UK has grants reviewed by patients and carers [28] as well as scientists. At European level, Responsible Research and Innovation (RRI) is a 'cross-cutting' theme through Horizon 2020, the €80 billion research and innovation funding programme [29]. This theme aims for members of society to act together to generate better outcomes for society through engagement in research and innovation. The importance of this theme for European funding illustrates the current evolution of PE in science from dialogue model towards the participatory model. In this model, different actors of society, including citizens and researchers, fully engage in science as collaborators and contributors (Figure 1). This transition will impact both directly and indirectly on the way scientists perform their research work. It also strongly suggests that PE activity will soon become a valued benchmarking criterion for grant attribution and career promotion [30].

Indeed, many have called for this further commitment from institutions to incentivise PE by providing a clear framework that acknowledges education and engagement activities, in addition to providing training structures for such activities [3,4]. Providing concrete initiatives such as the definition of Key Performance Indicators related to education and engagement activities, the use of these indicators for career promotion, financial commitment and providing PE training to researchers would allow wide scale improvements to PE in science. Currently, some initiatives and structures exist in many institutions, but others have yet to establish them.

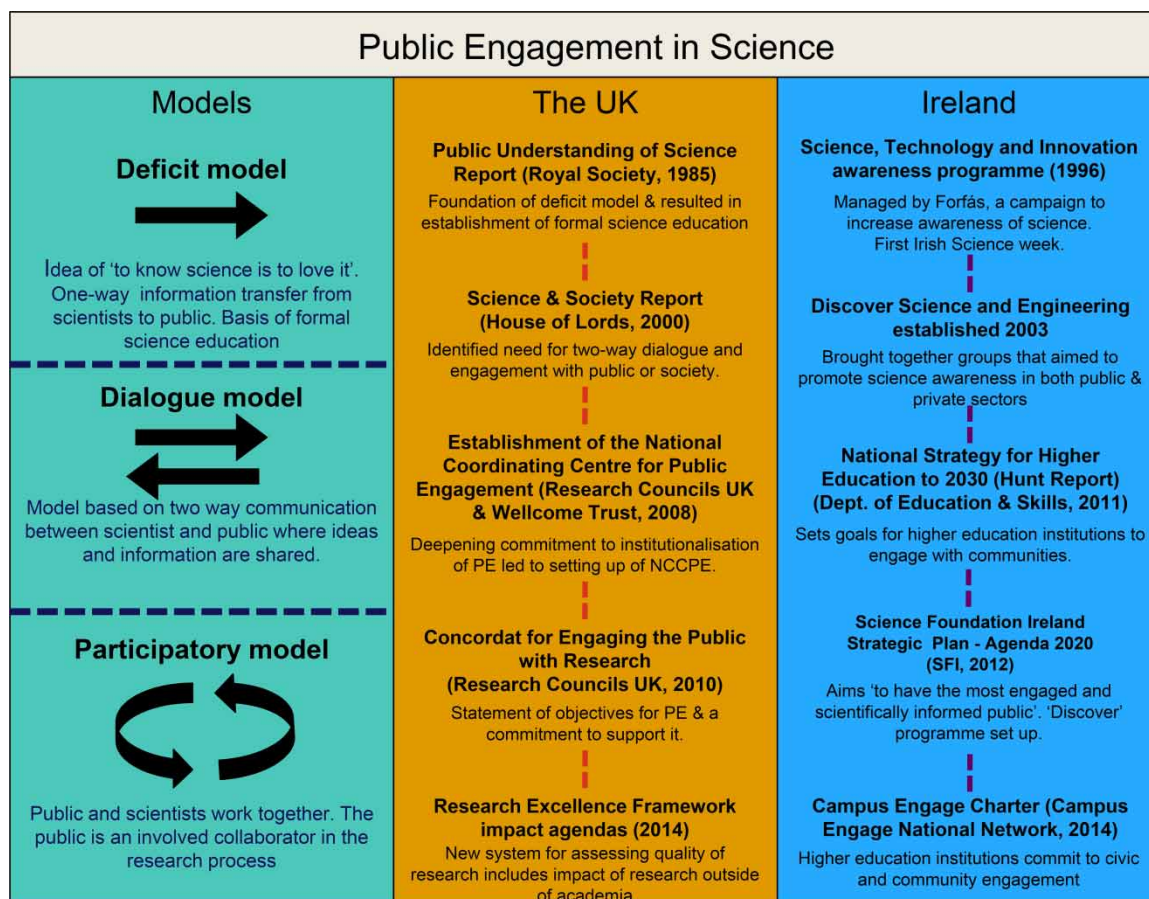


Figure 1. Models of public engagement (left panel) and history of public engagement the UK (middle panel) and recent development in Ireland (right panel).

The brief charting displays the transition from the original deficit model, which underpinned formal science education, to more recent definitions of, and commitments to, engagement as a process benefitting both scientists and the public.

How to overcome the barriers? Join existing activities!

Despite the clear benefit to researchers, the barriers that prevent them from engaging fully in PE are real and must not be underestimated. Researchers at different stages in their careers have all identified individual obstacles such as the lack of time, opportunity, funding and training as the main barriers preventing them from participating in PE [4,31]. Interestingly, these reasons largely overlap between established scientists and PhD students, reflecting scientists' preoccupation with their research and PE-related misconceptions. Institutional barriers such as a lack of recognition of the value of PE, and the idea that PE does not help career progression, as mentioned above, are also cited [4].

When starting out in PE in science, it is easy to be intimidated by the barriers to involvement. In reality, the three top PE blockers, lack of time, money and training, can be easily overcome by beginning with an established PE in science programme where researchers are not required to develop or organise events. Taking part in an existing PE activity can involve a minimal time investment, often includes training and requires little or no cost. This activity does not necessarily have to be on the specifics of the scientist's research field. This facilitates researchers who feel it is difficult to communicate their science which may be perceived as unappealing, complex or sensitive [4]. Confidence and ability in tackling these issues might come with better understanding of the public interest, experience and practice of PE.

Existing PE programmes typically only require researchers' time and enthusiasm and will generally not necessitate money. If funding is needed to run a specific activity, it is usually relatively inexpensive. Most grant

Table 1 Activities suitable to getting researchers started with public engagement in science

The research skills cultivated, as well benefits to researchers, aim of the activities and possible Irish and UK programmes to start with are indicated.

Research skills abbreviations: P, presenting; W, writing; T, teaching; O, organisation; PS, problem solving; EP, experimental planning; ID, interpreting data.

Activity	Research skills	Benefits	Aim	Examples of where to start
Careers talk	P	Communication skills	Talk about scientific careers Inspire young people in science	<ul style="list-style-type: none"> Smart Futures — IE: www.smartfutures.ie STEM Ambassadors — UK: www.stemnet.org.uk
Presenting to public	P	Communication skills Research clarity Idea exchange	Explain your research to general public Create dialogue about local research	<ul style="list-style-type: none"> Pint of Science: - IE: www.pintofscience.ie - UK: www.pintofscience.co.uk Café Scientifique — IE + UK: www.cafescientifique.org Bright Club — IE + UK: www.brightclub.org British Science Association connection website — UK: http://sciencelive.net
Science Outreach Competitions	P W PS	Communication skills Personal gains Professional recognition	Competition format used to enable outreach opportunities	<ul style="list-style-type: none"> Speaking: Famelab - IE: www.britishcouncil.ie/famelab - UK: http://www.cheltenhamfestivals.com/about/famelab/ Writing: Biochemical Society Communications competition www.biochemistry.org/getInvolved/sciencecommunicationcompetition.aspx Online, answering questions: 'I'm a Scientist get me out of here' - IE: www.imascientist.ie - UK: www.imascientist.org.uk/
Hosting school students	P O T	Rewarding Engage with local community	Students get a chance to experience science in a research laboratory Inspire the next generation of scientists	<ul style="list-style-type: none"> Nuffield Foundation — UK: http://www.nuffieldfoundation.org/nuffield-research-placements Check your institution for your local programme IE + UK
Science Week activities and regional science festivals	P T	Communication skills Idea exchange Research clarity Increase trust in your science Engage with local community	Engage families in research happening locally Inspire young people in science. Explain the scientific approach	<ul style="list-style-type: none"> Irish science week: www.science.ie Irish regional festivals: http://www.science.ie/events/festivals/ British science week: www.britishscienceweek.org British Science festivals: www.britishscienceassociation.org/uk-science-festivals-network-members
Hands on activities for school visits/ science festivals	T P O EP	Communication skills Sense of fulfilment Reinvigorate your research Engage with local community	Inspire young people in science. Provide science role models for children. Can start using existing kits/activities and then work towards developing your own. Spread the word about your science. Inspire the next generation of scientists	<ul style="list-style-type: none"> Royal Society of Biology 21st Century BioChallenges Activity Kits (loan out kits to use at exhibitions or in schools) — IE + UK: https://www.rsb.org.uk/get-involved/biology-for-all/activity-kits Royal Microscopy society kits — UK: http://www.rms.org.uk/discover-engage/microscope-activity-kits.html Under the Microscope — IE: www.microscopy.ie Cell EXPLORERS — IE: www.cellexplorers.com
	W	Communication skills	Explain about your area of research and the	<ul style="list-style-type: none"> Links to resources for getting started in science blogging: http://www.

Continued

Table 1 Continued

Activity	Research skills	Benefits	Aim	Examples of where to start
Blog, social media, email newsletter		Increase trust in your science	research work you do. Set up your own blog or join an existing network	theopennotebook.com/ science-blogging-essential-guide/resources/ <ul style="list-style-type: none"> View existing blogs: http://www.scienceseeker.org
Science competition judging	ID	Increase visibility of your science	Judge at local science fair or judge online competitions	<ul style="list-style-type: none"> Science video judging — ReelLIFE SCIENCE — IE: www.reellifescience.ie Contact your local science festival which may be looking for judges — IE + UK

providers expect their researchers to engage in PE and allow researchers to use a small portion of their funding to carry out simple activities. If this is not the case, most societies, professional associations and funder agencies offer opportunities to apply for outreach awards through separate calls. A fairly comprehensive list is available on the NCCPE website [32]. These small grants will allow the completion of a specific PE project and generally have a higher success rate than research grants.

Many existing PE programmes provide training that is aligned to their activities. In addition, many societies, funders or institutions run introductory training workshops in science communication or science outreach for researchers, including some dedicated to early-stage researchers (e.g. Biochemical Society, British Science Association, see Research Councils UK's 'Opportunities for Researchers' webpage [33]).

That 'Lack of opportunity' is cited as a barrier to PE is surprising since the main challenge for most science PE enablers is encouraging researchers to take part [4]. Scientists can take many actions to ensure they meet PE enablers:

- Investigate key national PE initiatives and contact regional outlets to get involved. Science festivals are a good place to start. National science weeks run in both the UK (March) and Ireland (November), and there may be local festivals or activities (Table 1).
- Find out when your institution is likely to be running events at national or local festivals and sign up.
- Find the PE section of your institution's website and get in touch to discuss the range of existing opportunities.
- Identify the PE section of funders or learned societies and learn more about opportunities offered to get involved (e.g. Biochemical Society [34]).
- Chat with a colleague you know has been involved and find out how you could join.

PE activities for getting started

There are many types of PE activities that will expose researchers to different kinds of public at different levels (Figure 2). Some of these do not involve face-to-face interaction between public and scientist. These can be passive, without questioning or discussion, for example a blog post or podcast. Alternatively, they can be active involving questioning or debating, such as online forum discussions. Face-to-face interactions as occur at science festivals or laboratory open days are most often active. It is recommended to start with the activity that best suits the personality and skillset of the scientists, as well as their schedule. Researchers who might feel intimidated by meeting with the public might want to start in a positive setting attended by enthusiastic children and parents such as at science festivals.

Table 1 outlines many established activities that are easy to get involved with. The main research skills that the activities develop as well as the key benefits to researchers are also listed along with examples of representative programmes based in the UK or in Ireland.



Figure 2. Researchers can engage in a diverse range of activities when starting with public engagement in science.

Clockwise from Top: *Research workshop at science festival.* Here botany and plant science researchers at NUI Galway talk to families about their work at a regional science festival. *Demonstration at a science festival.* An undergraduate science student demonstrates at a stall using hands on activities developed by Cell EXPLORERS to explain an aspect of neuroscience. *Judging School Video Competition (ReelLIFE SCIENCE Video Competition).* Cmdr Chris Hadfield, one of the guest judges, congratulates the winning class. Many research scientists were involved in shortlisting the videos through several rounds of judging. *Public speaking competition (FameLab Ireland).* PhD student Ivor Geoghegan explains his research to a large audience at the FameLab Galway heat. Pictures by Aengus McMahon Photography.

Joining an existing programme (Figure 2) will help to make a start in PE within established structures. Once scientists have identified what is needed to develop and run a successful event, they will be in a position to create one which is more specific to their own research. At this stage, ‘Science Communication — A practical

guide for scientists' by Laura Bowater and Kay Yeoman [35] is a highly recommended complete and practical guide.

Like training to be a scientist, achieving effective and rewarding PE involves a learning curve. It requires discovery of what you are most suited to and development of your skills. Like any new technique, it requires practice. What is important is that you take the first step and get involved.

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Competing Interests

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