



OPINION ARTICLE

REVISED **Aiming for long-term, objective-driven science communication in the UK [version 2; referees: 1 approved, 2 approved with reservations]**

Previously titled: Not Communicating science? Aiming for national impact

Andreas Prokop^{1*}, Sam Illingworth^{2*}

¹Faculty of Life Sciences, The University of Manchester, Manchester, M13 9PT, UK

²School of Research, Enterprise & Innovation, Manchester Metropolitan University, Manchester, M1 5GD, UK

* Equal contributors

v2 **First published:** 29 Jun 2016, 5:1540 (doi: [10.12688/f1000research.9079.1](https://doi.org/10.12688/f1000research.9079.1))
Latest published: 08 Dec 2016, 5:1540 (doi: [10.12688/f1000research.9079.2](https://doi.org/10.12688/f1000research.9079.2))

Abstract

Communicating science to wider lay audiences is an increasingly important part of a scientist's remit, and is something that many scientists are keen to embrace. However, based on surveys carried out amongst the UK public, as well as our own experiences in developing and delivering such activities, we believe that they are not always as effective at engaging members of the general public as they could be. In this opinion article we argue that in order to achieve more effective science communication, we need more objective-driven and long-term initiatives. As well as being implemented by the scientists themselves, funding organisations can play an important role in helping to drive such initiatives, and we suggest a list of actionable items that might allow for some of these ideas to be implemented.

Open Peer Review

Referee Status: ✓ ? ?

	Invited Referees		
	1	2	3
REVISED	✓	?	?
version 2	report	report	report
published 08 Dec 2016	↑	↑	↑
version 1	✗	✗	?
published 29 Jun 2016	report	report	report

1 Viviane Callier, Ronin Institute USA

2 Massimo Caine, University of Geneva Switzerland

3 Kathryn B. H. Clancy, University of Illinois USA

Discuss this article

Comments (0)

Corresponding authors: Andreas Prokop (Andreas.Prokop@manchester.ac.uk), Sam Illingworth (s.illingworth@mmu.ac.uk)

How to cite this article: Prokop A and Illingworth S. **Aiming for long-term, objective-driven science communication in the UK [version 2; referees: 1 approved, 2 approved with reservations]** *F1000Research* 2016, 5:1540 (doi: [10.12688/f1000research.9079.2](https://doi.org/10.12688/f1000research.9079.2))

Copyright: © 2016 Prokop A and Illingworth S. This is an open access article distributed under the terms of the [Creative Commons Attribution Licence](#), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Grant information: Science communication activities of AP are supported by the BBSRC (BB/M007553/1, BB/L000717/1). *The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.*

Competing interests: No competing interests were disclosed.

First published: 29 Jun 2016, 5:1540 (doi: [10.12688/f1000research.9079.1](https://doi.org/10.12688/f1000research.9079.1))

REVISED Amendments from Version 1

This version of the opinion piece has been substantially edited to make the message clearer that we are trying to communicate, i.e. the need for objective-driven, long-term science communication in the UK. We have streamlined these arguments, and present now more coherently the potential barriers to such a vision, as well as actionable suggestions for how to overcome them. We have also changed the structure and title of the paper to be more fitting to the content, and make it much clearer from the outset that this is an opinion piece and not a research article.

See referee reports

Potential shortcomings in UK engagement

The purpose of science communication is to “enhance public scientific awareness, understanding, literacy, and culture” (Burns *et al.*, 2003, pp. 198), and many funding bodies in the UK (and indeed worldwide) made it an obligation, over a decade ago, that researchers actively engage with lay audiences and communicate their research to them (see e.g. Holbrook, 2005). However, even a decade later, the ‘Public Attitudes to Science’ survey in the UK, conducted by Ipsos MORI on behalf of the British Science Association (Castell *et al.*, 2014), reported a clear shortfall amongst the general public in terms of science communication, with only 45% of respondents (n=1749, age >16) feeling aware of science in general and 51% stating they received too little information. Similarly, the ‘Factors affecting public engagement by researchers’ study by the Wellcome Trust (Hamlyn *et al.*, 2015) found that public engagement is more firmly embedded in the culture of the arts, humanities and social sciences than it is among researchers in Science, Technology, Engineering and Mathematics (STEM) - in spite of the fact that the majority of scientists are still keen to engage, with only 1% of STEM researchers (n=1556) stating that they would like to spend *less* time engaging with the public. The results of these surveys would seem to suggest that STEM researchers are not entirely successful at engaging the public with their research.

Here we argue for a need to re-think the ways in which we communicate science; that we require a long-term and objective-driven vision, and that support is required to ensure that initiatives incorporating such a vision, and the people who drive them, are given the opportunity to succeed.

Why engage long-term and with clear objectives?

How long-term strategies and clear objective-setting can lead to impact is nicely illustrated by a number of exceptional initiatives of science communication. For example, *Zoouniverse* is a long-term initiative encompassing numerous citizen science projects, and thus providing opportunities for non-experts around the world to help to contribute towards real scientific discoveries (see e.g. Cox *et al.*, 2015). *EuroStemCell* (<http://www.eurostemcell.org>) began as a science communication initiative for a European research consortium, and has since developed into an independent hub communicating the importance and value of stem cell research, and its web resources have become a central point of reference for

the public and researchers alike. *Understanding Animal Research* (<http://www.understandinganimalresearch.org.uk>) is a multi-faceted science communication initiative promoting and improving the acceptance of animal use in research, engaging with a variety of audiences using bespoke communication methods. The *iBiology* project generates films that explain in simple terms how science is conducted, thereby promoting a wider excitement about modern biology and an understanding of the processes by which scientific discoveries are made (Goodwin, 2014). Finally, the *Manchester Fly Facility* promotes the use of fruit flies in the biomedical sciences through science fairs, YouTube videos, student training strategies, and a dedicated school programme developing biology lessons - with all of its resources made publicly and freely available (Patel & Prokop, 2015).

All of these examples represent long-term initiatives driven by an overarching vision or objective. As is evident from the success of these projects, such an approach offers a number of important advantages:

First, long-term strategies provide enough time to develop a broader range of activities (e.g. science fairs, art-science collaborations, engagement in schools, citizen science, development of online resources etc.) and, with it, a widening of potential audiences and impact (see e.g. Patel & Prokop, 2015; Silvertown, 2009).

Second, long-term initiatives allow for gradual and cumulative developments, including the generation of high-quality activities and resources. Once strategies and resources have been generated and shared online, they can develop their own dynamics (e.g. web resources being viewed by the public; shared strategies being applied by fellow scientists anywhere in the world) and save preparation time for future events, thereby making initiatives more impactful and sustainable.

Third, long-term strategies make it possible to incorporate interdisciplinary expertise. For example, artists can help to improve the appeal and interactivity of an activity, and social scientists or specialists in science communication can facilitate strategy improvement in a number of ways: by helping to advance beyond the “deficit model” of communication and engaging audiences via two-way dialogue (Bucchi, 2008), by advising on formative research to guide objective setting (Davies, 2008; Nisbet & Scheufele, 2009), and by assisting with frame-setting and media work (Bubela *et al.*, 2009). Furthermore, such specialists can contribute expertise in production and project management, marketing, audience dynamics, and target audience-specific strategies.

Fourth, long-term initiatives provide room for the implementation of effective evaluation strategies (Jensen, 2014), which should ideally go beyond simply the collection of basic metrics and demographics, and should also aim to monitor gradual developments over time. For example, if a science communication project has the clear objective of improving the knowledge of different climate change mitigation strategies in a local community, this specific knowledge can be measured at different stages of the project to evaluate success and progress.

Finally, long-term initiatives make it more likely that science communication will be of professional and personal benefit to the engaging scientists. It can enhance a professional profile within scientific communities and add to promotion portfolios. For young researchers, the additional skills in communication, teaching, project and people management can help to make them stand out from their contemporaries in terms of future grant and job applications (Illingworth & Roop, 2015), or offer fantastic opportunities to transcend the academic environment by developing important transferable skills, such as didactic qualities for future teachers, or experiences with production, press, marketing and audience dynamics for those wanting to work in the media.

Improving science communication: overcoming barriers

As can be seen from the above discussion, long-term and objective-driven science communication can have a wide-range of potential benefits for a variety of stakeholders (scientists, general public, interdisciplinary collaborators, etc.). However, successful implementation of such initiatives requires stamina, belief, dedication and time. This poses important individual barriers to scientists who are attempting to communicate their research, in particular the lack of time, but also issues of self-perception (i.e. status, competence) and attitude, such as the view that outreach is subsidiary to research and university teaching (Hamlyn *et al.*, 2015). We feel that there are a number of further barriers which stand in the way of long-term and objective-driven science communication and which cannot be overcome by individuals or smaller collectives themselves. We believe that important encouragement and support could come directly from policy and decision makers who ultimately determine the portfolio and direction of research in the UK, but in particular also from the various UK funding organisations, which are in a powerful position to drive such developments. We will outline some of the most important barriers to long-term and objective-driven science communication, and make a number of actionable suggestions via which to overcome them:

First, it is important to develop a culture where objective-driven, long-term science communication has a fair chance of receiving the necessary support, to not threaten the enormous time and effort already invested into those initiatives that have gone a good distance and maintain a clear vision and pathway towards further impact. It is treading a thin line keeping the funding between spectacular one-off events, newly developed projects or initiatives (as the breeding ground for creative innovation), as well as of long-term science communication initiatives. Many funders consider support of ongoing activities in their guidelines already, but it requires awareness and vigilance to maintain a productive balance that will foster a vibrant culture of science communication.

Second, developing a culture of objective-driven, long-term science communication initiatives requires wide-spread sharing of and training in best practice. Funding organisations could further facilitate the instalment of public engagement officers helping scientists develop more powerful science communication strategies and providing urgently needed training. It could also become a more widely used practice that professional science communicators join science funding committees - not only so that content and strategies of proposed science communication projects benefit from a more balanced view, but also to give

constructive feedback to applicants, advising them on more efficient communication strategies. Furthermore, an audit in the guise of the impact case studies from the UK's last Research Excellence Framework exercise (Illingworth & Roop, 2015) might be helpful to connect science communication activities and to assess which of the current science communication initiatives would most benefit from further funding.

Third, developing long-term initiatives requires an efficient dissemination of information, resources and strategies to specific target audiences and between scientists. However, the advent of the internet and social media has resulted in a flood of information that can make it surprisingly difficult to communicate and disseminate. Here, funders could help by using their dissemination means to raise awareness of good initiatives of science communication. Analogous to lobbying for open access (e.g. Harnad *et al.*, 2004), funders could also use their influence to change journal policies towards being more receptive to the publication of science communication articles - which is the perhaps most powerful way to reach fellow scientists, provides an important path towards professional reward and further justification for the public money invested into those initiatives.

Finally, one of the most substantial barriers to objective-driven, long-term science communication initiatives is a lack of external recognition and reward by local line managements (Andrews *et al.*, 2005; Ecklund *et al.*, 2012), which tend to operate under financial and political pressures that are driven by performance in research and higher education. Initiatives that may have started with great enthusiasm will eventually have to face a reality-check based on the criteria of promotion or recruitment committees. Despite the opportunities that science communication can create, involvement in science communication is often viewed by scientists to be more damaging to their careers than helpful, as found in the Wellcome survey: "research suggests that researchers and institutions remain uncertain about systems of rewards for public engagement" (Hamlyn *et al.*, 2015, pp. 5). In order to tackle this problem, funders could collaborate to drive the development of a national professional framework for science communication, which could guide funders, institutions and researchers towards implementation of best practice and effective local protocols - including also professional reward and recognition for public engagement as a crucial motivator. However, we note that such a framework should avoid stratification and aim to be inclusive of all levels in terms of science communication experience.

The idea of collaboration between funders is certainly not new. For example, the Concordat for Engaging the Public with Research contained a comprehensive list of desirable standards and practices (RCUK, 2010) and was signed by an impressive list of UK science funders. Unfortunately, it did not include a concrete implementation strategy that could have driven it to impact. Similarly, the Beacons for Public Engagement Initiative (2008 to 2012) was funded by the four UK Funding Councils, Research Councils UK and the Wellcome Trust. It gave rise to the National Co-ordinating Centre for Public Engagement (NCCPE) providing new resource and capacity for public engagement (Duncan & Manners, 2012); but the initiative did not lead to a long-term and effective harmonisation or alignment of public engagement strategies across the contributing organisations. These examples illustrate that serious

collaboration between funding organisations could be achieved, and this would enormously facilitate many of the aforementioned actionable items and promote common strategies and objectives for science communication. In an ideal world, this could go as far as setting up a common fund for science communication, which would be easier to shield from organisation-specific objectives and policies, thus facilitating the development of overarching funding models that set new standards for science communication nationwide.

Final thoughts

This article is an opinion piece, based on the experience of two long-standing but very different personal science communication histories and backgrounds. We recognised that there is an astonishing congruence in views and experiences, and were also strongly encouraged by the very positive comments from competent colleagues (see acknowledgements), and by the numerous in-depth discussions we had with them. We feel passionately about the need to improve standards and to instil a solid culture of science communication, and have discussed the enormous opportunities provided by long-term and objective-driven initiatives to this end. We have expressed our opinion that bottom-up implementation driven by scientists will only go so far. We need more support from funding bodies tailored towards overcoming barriers that stand in the way of desirable developments towards a solid culture of science communication where efforts can be aligned at all levels including scientists, local institutions, funding organisations and policy makers in the UK - and similar may be true also in other countries.

Independent bodies such as the British Science Association or the NCCPE could help as facilitators during this process, capitalising on experiences for example from the Beacons initiative. Perhaps even government involvement is required to guide the process,

building on the code of conduct by the Council for Science and Technology, which stated the need for scientists to communicate their research to the wider society (Poliakoff & Webb, 2007). Their implementation might be most effective at the institutional level, for example using compliance as a factor that impacts on funding allocations, as has been successfully used by the Athena SWAN charter to address gender equality (Donald *et al.*, 2011).

We hope that our thoughts provoke useful discussion about future ways forward and encourage those who already follow good practice to make themselves heard.

Competing interests

No competing interests were disclosed.

Grant information

Science communication activities of AP are supported by the BBSRC (BB/M007553/1, BB/L000717/1).

The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

Acknowledgement

We are grateful to Dame Nancy Rothwell and Matthew Cobb for helpful discussions in the preparation of this manuscript, and would also like to thank a number of expert colleagues for helpful comments: Robert Dingwall, Mhairi Stewart, Sujata Kundu, Sheena Cruickshank, Catarina Vicente, Clare Blackburn, Stuart Allen, Tim Harrison and, Kingsley Purdham.

References

- Andrews E, Weaver A, Hanley D, *et al.*: **Scientists and public outreach: Participation, motivations, and impediments.** *J Geosci Educ.* 2005; **53**(3): 281–293.
[Reference Source](#)
- Bubela T, Nisbet MC, Borchelt R, *et al.*: **Science communication reconsidered.** *Nat Biotechnol.* 2009; **27**(6): 514–518.
[PubMed Abstract](#) | [Publisher Full Text](#)
- Bucchi M: **Of deficits, deviations and dialogues: Theories of public communication of science.** *Handbook of public communication of science and technology.* 2008; 57–76.
[Reference Source](#)
- Burns TW, O'Connor DJ, Stockmayer SM: **Science communication: a contemporary definition.** *Public Underst Sci.* 2003; **12**(2): 183–202.
[Publisher Full Text](#)
- Castell S, Charlton A, Clemence M, *et al.*: **Public attitudes to science 2014.** London, Ipsos MORI Social Research Institute. 2014; 194.
[Reference Source](#)
- Cox J, Oh EY, Simmons B, *et al.*: **Defining and Measuring Success in Online Citizen Science: A Case Study of Zooniverse Projects.** *Comput Sci Eng.* 2015; **17**(4): 28–41.
[Publisher Full Text](#)
- Davies SR: **Constructing communication: Talking to scientists about talking to the public.** *Sci Commun.* 2008; **29**(4): 413–434.
[Publisher Full Text](#)
- Donald A, Harvey PH, McLean AR: **Athena SWAN awards: Bridging the gender gap in UK science.** *Nature.* 2011; **478**(7367): 36.
[PubMed Abstract](#) | [Publisher Full Text](#)
- Duncan S, Manners P: **Embedding Public Engagement within Higher Education: Lessons from the Beacons for Public Engagement in the United Kingdom.** *Higher Education and Civic Engagement.* Springer, 2012; 221–240.
[Publisher Full Text](#)
- Ecklund EH, James SA, Lincoln AE: **How academic biologists and physicists view science outreach.** *PLoS One.* 2012; **7**(5): e36240.
[PubMed Abstract](#) | [Publisher Full Text](#) | [Free Full Text](#)
- Goodwin SS: **iBiology: communicating the process of science.** *Mol Biol Cell.* 2014; **25**(15): 2217–2219.
[PubMed Abstract](#) | [Publisher Full Text](#) | [Free Full Text](#)
- Hamllyn B, Shanahan M, Lewis H, *et al.*: **Factors affecting public engagement by researchers. A study on behalf of a Consortium of UK public research funders.** 2015.
[Reference Source](#)
- Harnad S, Brody T, Valliãres F, *et al.*: **The access/impact problem and the green and gold roads to open access.** *Serials Rev.* 2004; **30**(4): 310–314.
[Publisher Full Text](#)
- Holbrook JB: **Assessing the science-society relation: The case of the US National Science Foundation's second merit review criterion.** *Technol Soc.* 2005; **27**(4): 437–451.
[Publisher Full Text](#)
- Illingworth S, Roop H: **Developing Key Skills as a Science Communicator: Case Studies of Two Scientist-Led Outreach Programmes.** *Geosciences.* 2015; **5**(1): 2–14.
[Publisher Full Text](#)
- Jensen E: **The problems with science communication evaluation.** *J Sci Commun.* 2014; **13**(1): CO4.
[Reference Source](#)

Nisbet MC, Scheufele DA: **What's next for science communication? Promising directions and lingering distractions.** *Am J Bot.* 2009; **96**(10): 1767–1778.

[PubMed Abstract](#) | [Publisher Full Text](#)

Patel S, Prokop A: **How to develop objective-driven comprehensive science outreach initiatives aiming at multiple audiences.** *BioRxiv.* 2015; 023838.

[Publisher Full Text](#)

Poliakoff E, Webb TL: **What factors predict scientists' intentions to participate**

in public engagement of science activities? *Sci Commun.* 2007; **29**(2): 242–263.

[Publisher Full Text](#)

RCUK: **Concordat for engaging the public with research.** Swindon, RCUK. 2010.

[Reference Source](#)

Silvertown J: **A new dawn for citizen science.** *Trends Ecol Evol.* 2009; **24**(9): 467–471.

[PubMed Abstract](#) | [Publisher Full Text](#)

Open Peer Review

Current Referee Status:   

Version 2

Referee Report 26 January 2017

doi:10.5256/f1000research.11083.r18348



Massimo Caine

Microbiology Unit, Department of Botany and Plant Biology, University of Geneva, Geneva, Switzerland

I have read the revised article.

The authors have expanded the manuscript from the comments previously raised and have proposed a new version indeed more focused on the issues that they wish to address.

However, I must say that, overall, I hardly find the spark of novelty that should lead the reader to take action based on what is presented. Personally, as interested reader and (ideally) a potential funder, I would have liked to better understand what have made successful the UK-example described (*e.g.* impact evaluation, audience deliverables) so to better frame the examples within the long-term/objective driven funding discussion (which is, in the end, the main objective of the current submission). Also, on a different but related note, reducing the description of the barriers to (i) stakeholders commitment and (ii) funds availability lacks to address some other quite important barriers that would have worth to be mentioned (*e.g.* government/political agenda, academic curricula, peers support etc.). This could have been expanded as well for the sake of discussion.

Given my hesitation concerning the above-mentioned issues, I am accepting the manuscript with reservation (and with apologies for the delay). This, to my understanding of the F1000 reviewing process, will make the article ready to be indexed.

I have read this submission. I believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Competing Interests: No competing interests were disclosed.

Referee Report 03 January 2017

doi:10.5256/f1000research.11083.r18349



Viviane Callier

Developmental Physiology, Ronin Institute, Montclair, NJ, USA

I have now read the revised article.

The revision is a significant improvement on the first version, in that the authors provide specific examples of science communication initiatives and have better organized the text.

The main message, if I understand it correctly, is that policy makers and science funders need to provide resources and the right incentives to support a strong culture of science communication. While true, I don't know that this idea is particularly novel -- and with funding agencies' budgets so constrained now, it's not clear to me whether they'll be sold on creating a special science communication fund.

The authors list several challenges of science communication related to resources and incentives, but don't really talk about the challenges inherent to science communication that would remain if such resources/incentives were available. I think this area might be a fruitful one to explore. For example:

1. Who is our audience, and how do we know when we've reached them? (Can you talk about challenges in measuring this, and propose ideas?)
2. What do we want them to *do* with the information being communicated? (Your article talks about "objective-driven" communication, but nowhere is it specified what the objectives or outcomes are!)
3. How do we measure whether the audience has received the message and done what we intended (e.g., was the objective accomplished)?

These are the central questions to me, and the really critical ones for any science communicator to clarify before embarking on a science communication project.

Although I did not find the piece to make novel points, I did find the article much improved on the first version, and because tomorrow is Christmas I am marking it approved.

I have read this submission. I believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.

Competing Interests: No competing interests were disclosed.

Referee Report 20 December 2016

doi:[10.5256/f1000research.11083.r18646](https://doi.org/10.5256/f1000research.11083.r18646)



Kathryn B. H. Clancy

Department of Anthropology, University of Illinois, Urbana, IL, USA

I have now read the revised article.

I'm still struggling to understand the importance of this opinion piece, and why it belongs in F1000. I am also still unclear on the purpose of telling this audience that long-term planning for science communication in the UK is important. I do happen to think these things are important, I'm not sure the authors are conveying these points in a way that will reach those who don't feel this way.

A few examples:

The authors name a number of “exceptional initiatives of science communication,” then state “All of these examples represent long-term initiatives driven by an overarching vision or objective. As is evident from the success of these projects, such an approach offers a number of important advantages.” But they list five initiatives, they don’t spend any time describing why these initiatives are exceptional or effective. Then, the “important advantages” they list next are startlingly obvious: e.g. that long-term planning allows for time to develop “a broader range of activities,” and “graduate and cumulative developments” of programming.

The authors identify some of the biggest barriers to science communication: a lack of a culture that supports it, and few incentives for scientists. But again, this isn’t novel so much as exactly the sort of thing science communicators discuss all the time. I also didn’t read the responses to these barriers as particularly novel, but again exactly the sorts of things we all bemoan all the time.

I have read this submission. I believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Competing Interests: No competing interests were disclosed.

Version 1

Referee Report 24 August 2016

doi:[10.5256/f1000research.9772.r15848](https://doi.org/10.5256/f1000research.9772.r15848)



Kathryn B. H. Clancy

Department of Anthropology, University of Illinois, Urbana, IL, USA

The opinions shared in this piece were undercited, vague, and not novel.

Title and abstract: The authors should consider a title that describes the take-home message of the article. They should also decide on one way of capitalizing the title (all or nothing).

Article content: The organization of this paper was not clear, and it also wasn’t clear what this opinion piece was intended to do. Was this written towards funding organizations, individual scientists? What are the actionable items that might allow for a funding organization to test out some of these ideas? A conceptual model or figure would have greatly helped clarify this.

Conclusions: The authors might get more traction by developing a more concrete conceptual model with testable hypotheses. This would also help them fund the work to show if their ideas would lead to improved science literacy among the general public.

I have read this submission. I believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Competing Interests: No competing interests were disclosed.

Author Response 18 Nov 2016

Andreas Prokop, The University of Manchester, UK

What have we changed in this version?

This version of the opinion piece has been substantially edited to make the message clearer that we are trying to communicate, i.e. the need for objective-driven, long-term science communication in the UK. We have streamlined these arguments, and present now more coherently the potential barriers to such a vision, as well as actionable suggestions for how to overcome them. We have also changed the structure and title of the paper to be more fitting to the content, and make it much clearer from the outset that this is an opinion piece and not a research article. Please, see our detailed responses below. We look forward to our further discussion.

Response to Reviewer 1

Title and abstract: The authors should consider a title that describes the take-home message of the article. They should also decide on one way of capitalizing the title (all or nothing).

- Thank you for your comments. We take your points regarding the title, and as such have modified it accordingly.

Article content: The organization of this paper was not clear, and it also wasn't clear what this opinion piece was intended to do. Was this written towards funding organizations, individual scientists? What are the actionable items that might allow for a funding organization to test out some of these ideas? A conceptual model or figure would have greatly helped clarify this.

Conclusions: The authors might get more traction by developing a more concrete conceptual model with testable hypotheses. This would also help them fund the work to show if their ideas would lead to improved science literacy among the general public.

The opinions shared in this piece were under cited, vague, and not novel.

- **Organisation and objective:** The paper has been edited so that it is now much clearer in terms of its objectives, and at your suggestion we have included a list of actionable items that we believe would be of benefit to funding organisations. In relation to a conceptual model with a testable hypothesis this is, in our view, not something that would sit well in an opinion piece. However, we now present some actionable items as potential solutions to overcoming the barriers that we present. In regards to the audience of this article, please, see the next bullet point.
- **Novelty and target audience:** This article is less aimed at academic science communicators than at STEM scientists who engage in science communication and at funding bodies that support STEM research. The aim is not to present novel ideas (although these thoughts will be novel to most STEM scientists working at the coal-face of science communication), but to alert to shortcomings and reinforce thinking about possible actionable ways in which to improve on this, many of which are being underused now or have been thought about but were never properly implemented (see last paragraph of section 3).
- **Citations and vagueness:** We believe that this version of the manuscript has addressed these issues. We are much clearer in the scope of the paper (identification of problem, context for why it exists, and potential solution(s)), and are also more rigorous in our use of referencing. We have now included a paragraph providing concrete examples of long-term

objective-driven initiatives. We also believe that some of the solutions that we propose are novel, and that this is now easier to see given the edit of the paper.

Competing Interests: none

Referee Report 09 August 2016

doi:[10.5256/f1000research.9772.r14993](https://doi.org/10.5256/f1000research.9772.r14993)



Massimo Caine

Microbiology Unit, Department of Botany and Plant Biology, University of Geneva, Geneva, Switzerland

This opinion article seeks to describe standards, barriers and possible initiatives that may be relevant for the development of science communication in the UK. Even if opinions concerning a certain topic (in this case science communication) may be very wide and call into consideration several aspects of the subject, I find that the manuscript lacks a clear focus, which, in turn, makes the flow of the text very hard to follow.

In particular, in the initial part of the manuscript, authors state that they “will discuss the current practice of science communication in the UK”. However, despite a very general description of the relevance of science communication practice for (i) policy making; (ii) education; (iii) scientific networking and (iv) professional development, there is a substantial lack of any description of experience, best practice, event or initiative that may have taken place in the UK. Again, when describing the several barriers that hamper a proper diffusion and development of science communication, the observations are rather general, superficial and seemingly not focused on the UK scenario (at least this is the perception I have as non-UK reader). Consequently, the suggestions on how to overcome such barriers are extremely hard to be contextualized within and they seem to me rather focused on funding agencies and their policies rather than on the good practice/development of science communication.

In light of that, despite the good will that authors put in place for the cause of science communication, I regret to say that I cannot recommend this opinion article to be indexed as it is.

I have read this submission. I believe that I have an appropriate level of expertise to state that I do not consider it to be of an acceptable scientific standard, for reasons outlined above.

Competing Interests: No competing interests were disclosed.

Author Response 18 Nov 2016

Andreas Prokop, The University of Manchester, UK

What have we changed in this version?

This version of the opinion piece has been substantially edited to make the message clearer that we are trying to communicate, i.e. the need for objective-driven, long-term science communication in the UK. We have streamlined these arguments, and present now more coherently the potential barriers to such a vision, as well as actionable suggestions for how to overcome them. We have also changed the structure and title of the paper to be more fitting to the content, and make it much clearer from the outset that this is an opinion piece and not a research article. Please, see our

detailed responses below. We look forward to our further discussion.

Response to Reviewer 2

This opinion article seeks to describe standards, barriers and possible initiatives that may be relevant for the development of science communication in the UK. Even if opinions concerning a certain topic (in this case science communication) may be very wide and call into consideration several aspects of the subject, I find that the manuscript lacks a clear focus, which, in turn, makes the flow of the text very hard to follow.

- Thank you for your comments. As explained in our response to Reviewer 1, we concede that the central thesis may not have come across clearly enough. We have now re-focused and edited the paper, and we hope that we make the main objective much clearer, i.e. that there is a problem (a lack of long-term, objective-led science communication), why this problem exists, and some suggested solutions for how we might best tackle this problem.

In particular, in the initial part of the manuscript, authors state that they “will discuss the current practice of science communication in the UK”. However, despite a very general description of the relevance of science communication practice for (i) policy making; (ii) education; (iii) scientific networking and (iv) professional development, there is a substantial lack of any description of experience, best practice, event or initiative that may have taken place in the UK.

- We agree that the statement about general practice did not match well with the material provided, and it has been removed. To provide concrete descriptions of good practice, we have added a whole paragraph on objective-driven long-term initiatives that are existing in the UK and beyond.

Again, when describing the several barriers that hamper a proper diffusion and development of science communication, the observations are rather general, superficial and seemingly not focused on the UK scenario (at least this is the perception I have as non-UK reader). Consequently, the suggestions on how to overcome such barriers are extremely hard to be contextualized within and they seem to me rather focused on funding agencies and their policies rather than on the good practice/development of science communication.

- To address the critique that comments and opinions that we expressed are too general and potentially over-reaching, we have tightened these up significantly and provide now a more rigorous justification for their inclusion. However, we have still chosen to focus on the role that funding agencies and their policies play, because we believe that they are in the best position to lower barriers and facilitate effective science communication.

Competing Interests: none

Referee Report 04 August 2016

doi:10.5256/f1000research.9772.r14992



**Viviane Callier**

Developmental Physiology, Ronin Institute, Montclair, NJ, USA

I found the article to be written in vague, abstract terms, making it difficult to extract any take-home message. The problem that was to be solved wasn't clearly articulated, nor was the proposed "solution" clear to me. I found the article to be a poor example of science communication.

I have read this submission. I believe that I have an appropriate level of expertise to state that I do not consider it to be of an acceptable scientific standard, for reasons outlined above.

Competing Interests: No competing interests were disclosed.

Author Response 18 Nov 2016

Andreas Prokop, The University of Manchester, UK

What have we changed in this version?

This version of the opinion piece has been substantially edited to make the message clearer that we are trying to communicate, i.e. the need for objective-driven, long-term science communication in the UK. We have streamlined these arguments, and present now more coherently the potential barriers to such a vision, as well as actionable suggestions for how to overcome them. We have also changed the structure and title of the paper to be more fitting to the content, and make it much clearer from the outset that this is an opinion piece and not a research article. Please, see our detailed responses below. We look forward to our further discussion.

Response to Reviewer 3

I found the article to be written in vague, abstract terms, making it difficult to extract any take-home message. The problem that was to be solved wasn't clearly articulated, nor was the proposed "solution" clear to me. I found the article to be a poor example of science communication.

- The brevity of this comment makes it difficult to respond to and engage with in a detailed manner. However, we take the point that there were aspects of the opinion piece that were vague, and have addressed this thoroughly, as was explained above. We hope that the new version of the article now clearly describes the problem and the potential solution(s).
- If this is not the case, then we would like to ask the reviewer to please be a little bit more constructive in their criticism, so that we can improve the manuscript further.

Competing Interests: none