



RESEARCH ARTICLE

What's in a Name? Exploring the Nomenclature of Science Communication in the UK [version 1; referees: 1 approved, 3 approved with reservations]

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This study, via a consideration of the literature, and a survey of science communicators, presents concise and workable definitions for science outreach, public engagement, widening participation, and knowledge exchange, in a UK context.

Sixty-six per cent of participants agreed that their definitions of outreach, public engagement, and widening participation aligned with those of their colleagues, whilst 64% felt that their personal definitions matched those of their institute. However, closer inspection of the open-ended questions found the respondents often differed in the use of the nomenclature. In particular, the respondents found it difficult to define knowledge exchange in this context.

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Introduction

Burns *et al.* (2003, pp. 183) define science communication as:

“...the use of appropriate skills, media, activities, and dialogue to produce one or more of the following personal responses to science (the AEIOU vowel analogy): Awareness, Enjoyment, Interest, Opinion-forming, and Understanding.”

This robust definition covers most aspects of communicating science to the public under a number of different guises. Where things start to get complicated is in the semantics regarding the different types of science communication, and in their appropriate use and classification.

Science communication is often analogously and interchangeably referred to as science outreach, public engagement, widening participation, and/or knowledge exchange, but what do these terms actually mean? As well as institutional biases towards the ‘correct use’ of these terminologies there exists personal nuances in terms of their interpretation, which oftentimes depend upon the role of the person in question and how they perceive science communication to fit into their research & teaching practices, and beyond.

It can be argued that these definitions are simply a matter of semantics, but with science communication becoming more prevalent in grant applications and income generation (see e.g. the Research Council UK’s ‘Pathway to Impact’ report [<http://www.rcuk.ac.uk/ke/impacts/>]), it is important for there to be consistency in what is a developing field. The advent of ‘Science 2.0’ (see e.g. Nattkemper, 2012) and what it entails is also an important driver behind having a clear and consistent nomenclature associated with science communication. Science 2.0 proposes a systemic change in the modus operandi of doing research and organising science, in which science communication will play a key part. With potentially large pots of money available in future grants, under specific terms and conditions, there needs to be a consistent terminology that can be drawn upon by the academic community and beyond.

According to the European Commission public consultation into Science 2.0 (<http://ec.europa.eu/research/consultations/science-2.0/background.pdf>), something else that requires careful consideration is “the need to develop researcher and researcher reward schemes that reflect this (new) approach”. With potential reward schemes attributed to science communication activities, as well the creation of new job positions to fill these roles, it is important for all concerned to ensure that the language used in science communication is consistent.

This study, therefore, begins by discussing some of the definitions for science outreach, public engagement, widening participation, and knowledge exchange in the UK, derived from the common usage of these terms in the literature, and from the experiences of the authors. It then compares these definitions with the results of a survey of practicing science communicators from across the UK, and comments on the similarities and differences between the two, before identifying some suggestions for future nomenclature definitions within the field.

Literature analysis

The term ‘science outreach’ has been commonplace in research literature since the early 1990s, at which time the number of research articles on science communication started to increase. Many of these early articles describe science outreach as a school/education-linked activity, whereby academics are engaging with different groups of people such as the general public, students and teachers (see e.g. Greenler *et al.*, 1993; Kelter *et al.*, 1992). The term science outreach, which included activities such as mentoring, tutoring, giving presentations, supporting teachers and involvement with after-school clubs and summer schools, continued to become synonymous with school-related activity in to the 2000s, (e.g. Andrews *et al.*, 2005; Krasny, 2005). Recently Ecklund *et al.* (2012) suggested that scientists involved in science outreach are often also engaged in some type of outreach involving school-aged children, demonstrating that the connection between school-related activity and science outreach remains strong.

Although much of the literature using the term ‘science outreach’ is based on work carried out in North America, this definition is similar to that used in the UK. Many organisations in the UK who fund science communication (e.g. Royal Society, Royal Society of Chemistry, Society of Biology, and the Wellcome Trust) use science outreach when explicitly discussing science communication with school children.

Although this link to school activity is present in the UK, there is some overlap with other commonly used science communication terms, in particular, public engagement; with some science communication practitioners using both terms together, e.g. schools outreach and public engagement.

In recent years there has been a shift from the deficit model of the ‘Public Understanding of Science’ towards a dialogue-based approach, which can be referred to as a ‘Public Engagement with Science and Technology’ (Schäfer, 2009, and references therein).

Public engagement can be thought of as a way to restore public trust in science, by developing a two-way dialogue between the general public and the scientific community (Wynne, 2006). Public engagement can foster global communication, enable shared experiences and methodology, standardize strategy, and generate shared viewpoints (Cohen *et al.*, 2008). Furthermore, it can be defined as a deliberative process, promoted in both academic and policy circles, as a potential means to build public trust in risk decisions and decision-makers (Petts, 2008). With regards to policy makers, public engagement can be viewed as both relevant and useful in a regulatory context (see e.g. O’Doherty & Hawkins, 2010), with the results of public discussions with scientists being a worthwhile process in scientific development (Jones, 2007).

Recent years have seen increasing encouragement by research institutions and funding bodies for scientists to actively engage with the public, who ultimately finance their work (Bowler *et al.*, 2012), and whilst many research institutions now have dedicated resources for public engagement activities, such activities are not yet considered essential (Neresini & Bucchi, 2011). It is also unclear as

to whether the institutional approach to public engagement is to focus on engaging with the public to promote their research and raise understanding, or if it is to open up a two-way dialogue in order to get their opinion on scientific research and protocol, especially in relation to potential political and ethical ‘hot potatoes’, e.g. geoengineering (Parkhill & Pidgeon, 2011) and nanotechnology (Jones, 2007).

The American National Centre for Media Engagement (<http://mediaengagedev.org/engagement/why-engage/difference-between-outreach-and-engagement>) defines outreach as “a mechanism for delivering value-added content”, whereas engagement means, “collaboratively addressing community concerns.” This would seem to be consistent with the UK-centric arguments that have been laid out above, i.e. that outreach is a means of educating the general public (in particular school children), whereas public engagement involves a two-way dialogue in which the general public can offer advice and opinions as to the current state of scientific research. This approach to defining public engagement as something different from outreach is corroborated by Holliman *et al.* (2009, pp. 56) who state that:

“There is a heterogeneous community of practice operating in the space between what can be characterized as deficit-informed ‘science outreach’—aimed primarily at increasing scientific literacy—and dialogue-informed ‘public engagement’ seeking to foster productive exchanges between scientists and other stakeholders (including members of the public).”

However, there still appears to be some uncertainty as to the difference between these approaches, and also to potential overlaps with regards to audiences; it is also unclear as to whether these definitions are consistent at an institutional level. As Rowe & Frewer (2005, pp. 251) remark:

“Imprecise definition of key terms in the ‘public participation’ domain have hindered the conduct of good research and militated against the development and implementation of effective participation practices.”

Widening Participation involves interventions targeted at social groups under-represented in Higher Education (HE), in order to encourage them to attend university. According to the Office of Fair Access (OFFA; <http://www.offa.org.uk/>) this includes:

- Students from disadvantaged backgrounds
- Students with disabilities
- Students from some ethnic minority backgrounds
- Care leavers
- Part-time and mature students

With graduates benefitting from higher levels skills, knowledge, and access to the networks that are necessary to find higher paid work, the affordances of higher education are clear. Assuming

disadvantaged social groups are afforded the same opportunities of access to employment through their university education, widening participation can help reduce social exclusion. It is not surprising, therefore, that the New Labour government largely reshaped the UK HE landscape in alignment with this ambition, with activity co-ordinated through Aimhigher, Lifelong Learning Networks, and the National Academy of Gifted and Talented Youth (see e.g. Frost, 2005).

However, the institutional landscape has since changed, with a greater onus now on the universities to independently deliver these objectives. In addition, university widening participation activity has come under greater scrutiny by the Higher Education Funding Council England (HEFCE), whereby universities opting to charge over £6k annual tuition fees, must also agree to Fair Access Agreements (McCaig & Adnett, 2009).

In practice, widening participation aligns with the Pipeline or Learner Pathway model (see e.g. Clewell & Villegas, 1999); involving interventions designed to raise awareness and expectations of HE at various points within a learner’s education. With the emphasis on social mobility, widening participation focuses largely on targeting younger students from disadvantaged backgrounds utilising quantitative measures of poverty and deprivation, for example, the Index of Multiple Deprivation (Deas *et al.*, 2003) and the eligibility for Free School Meals datasets.

In addition, widening participation can also be thought of as a consideration of the student lifecycle, beyond pre-entry and transition, to include university curriculum design, student support and employability. This follows concern that students from disadvantaged backgrounds perceive universities as ivory towers, i.e. places that are beyond their reach and are not for the likes of people like themselves (see e.g. Mangan *et al.*, 2010). It is important, therefore, to consider the impact of traditional university practices or institutional culture, not only on access, but also on the retention and progression of students from non-traditional backgrounds through HE.

Various conceptualisations of knowledge exchange have been in UK higher education discourse since the late 90s, when the Higher Education Reach Out to Business and Community (HEROBC) initially emerged. HEROBC was initially part of the so-called ‘third stream’ of funding, designed to sit alongside institutions’ teaching and research activities, and to provide funds for universities and colleges to pursue interactions with business and the wider community. At the time these interactions were exclusively centred on knowledge and/or technology transfer (rather than exchange), with the purpose of HEROBC being to develop the capacity and capability for knowledge transfer between Higher Education Institutions (HEIs) and other sectors. Typical activities that were funded through HEROBC included skills matching between university and business, and the provision of gateways to enable business to access university expertise and employability initiatives.

In 2001, HEROBC evolved into the Higher Education Innovation Fund (HEIF), which focussed on funding activities designed to increase the capability of universities “to respond to the needs

of business, especially in instances that would lead to identifiable economic benefits” (HEFCE, 2005, pp. 5) HEIF has since featured in four separate funding rounds, with explicit reference to knowledge exchange (rather than knowledge transfer) first emerging as a prominent part in December 2003 around the call for HEIF-2.

HEFCE, through the annual Higher Education Business and Community Interaction Survey (HEBCIS), now leads the categorisation of knowledge exchange activities. HEBCIS requires universities to report expenditure across various knowledge exchange categories including contract research, consultancy, CPD, business start-up, employability programmes etc. As university HEIF allocations are tied to levels of expenditure reported through HEBCIS, this exercise has been a big influence on what UK universities prioritise, resource and define in terms of knowledge exchange.

Despite the focus on expenditure, the important social, cultural and community role that universities play in wider society has not been entirely ignored. Influential voices have emerged around these concepts, most notably Professor David Watson (ex-Vice-Chancellor at Brighton University) who has been a champion of this societal agenda and the role that universities have to play within it, focusing on “civic and community” partnerships (Watson, 2007).

Watson’s conceptualisation of knowledge exchange is rooted in a more engaged ‘two-way’ relationship between universities and external partners that sets out a much broader notion of knowledge transfer and knowledge exchange. John Goddard, the emeritus Professor of Regional Development Studies at Newcastle University UK, has also commented on the positions of universities as powerful engines of local and regional economic growth (see e.g. Goddard, 2009).

The most recent HEFCE definition states knowledge exchange “refers to HEIs’ engagement with businesses, public and third sector services, the community and wider public” (<http://www.hefce.ac.uk/glossary/#letterK>). This adoption of a more explicit referencing of engagement within the knowledge exchange landscape has largely come about through a subtle yet important shift within funding council priorities prefaced, for example, within the Beacons for Public Engagement initiative (2008–2012) and leading towards the uptake of the impact agenda within the UK’s Research Excellence Framework.

Survey

In order to assess the current opinion relating to the definitions of outreach, public engagement, widening participation, and knowledge exchange in UK HEIs, a survey conducted in the UK asked participants to relate their experience of science communication and its nomenclature.

The survey was conducted using Bristol Online Surveys (<https://www.survey.bris.ac.uk/>), and comprised 8 questions delivered with a mixed-method approach (i.e. qualitative and quantitative questions). The focus was to evaluate the participant’s views on what constituted outreach, public engagement, widening participation,

and knowledge exchange. It also aimed to assess whether or not the participants felt as though their own opinions aligned with those of colleagues and their institution. A copy of the questionnaire is included as [Supplementary material](#).

The survey was advertised via email, social media accounts, and the ‘psci-comm’ mailing list hosted by JISCMAIL. This study was carried out according to the British Educational Research Association’s (BERA) ethical guidelines for educational research, with all of the data in this study fully anonymised.

Results & Discussion

Dataset 1. Answers to science communication questionnaire

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These are the responses to the questionnaire that was used in this study to assess practitioner’s definitions of nomenclature in relation to science communication.

In total, 47 people participated in the survey, and all but one of them stated that they currently participated in outreach, public engagement, or widening participation events at their institute or company. Of the actively involved participants, 44 were located solely in UK, one in the Netherlands, and one was based in both the Netherlands and the UK.

Figure 1 shows the results of the survey in relation to how the participant’s personal definitions differed from those of their colleagues and institutes/companies.

Sixty-six per cent of the participants agreed that their definitions of outreach, public engagement, and widening participation aligned with those of their colleagues, whilst 64% felt that their personal definitions matched those of their institute.

Only five of the participants felt as though the alignment of their definitions was different when comparing colleagues to institutes. Of these five, three of the participants felt as though their definitions matched those of their colleagues but not those of their institute, whilst two of the participants considered their definitions to be aligned with those of their institute, but not of their colleagues. These results suggest that in a still emergent field, the participants of this survey are likely to be the driving influence behind the definition of science communication at an institutional level.

It is also worth noting that whilst the majority of the participants felt as though their personal definitions of outreach, public engagement and widening participation matched those of their colleagues and institutes, there were approximately a third that did not feel as though this was the case. If the participants that took part in this survey represent a fair cross-section of people working in science outreach, public engagement, and widening participation across the UK then it is somewhat alarming that such a significant proportion of them feel as though the fundamental basis on which their work is founded lacks such clemency in its definitions.

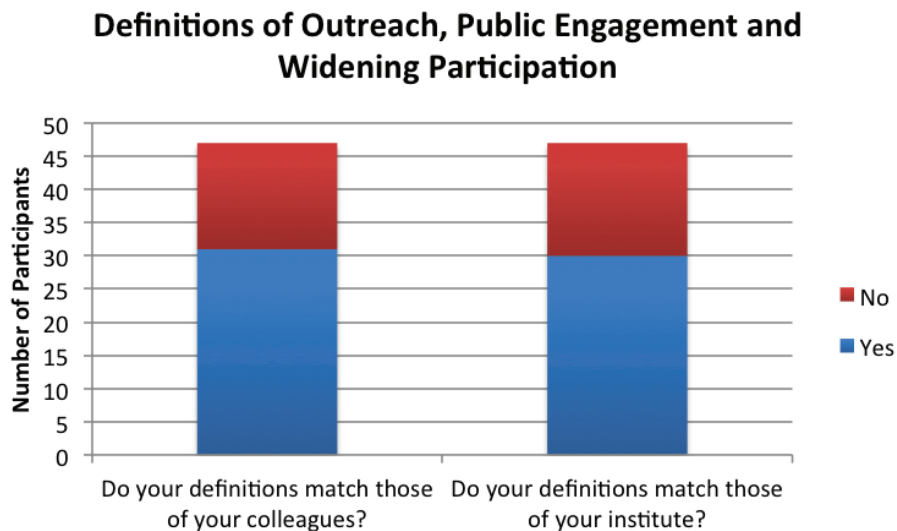


Figure 1. Stacked columns showing how participant's personal definitions differed from those of their colleagues and institutes/companies.

What is not clear from the above statistics is if there is any agreement between the participants' personal definitions of outreach, widening participation, and public engagement. As such, in addition to the questions regarding how the participants felt their definitions matched those of their colleagues and institutes, the survey also contained the following questions, which aimed to further explore how these different facets of science communication are defined in the UK:

- How would you define outreach?
- How would you define public engagement?
- How would you define widening participation?
- Respondents were also asked to define how knowledge exchange related to outreach, public engagement and widening participation

From the responses to these open-ended questions, word clouds were created, in which an image was composed of the words used, for which the size of each word indicates its frequency. These word clouds are shown in [Figure 2–Figure 5](#), all of which were produced using the web-based application Wordle (www.wordle.net). In the generation of these word clouds the key word(s) addressed in the question were removed, and all of the words were capitalised (so as to avoid repetition). For example, for the question concerning knowledge exchange, only the words 'knowledge' and 'exchange' were removed from the text used in the generation of the word cloud.

Regarding the responses to the definition of outreach ([Figure 2](#)), what is immediately noticeable is the frequency with which the word 'schools' is used. Nearly half (46%) of the respondents made a direct association between science outreach and school education, whereby it was the job of the academic/scientist to translate their research/knowledge into an activity that would ensure a student would understand, become engaged and hopefully inspire into considering science at a higher level.

One respondent stated it was not an act solely for school students, but generally for young people under the age of 20. Others noted that outreach takes place outside the university campus (in any location) or specifically targeted communities that are considered 'hard-to-reach', or generally disengaged from university education.

Interestingly, some respondents explicitly discussed the connection between outreach and public engagement. One respondent stated they believed outreach was "more educational than public engagement", whilst two respondents believed outreach to be a subsection to public engagement, but did not elaborate on how the terms were differentiated. One respondent suggested that outreach was "More one-way focused, having a scientist talk to a non-expert, not necessarily in a two-way conversation."

From the results of the survey, the largest collective response to the issue of defining public engagement was that it was a two-way dialogue used to share information between two distinct groups, with 18 of the participants referring to something that was 'two way' or involved a sharing of ideas, rather than a one-way discourse. This is evidenced by the prominence of the words 'two', 'way' and

[illegible]

Whilst the most popular participant response to the nature of public engagement involved some sort of two-way communication, it is interesting to note that this accounted for only ~38% of the

The analysis of the results from responses to definition of widening participation, encouragingly reveal a broad consensus. A vast majority (89%), for example, articulated in various ways that widening participation refers to broadening access to university to include a wider range of social groups, in particular, people from groups currently under-represented in higher education, as evidence by

the prominence of these terms in the word cloud shown in [Figure 4](#). That said, three respondents claimed to have not have heard of the term widening participation before, whereas two expressed a rather cynical perception that widening participation had become “hijacked by university recruitment agendas”, and another respondent referred to “the annoying habit of targeting minority groups.”

The survey reveals less clarity, however, in terms of identifying specific target groups (some respondents referred to one or more target groups):

- Twelve respondents simply referred to a universal target group e.g. society, the public or simply engaging more people.
- Nine referred to groups that were under-represented or hard-to-reach, but most were unable to provide specific examples. Only one respondent, for example, referred specifically to minority ethnic status, only one to gender, and another referred specifically to disability.
- Nine understood widening participation in terms of relating specifically to schools or younger people
- Eight referred to atypical social groups, i.e. groups who would not normally or traditionally attend university
- Six referred to groups experiencing some form of disadvantage
- Three understood widening participation targets in terms of targeting geographical areas
- There were no references to mature or adult learners from non-traditional backgrounds

A large number of responses refer to atypical social groups, people who express certain characteristics that appear to be defined against some notion of what constitutes a normal student, for example “those with different cultural attitudes and ideals.” This finding chimes with the concern that university staff continue to understand diversity in a way that reproduces the notion of universities as places for some normalized subject, defined against an atypical Other. Only one respondent, for instance, referred to widening participation in terms of curriculum support/design for widening participation of students already in HE.

In the survey, participants were asked how they felt knowledge exchange related to outreach, public engagement and widening participation, the results of which are shown in the word cloud in [Figure 5](#). What is immediately clear is that there is no consistent definition or understanding of knowledge exchange amongst respondents. There are instead a broad range of concepts, definitions and views of knowledge exchange in evidence.

Seventeen per cent of respondents admitted that they had not come across the term “knowledge exchange” before, with 19% identifying knowledge exchange as related to interactions between

universities and business partners, leading to increased economic activities. By far the largest number of respondents (36%) felt that knowledge exchange was related to all three activities including outreach, public engagement and widening participation, often conceptualising it as (in the words of one respondent) “an essential part as it allows external stakeholders to influence our activities but also allows us to share expertise.”

From the word cloud of these results, shown in [Figure 5](#), it is perhaps surprising that the word outreach is so dominant, given that the earlier definitions in the survey ([Figure 3](#)) generally reference outreach activities as those within schools rather than commercial or income-generating partnerships with business or industry. The prevalence of public engagement (and widening participation) in the participants’ responses is perhaps to be expected, given the relationship between the professional support for knowledge exchange and public engagement within most institutions. Given the more business-oriented nature of knowledge exchange that was laid out previously, it was perhaps surprising to see less use of words such as commercialisation, HEIF, business, and enterprise.

Conclusion

Perhaps the most noticeable result from this study is that the open-ended responses to the survey resulted in a wide range of definitions of outreach, public engagement, widening participation and knowledge exchange amongst the participants, despite the quantitative data indicating that two thirds felt that their definitions of outreach, knowledge exchange, and public engagement agreed with those of their colleagues. This would seem to indicate that further communication is required both within and between institutes to ensure a level of consistency amongst science communicators.

Based on the current literature, and the results of this study, the following broad definitions are offered for each of the four considered topics:

Outreach: a one-way discourse, in which scientists communicate their research to the general public.

Public Engagement: a two-way dialogue, in which scientists converse with members of the general public in a mutually beneficial manner.

Widening Participation: any activity that engages with social groups under-represented in HE, in order to encourage them to attend university.

Knowledge Exchange: any activity that involves engagement with businesses, public and third sector services, the community and the wider public, and which is monitored for funding purposes.

It is acknowledged that there is still some overlap between these definitions, for example a school assembly given by a university researcher at a local school might well be classed as being an outreach, widening participation, and knowledge exchange activity. In such instances it is important to consider the context of these classifications. In this example, the researcher’s faculty might classify the activity as outreach, the university’s widening participation

team (or equivalent) may catalogue it as a widening participation activity, and the knowledge exchange offices (or equivalent) could acknowledge it in their records for HEFCE.

It is important for science communicators to consider the context in which their activity takes place, because depending on its classification, the activity may be eligible for different amounts of funding from different areas of resource. This consideration of context is especially important when applying for external funding, where science communicators will be expected to outline the specific area(s) in which their activity can be categorised.

The main limitations of this survey were the sample size, and also the fact that the participants were mainly active science communicators. For future work, it would be conducive to pursue responses from active researchers who did not consider themselves science communicators.

The results of the survey also indicate that the respondents were less comfortable defining terminology around knowledge exchange than they were about outreach, public engagement and widening participation. The job titles and functions of respondents may be an important factor here, and further work is needed to confirm this. A future study is planned which also aims to assess how the different perceptions of science communication nomenclature would break down according to stakeholders. For example, the ways in which an academic, museum and learned society view these definitions might be very different. An international study, with a much larger target audience, is also required so as to assess differences in perceptions of the science communication lexicon between countries, both those traditionally associated with the field and those that are not.

It is also worth noting that no mention has been given to the effect of science communication on the researchers, i.e. the sector of the field that is concerned with improving the effectiveness and engagement of scientists in communicating their research to a variety of audiences. A future study would also aim to assess how this aspect of science communication fitted in with the external facets discussed above.

This study, via a consideration of the literature, and a survey of science communicators, has presented concise and workable definitions for outreach, public engagement, widening participation and knowledge exchange. However, as with all names it is important that the people using them feel comfortable with them, and also that there is at least some form of consistency within the field (and beyond) as to their usage. This consistency will only come about by communication both within and between institutions, and this study aims to act as a starting point for such conversations, with planned future work aiming to further explore the perceptions of science communication and its nomenclature amongst a much wider target audience.

Data availability

Dataset 1. **Answers to science communication questionnaire.** These are the responses to the questionnaire that was used in this study to assess practitioner's definitions of nomenclature in relation to science communication. <http://dx.doi.org/10.5256/f1000research.6858.d97179> (Illingworth *et al.*, 2015).

Author contributions

Conceived and designed the experiments: SI. Performed the experiments: SI. Analysed the data: SI, JR, SM, SG. Wrote the paper: SI, JR, SM, SG.

Competing interests

The authors declare that there are no competing interests, either financial or otherwise.

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Supplementary material

Science communication questionnaire.

[Click here to access the data.](#)

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Referee Report 19 August 2015

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Cornelia Lawson

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The article looks at a series of, perhaps, interchangeable terms used in the context of science communication and knowledge exchange and how they are understood by those working in academia. It provides an informative and brief literature review and concise definitions for each of the terms: outreach, public engagement, widening participation and knowledge exchange, and presents results of an original survey of science communicators.

The research question is important and timely as concepts of science communication and knowledge exchange merge and the impact agenda gains in importance in the UK and elsewhere. However, I have some mayor concerns regarding the empirical analysis. The sampling framework and the sample are not sufficiently described making it difficult to interpret the results. In particular, at several points the authors mention science communicators but do not specify whether these were the target population. They also make no estimate as to how many people were reached and which sectors they work in. It is therefore not clear whether the final sample can be considered representative (as is claimed in making use of the phrase 'fair cross-section').

The sample is very small and one is left wondering whether interviews with a similar number of respondents would not have enabled a better analysis and insights. The final sample also includes employees of universities and of companies but it is not clear how they are distributed and whether answers differ between the two. This is of importance as some of your conclusions seem to assume a homogeneous institutional environment, i.e an academic work environment. More over, we do not know whether respondents are academics, administrators, or professional science communicators. No collecting such information is a major flaw.

The use of word clouds to analyse your data strikes me as very odd. The word clouds add no information what so ever and I would suggest removing them. First of all because it can only highlight word frequency, which it does not do very accurately (e.g. it does not look for word stems), and because it does not allow to reader to know the actual frequency or importance of words but only their relative frequency and importance. Other packages such as NVivo should be used as it allows to identify relationships between words and to deduce linkages between the different answers provided.

Alternatively a comparison of definitions found in the literature and definitions provided by respondents would provide more interesting results and allow some important insights into how concepts are diffusing.

A few final remarks on the literature review: The article does not specify when public engagement and

widening participation were introduced as concepts and/or policies in the UK and I think this could be added. The impact agenda within the UK's REF is mentioned towards the end of the review and from there it seems that outreach, public engagement and knowledge exchange are part of this agenda, while widening participation is not. Perhaps this could be commented on here and in the conclusion.

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 14 Sep 2015

Samuel Illingworth, Manchester Metropolitan University, UK

Thank you for your helpful comments, which we have taken on board, and which have been used to improve the overall quality of the paper.

Regarding the sampling framework and the sample size, we agree that this was not discussed in enough depth, but as discussed in the response to the previous comments this has now been rectified and discussed in the main body of the paper. Any claims that the paper makes in terms of generalisations have also been re-addressed, as we agree that given the sample size this is not appropriate.

We also agree that not collecting further demographic data in terms of job titles and roles was an oversight, and as discussed in the responses to the previous comments, and also in the paper itself, this is something that we intend to do in future studies, using the findings of this study as a starting point for further investigation.

We accept that the use of word clouds to illustrate the key points in the data was at best inconclusive and at worst potentially misleading. However, this has now been addressed, with a more in-depth analysis using NVivo now provided, which allows for a more considered examination in terms of the relative frequency and importance of the responses.

Regarding the introduction of these terminologies in terms of policies, concerns about “access” to high education began to emerge alongside the expansion of the university sector in the latter part of 19th Century, but a research agenda on differential access only began to emerge following the recommendations of the Robbins Committee in 1963 to expand university attendance. These concerns resurfaced in 1990s when the divide between universities and polytechnics ended, ultimately leading to a commitment by the 1997 Labour Government to again expand by the sector by tackling barriers to higher education. Consequently, Labour established OFFA. This has now been commented on in the literature survey.

In terms of the relationship between widening participation and REF, widening participation tends to align with teaching outcomes, rather than research. However, it is accepted that there is a blurring of the boundaries, e.g. a research-focused public engagement event may well inspire someone to attend university who wouldn't have otherwise. In addition to this, it is important to note that widening participation will likely become part of the Teaching Excellence Framework – an outcome based model that the UK government proposes to evaluate quality of teaching. This has also been commented on in the conclusions, as suggested.

Competing Interests: No competing interests were disclosed.

Referee Report 17 August 2015

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This is an interesting topic, and one that is ripe for study. As the authors point out, there is a growing amount of activity in and funding for various kinds of science communication (they point to the phenomenon of 'Science 2.0', but they may also like to think about this relates to scholarship on Mode 2 knowledge production - e.g. see [Etzkowitz & Leydesdorff \(2000\)](#)). There is definitely lots going on, a mass of different terms for related activities, and a degree of slippage between different terminologies.

As the authors themselves point out, though, there are some problems with their methodology, and I also feel that the analysis and discussion would benefit from a fuller engagement with the literature. I'll take the latter point first.

To start with, I think the authors need to more clearly make a case for their focus on the terms that their analysis is based on (that's rather clumsily put - but I hope my point will become clear). Their starting point, unreferenced, is that "Science communication is often analogously and interchangeably referred to as science outreach, public engagement, widening participation, and/or knowledge exchange". Yes - but many other terms are also used, including dialogue, PUS, scientific literacy, tech transfer, third stream activity, and co-enquiry. Why were *these* terms selected (and indeed why not 'science communication' itself)? This sense of arbitrariness is heightened by a literature analysis that bounces around in a somewhat haphazard way. The authors ignore, for instance, work that has attempted to define some of these terms (Burns *et al.* (2003), whom they cite at the very start of the paper, offer an extended discussion of terms they see as similarly related to science communication, including scientific literacy and PUS; the work of the NCCPE - <http://www.publicengagement.ac.uk> - is also a valuable resource for seeing how different forms of science communication have been framed). By interpreting the 'participation' that the science communication literature often refers to (e.g. in the Rowe & Frewer article they cite) as being about 'widening participation' initiatives they also make a bridge to an area of university outreach and external relations that is infrequently discussed in the main body of science communication research (wrongly so, I think - but that's another discussion); rather, the term 'participation' tends to be used in the tradition of deliberative theory and public participation in science research and policy (a randomly chosen example would be [Bogner \(2012\)](#)). All this is to say that things like 'public engagement' and 'widening participation' actually have rather different histories, and different communities around them - so it doesn't surprise me, for instance, that some respondents hadn't heard of widening participation initiatives. These are likely to be *organised* quite different within university systems. I was also surprised that the authors didn't spend more time considering other empirical work on practitioner definitions of these terms or of science communication generally. Some of my work has treated this (not that it's necessarily essential reading - but see, e.g., [Davies \(2013\)](#), but Jason Chilvers, John C Besley, and Kevin Burchell, among others, have also published analyses of how scientists and other practitioners of public communication tend to define and understand it (e.g. [Chilvers \(2008\)](#); also [Besley \(2010\)](#)).

So - in short, I think both the framing of the study, and the analysis and discussion, would benefit from a

more thorough engagement with the qualitative literature that has built up around the meaning and practice of science communication. I also have some comments about the methodology and analysis - largely to do with the need for more explanation as to what the former was, and why it was chosen. For instance, the authors note that the survey was "advertised via email, social media accounts, and the 'psci-comm' mailing list"; earlier, they say that the study aimed to understand opinion on definitions of the four terms "in UK HEIs". What, exactly, is the target participant group? Everyone working in UK HEIs? A certain subset of this population, those who are interested in science communication? The HEIs themselves, as institutions (i.e. as organisations with particular brands)? How was the sampling strategy (the distribution of the survey) designed to reach the desired population? In terms of the survey advertisement via "email and social media accounts": email to whom, and why, and which social media accounts (and why - but you get the picture...)? The PSCI-COMM list is distributed to a large group of those interested or working in or researching science communication, in the UK but also internationally. Is the target population therefore 'science communicators'? (In practice almost all respondents had participated in science communication in some way, so perhaps so. But this needs to be clear.) [Apologies - I've just re-read your comment in the conclusion that respondents only being active science communicators is a weakness of the study. But in that case, if you're interested in everyone working in UK HEIs from chancellors to cleaners, you need to justify why you used a survey methodology, and why you thought your sampling strategy would reach everyone.]

I would also like to know more about how the analysis, and particularly the qualitative analysis, was carried out. Using word clouds is a rather basic means of analysis, as it tells us only how often a word is cited, not the context in which it is used or the meaning that is attached to it; discussion of the qualitative responses is therefore important. Were these coded in some way? How were themes robustly identified? The data evidently did not reach saturation (to use a term from grounded theory), as the authors emphasise the diversity in the definitions given. Do you think you needed a larger sample size, or is there so much interpretative flexibility in these terms that saturation would never be reached?

The authors do note, in the conclusion, that the sample size is a weakness of the study, and I would agree with this. As far as I can tell you were also not able to identify the role or situation of your respondents, only whether they had participated in science communication activities in the past. This, to me, also weakens the results significantly - or at least represents a lost opportunity. There are big differences between different kinds of communities within universities and as participants in communication (e.g. scientists, outreach officers, admin staff, PR teams, tech transfer offices...). It seems unlikely that these communities would have homogeneous definitions of the terms in question - or even have heard of them all (as your findings suggest).

I want to close - and I do apologise for the lengthy review - with a broader point. The issues that you touch upon raise some fascinating questions. I would love to know more, for instance, about the relations between individuals and teams in universities working on 'widening participation' and on public engagement-type projects, and I would be very curious to know if academic staff give different kinds of definitions of these terms to those who organise science communication on a professional basis. In this regard I would encourage you to look beyond finding the 'right', or even commonly used, definitions of particular terms. Alan Irwin has talked about 'third order' studies of science communication, which explore how different terms are mobilised by different groups, and the kinds of effects that this has (see [Irwin \(2008\) In: Bucchi M and Trench B \(eds\), *Handbook of Public Communication of Science and Technology*, London and New York: Routledge](#)). Your study suggests interesting ways to explore how very different meanings can be applied to the same terms - it would be great to hear more, in the future, about how these different meanings are made to matter in particular contexts (such as, to go back to the very beginning, moves towards Mode 2 and entrepreneurial universities). I wish you all the best with this future

research.

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 14 Sep 2015

Samuel Illingworth, Manchester Metropolitan University, UK

Thank you for your comments, which we found extremely useful, and which have helped us to reshape the paper into a more effective and considered study.

The comment regarding the choice of outreach, public engagement, widening participation and knowledge exchange, and why these were chosen for selection is a pertinent one. However, we believe that in the context of UK institutions, these are the phrases that are most readily used in relation to science communication. PUS and scientific literacy are terms that are, in our experience, used more in an American and European context, whereas tech transfer and third stream activity would arguably be covered by knowledge exchange. However, we agree that the wording in the text was a bit strong, and has now been changed. We have also made a note in the conclusions regarding that future studies should also present participants with an open-ended question to define any further terms within the science communication lexicon which they believe to be important, and why.

Regarding the bounciness of the literature analysis, we think that the literature that we have engaged with illustrates that there is no concise definition of the terms that we have chosen, and as such serves its purpose as a useful introduction and rationale for this study. It is understood that the selected terms have different historical and academic contexts, but we believe that the literature that we have engaged with illustrates this point.

As noted in the response to the previous reviewer's comments, we have now addressed the issue of the sampling size and the sampling strategy, and accept that not doing so in the previous version of this paper was an oversight. It should have also been made more apparent that only the responses from UK-based participants were included in the analysis, and this has now been corrected for in the text. In addition to this, only the participants who reported as being active in science communication were included in the analysis; again this has now been made clearer in the text.

We agree that Wordle was not the most academically rigorous way of presenting our data, and that word frequencies could be potentially misleading. As such the word clouds have been replaced with tables that outline the major themes for the thematic analysis, and the frequencies associated with them. A far more detailed description of how this thematic analysis was carried out using NVivo is also given. Through an open coding approach, descriptive saturation was reached, and this is also now discussed in detail in the text.

Again, we acknowledge that the lack of sufficient demographic data reduces the potential depth of the analysis, representing a lost opportunity that we hope to address in future studies. This will include, as noted in the conclusions, investigating how different stakeholders define different

aspects of science communication, and how and why this changes depending on job title, and both across and between institutes.

Thank you for your suggestions regarding future studies, especially your comments regarding how definitions of the nomenclature may change depending on job role. This has now been further discussed in the conclusions where we talk about future work, where with a broader study and more demographic data such questions will be targeted. We agree that there may well be no 'right' definition of particular terms, but having broad and workable descriptions might well help better communication between the different practitioners of science communication.

Competing Interests: No competing interests were disclosed.

Referee Report 10 August 2015

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Paige Brown Jarreau

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Summary: A re-analysis of the data and a significant re-write is advised.

The authors have provided a fine if brief literature overview of definitions of science outreach, public engagement, widening participation and knowledge exchange. This is also a timely topic, as the need for evidence-based science communication has grown in today's complex ecosystem of science new media and outreach efforts on the part of scientific institutions.

However, there are major flaws in this paper as it is currently written and presented. The sample is extremely small for an online survey - this sample would have been more appropriate for in-depth interviews with each respondent. This is acceptable as long as the audience/population is clearly defined. Are those who answered the survey mostly active scientists, or mostly dedicated science communicators? This could make a big difference to participants' definitions of science communication, outreach, public engagement, widening participation and knowledge exchange.

Why only 47 respondents? The 'psci-comm' mailing list serves a much larger number of people than this (and the authors also don't make any estimate of how many people they reached with their survey.) How long was data collected for? The authors should more clearly spell out their sampling goals and procedures.

"These results suggest that in a still emergent field, the participants of this survey are likely to be the driving influence behind the definition of science communication at an institutional level." How so? Please make this statement, and how/why this conclusion was reached, more clear.

"If the participants that took part in this survey represent a fair cross-section of people working in science outreach, public engagement, and widening participation across the UK then it is somewhat alarming that such a significant proportion of them feel as though the fundamental basis on which their work is founded lacks such clemency in its definitions." The authors should be VERY careful in making any statement regarding the implications of this survey representing a fair cross-section of people working in science outreach, etc., as per my comments on the sampling procedure above. The authors don't present any

data on the basic demographics of the respondents. This was a critical oversight.

In the analysis of survey responses, I am not under the impression that Wordle is an academically rigorous method for mapping word and concept frequency. Other qualitative analysis tools such as AtlasTi would have been preferable, even if figures were created in Wordle for demonstration purposes only. Wordle images, while a visually appealing, make it very difficult to quickly gauge relative word frequency.

The authors' methodology in qualitatively analyzing, coding and interpreting the survey responses is very unclear, if not missing altogether. How were the survey responses approached during data analysis? Were the authors' primarily looking for responses that corresponded with how the scientific literature defines concepts of outreach, engagement, etc., or were novel or conflicting definitions also coded and analyzed (e.g. open vs closed coding)? From the description of survey response analysis, it is not clear if the data analysis reached saturation, or what theory or framework guided the textual analysis.

It would be very useful to know the demographic information of those respondents who provided alternative definitions of outreach and engagement, and of those respondents who were unable to define widening participation, etc. Are these scientists? Are these professional science communicators? This type of basic information would enrich the meaning of these results. The authors state only in their conclusion section that the respondents were "active science communicators." What type of science communicators? How many were involved in academic institutions? I think this type of information is paramount to the authors' interpretation of their findings, and the lack of this data is a significant weakness in this paper.

What insights did we glean from the authors' survey of 47 science communicators regarding the definitions and terminology surrounding science outreach, public engagement, widening participation and knowledge exchange beyond what the authors presented in their literature review? What insights to the field and definition of science communication were uniquely contributed by this study? In this the authors are also unclear. It would have been useful for the authors to compare and contrast at greater length their respondents' definitions of these concepts to published scientific literature definitions.

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 14 Sep 2015

Samuel Illingworth, Manchester Metropolitan University, UK

Thank you for your comments, which were very insightful, and which we have used to address these flaws, thereby helping to improve the academic rigour of the paper.

Estimating the number of active science communicators in the UK is beyond the scope of this study. However, given that this study aims to provide an initial scoping exercise into the thoughts and consistency of active science communicators across the UK, and taking into account the limited time frame and zero budget of this study, an ideal sampling size of between 50 and 100 participants was chosen for the survey. Given the limitations in budget (which also precluded a more in-depth interviewing / focus group approach), a convenience sampling strategy was

adopted, in which the survey was advertised using the 'psci-comm' mailing list hosted by JISC Mail, as well through the Twitter accounts of the authors, all of whom are active participants in science communication networks across the Twittersphere. The target audience were people that identified themselves as being active UK science communicators, which is why this particular mailing list was adopted. Given that the psi-comm mailing list contains several hundred active science communicators, and that between them the authors have several hundred Twitter followers that identify themselves as UK-based science communicators, it is disappointing that more people were not able to participate in the survey, but we believe that the number of responses is still sufficient for the purposes of this study. This has now been made clearer in the text.

Regarding the two statements relating to science communication at an institutional level and the cross-sections of science communicators that were represented, we agree that it was inappropriate to make such generalisations, and so these have been removed from the text.

We agree that Wordle was not the most academically rigorous way of presenting our data, and that word frequencies could be potentially misleading. As such the word clouds have been replaced with tables that outline the major themes for the thematic analysis, and the frequencies associated with them. A far more detailed description of how this thematic analysis was carried out using NVivo is also given. Through an open coding approach, descriptive saturation was reached, and this is also now discussed in detail in the text.

In terms of the lack of demographic data that was collected in regards to this survey, we realise that this was an oversight, and we have commented on this in the text. However, we still believe that this study is worthwhile, and that it has presented a relatively concise set of definitions that can be used for further discussions.

Competing Interests: No competing interests were disclosed.

Referee Report 06 August 2015

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Laura Fogg Rogers

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This article attempts to define common definitions for inter-changeable terms used in science communication through a literature review and survey of science communicators. It is a timely article, as this is a much sustained debate in both academic and practitioner circles, and relates to discussion in the literature about funding, incentivising and rewarding science communication. More particularly, it links directly to efforts to define the 'impact' of science communication through processes such as the Research Excellence Framework and the Public Engagement with Research agenda. The article is well grounded in this literature and refers to many of the current debates in this field.

The article uses survey results to move forward the debate on these definitions, attempting to find consensus amongst science communication practitioners. However there were only 47 participants involved in the survey, which is a low sample size. The authors acknowledge this point however, and also note that it may be useful to repeat the survey with researchers and professionals who don't consider themselves science communicators.

Despite these limitations, the survey results indicate that while 66% of respondents state that their definitions match those of colleagues, the resulting qualitative data indicates wide differentiation. These results are presented through Wordle diagrams. While these are visually interesting, further qualitative thematic analysis, along with matrix analyses for coding frequency, could also have added to the results. Percentages are given for word frequency, but a methodology for how this was obtained would be useful.

The resulting concluding definitions are a useful addition to the field, but still produce considerable overlap between activities. The article notes that further work is needed, and I would concur that this is a topic ripe for more in depth research.

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.

Author Response 14 Sep 2015

Samuel Illingworth, Manchester Metropolitan University, UK

Thank you for your comments, which are greatly appreciated, and which we have used to improve both the content and presentation of our study.

As you have pointed out, we acknowledge that the number of participants in this survey is small, and the purpose of this study was to act as an initial scoping exercise amongst science communicators to try and determine how they would summarise the terms of outreach, public engagement, widening participation and knowledge exchange within the umbrella term of 'science communication.' The idea for this paper was to begin to further develop the conversation that needs to take place in regards to how science communicators use the terminology in their fields, initially on a UK-wide basis.

Given that limited demographic data was taken in this study (which was in hindsight an oversight), the Wordle diagrams were simply a tool to indicate the frequency with which certain words occurred. However, it was not at all clear from the original paper how this had been done, and further thematic analysis has now been carried out using NVivo, with the text being rectified to reflect this. The word clouds have also been replaced with tables that outline the major themes for the thematic analysis, and the frequencies associated with them.

Competing Interests: No competing interests were disclosed.