

## **Muddying the waters or clearing the stream? Open Science as a communication medium**

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**Abstract** *Open Science may be practised both for philosophical and pragmatic reasons. As the resources produced by open projects are potentially accessible to public audiences, Open Science offers both a novel medium for public access and involvement in the process of science and an innovative method for real-time science communication. Does such direct access clear the stream of communication or muddy the waters with unfocussed, unclear and unvetted comment? This paper suggests that adopting an Open Science approach allows the capture of an authentic and clear record of research. However, researchers acknowledge this involves opening their work up to a different type of scrutiny.*

**Keywords.** Open Science, science communication, public engagement

### **1. Introduction**

The furore surrounding the leaking of emails from the Climate Research Unit at the University of East Anglia, UK – the so-called ‘Climategate’ affair – drew the world’s attention to the delicate structure of unspoken rules on the sharing of data among scientists. While one investigatory panel found no reason to doubt the rigour and honesty of the scientists involved, there had none the less been a ‘consistent pattern of failing to display the proper degree of openness’<sup>1</sup>. The demands, promulgated through the blogosphere, for openness and access to data and for the opportunity to comment on and challenge science are, the Russell panel concluded, simply a ‘fact of life’ and indicative of a ‘transformation in the way science has to be conducted in this century’<sup>2</sup>.

Since the founding of the first scientific societies in the seventeenth century, openness has been considered ‘arguably the great strength

of the scientific method. Through open examination and critical analysis, models can be refined, improved or rejected.’<sup>3</sup> Open Science extends this practice across a continuum, from publication in open access journals or repositories, to allowing open peer review, to publishing datasets, to making ‘everything – data, scientific opinions, questions, ideas, folk knowledge, workflows and everything else’ available as it happens<sup>4</sup>. Open Science may be adopted for pragmatic reasons – perhaps as a way to facilitate the workings of multi-site and multi-national research collaborations – or on philosophical grounds, for example that the resources produced by researchers should ‘flow as public goods into an open infrastructure that supports and facilitates [their] reconfiguration and integration’<sup>5</sup>.

### **2. Traditional and new media**

Researchers’ traditional channels of communication have long included peer-reviewed journals and the proceedings of conferences and symposia. However, publication by no means guarantees either a readership or dissemination: it is ‘a sobering fact that 90% of papers that have been published in academic journals are never cited. Indeed, as many as 50% are never read by anyone other than their authors, referees or journal editors’<sup>6</sup>. The requirement to make research outputs publicly available is becoming more widespread: for example, the UK’s Engineering and Physical Sciences Research Council has mandated open access publication, while leaving up to the researchers the choice of whether to self-archive in an open access institutional repository or pay-to-publish in an open access journal<sup>7</sup>. As well as making it possible to ‘expand the sharing of research findings and better serve scientists as

well as the “long tail” of other potential users<sup>8</sup>, open access publication has been shown to be associated with increased citation rate<sup>9</sup>.

In recent years the upsurge of social media (such as blogs, wikis, file-sharing and social networking websites) has provided researchers with alternative means of communication. The Research Information Network found that frequent users employed such media to learn about research beyond their own communities, to filter information and to engage with colleagues. However, while researchers are broadly supportive of the use of social media, levels of take-up are relatively low (about 13% are frequent users). For completely open notebook science, take-up is very low indeed (around 5%)<sup>10</sup>.

Open notebook science, in which ‘researchers post their laboratory notebooks on the Internet for public scrutiny [...] in as close to real time as possible’<sup>11</sup>, allows claims to be ‘linked directly to the underlying data that are made public as they arise’<sup>12</sup>; that is, without the formal seal of peer review. Peer review is widely regarded by the research community as an ‘essential mechanism to ensure that only high-quality research is funded’ and a system with no ‘practicable alternatives’<sup>13</sup>. While alternatives have been suggested and tested, a 2006 experiment in open peer-review by the journal *Nature* concluded that despite there being ‘a significant level of expressed interest in open peer-review [...] there is a marked reluctance among researchers to offer open comments’<sup>14</sup>.

### 3. Public engagement with research

Open Science projects exist through and depend on the Internet; therefore they are accessible to audiences – including public audiences – beyond the research groups that generate their content. Using the widest possible range of tools to sustain active discussion of scientific issues of interest or concern is productive in itself: ‘there are societal debates that have much to gain from the uncensored voices of researchers. A good blogging website [...] can make a difference to the quality and integrity of public discussion’<sup>15</sup>. Far from being passive listeners, members of the public are increasingly becoming actively engaged on the issues that science raises for society; something both recognised and encouraged by governments. For example, the UK Department for Business, Innovation and Skills believes there to be a ‘pressing need to strengthen the

level of high-quality science engagement with the public on all major science issues’<sup>16</sup>.

The development of ‘citizen science’ projects, in which ‘individual volunteers or networks [...] perform research-related tasks’<sup>17</sup>, is one response to this perceived need for public engagement with science. The Galaxy Zoo project, for example, has recruited the services of some 200,000 volunteer citizen scientists to classify the morphology of galaxies photographed by the Sloan Digital Sky Survey. The use of human resources to deal with huge quantities of data is common to a number of citizen science projects; whether participation goes beyond the generation of data is less well-investigated. Trumbull et al.<sup>18</sup> found that participants in one such project showed evidence of thinking that fitted various aspects of systematic enquiry but Brossard et al.<sup>19</sup> found no evidence of change in participants’ understanding of the scientific process.

Projects run under Open Science principles, which make the projects’ resources available for re-use by public contributors, have the potential to allow public participants to move beyond being data-organisers to a situation in which they are actively involved in discovery and problem-solving. The resources available from open projects range from publications, technical descriptions, software, to full project data. For example, the Bloodhound@university project (part of the Bloodhound SSC project, which aims to build a car capable of reaching 1000mph) aims to provide full information from the car’s engineering team ‘about the car, the project, the design challenges and the successes, [...] current problems and challenges facing the project’ and invites users to ‘contribute to solving these problems if they are able’<sup>20</sup>.

However, as open projects increasingly include participants with a variety of backgrounds and expertises, the question arises of how best to facilitate contributions to research or responses to controversies from a multiplicity of perspectives, ideas, knowledge, and values<sup>21</sup>.

### 4. Findings

Data used in this paper have been collected from interviews and case studies. Interviewees were selected through a combination of snowball sampling (‘targeting one member of a population (often but not always a difficult-to-reach group) and asking them to connect the researcher with another member of the group, then asking that new member to do the same until the sample is

complete<sup>22</sup>), convenience sampling ('using readily-available participants, such as people already known to the researcher, members of the research team, colleagues, etc'<sup>23</sup>) and self-selective sampling. The combination of these techniques allowed for the best use of the people available and the gathering of authentic views and experience within the constraints of relatively small communities. To date, twenty-two interviews have been conducted with professional and amateur researchers, professional and amateur public engagement practitioners and members of the public. An interview guide was developed and used to conduct semi-structured interviews lasting between 40 and 45 minutes. All interviews were conducted by the researcher either in person or by telephone, digitally recorded and transcribed. The data analysis was emergent and inductive, with categories developed through constant comparative analysis, rather than coding categories determined before analysis. Data from the first four interviews were analysed manually to identify major themes and then re-analysed using a standard software package (Nvivo8), to deepen and extend the coding frame. All subsequent interviews have been analysed shortly after completion. To increase reliability, a selection of interviews has been re-coded by the researcher and by a colleague unconnected with this research.

The research protocol was approved through the University of the West of England's ethical research and governance system. A point of departure from conventional practice was that, in the spirit of openness, interviewees were given the choice of whether to be anonymous or whether to allow their names and other identifying factors to be disclosed as part of the process of dissemination of information. For this reason, in the data reported here, some interviewees are indicated by name while others remain anonymous.

#### 4.1 Capturing the record

Open Science enables researchers to make use of innovative methods to share information about their work live, unedited and in real-time. Rather than the classic peer-reviewed paper, which is 'effectively just [a] snapshot of what the authors have done and thought at [one] moment in time'<sup>24</sup>, the variety of communication methods used in Open Science can allow researchers to reveal (and readers to discover) the complexities of the research process,

although the elegance of the output may suffer as a result.

*A paper is very much about the perfect, completed, part of the record [...] blogging's different. It's more real-time and it shows the full processes you've gone through, the discussions with people. That's nice.* (Hendy, professional researcher)

*A blog is almost like part of the journey to the end result [...] perhaps you're more willing to share the ups and downs of the research journey on a blog* (Anonymous 1, professional researcher)

*Reporting science in real time is not always pretty* (Bradley, open scientist)

As well as shared practical tools (wikis, repositories, data tagging, blogs, social networks, etc), Open Science can capture an authentic and clear record of research and potentially increase access to research outputs. This allows researchers and members of the public to share, re-use and re-purpose data to support other work, although researchers vary in their willingness to make data available.

*The dataset should be there [...] that data might actually support all sorts of other enquiries and it's such a waste of that resource not to make it available* (Anonymous 2, professional researcher)

*I think we'll get to a point where most data is made available in some form although will be difficult for many people to feel comfortable with making all that stuff available immediately* (Neylon, open scientist)

Having placed the research record in public view, it is important that researchers can be confident that it will remain available and not decay.

*It must be a safe haven for their research [...] not fall apart, not suffer from bit rot* (Anonymous 2, professional researcher)

#### 4.2 A new kind of scrutiny

Open Science is a novel medium for direct, unmediated access to the process of science. However, interviewees acknowledge that this involves opening themselves and their work up to a different kind of scrutiny.

*With Web 2.0 and blogging there is more information available, more transparency, so if somebody comes across an interesting piece of work that has been published by a journalist, they have a greater ability to follow that up in depth* (Murcott, journalist)

*I've got far more comfortable doing it [blogging], especially because you get a lot of positive feedback; I'm happy putting something out and having it closely, carefully scrutinised* (Hendy, professional researcher)

*Transparency ... allowing people to see what's going on; that's an important aspect of being open. I wouldn't go as far as some people do and use open to mean you have no controls whatsoever; anyone can contribute* (Millard, professional researcher)

Both professional and amateur scientists have concerns about the quality of open data and of the extent to which those who have produced or commented upon it can be trusted.

*We do need to know about the quality of the data [...] some write-up about its quality assurance and how it was got* (Horton, amateur researcher)

*You can't have free and open and accessible and fluid and fact-checked and pithy and nuanced* (Sanderson, professional public engagement practitioner)

*I want to see comments, annotations, citations made by people who are judged by their peers to be at a certain level of professionalism* (Millard, professional researcher)

### 4.3 Collaboration and communication

For researchers, Open Science both enhances the development of collaboration and communication among research groups, as well as being a way for publicly-funded researchers to meet their responsibilities to communicate with the wider public.

*If we can describe exactly how we've done an experiment, then that helps [others] to do their experiment* (Neylon, open scientist)

*It's about knowing and understanding how science is done [...] the day-to-day slog in the laboratory, the grant application process, the paper-writing process, the interaction, meetings ... that I see as invaluable* (Murcott, journalist)

For members of the public, it offers an opportunity to engage directly with science, as it happens and in close to real time.

*I think we might become something more active, simply because of the facility the Internet gives you to find other people, to talk, to contribute to things you feel you know something about* (Anonymous 3, member of the public)

However, interviewees recognised that practising Open Science can place significant demands on researchers' time.

*There's a lot of time demands. I find it hard finding time in my working life to put time into [open science]* (Hendy, professional researcher)

*Scientists need to be prepared to engage for what might seem an inordinately long amount of time for what might appear to be a very short outcome.* (Murcott, journalist)

*I think the team has to be careful about the overhead in how they facilitate external input.* (Anonymous 4, public engagement researcher)

### 4.4 Public participation in research

Open Science holds the possibility of allowing members of the public to contribute directly to research. The growing number of public participation and citizen science projects testifies to such public willingness to become involved.

*... their number one reason for participating in Galaxy Zoo is they want to make a contribution to science.* Raddick (public engagement researcher)

Researchers acknowledge that Open Science allows the potential for considerable contribution by the public.

*If you allow them – the audience, the community – to surprise you, then they will* (Neylon, open scientist)

*There would be a chance that a member of the public could do the analysis. And if they saw something before the scientists did, that would be a big bonus* (Anonymous 3, member of the public)

*I'm really interested in these collaborative mathematics projects [...] I've had some really good interactions with people I wouldn't otherwise have access to, who've given me the links to data and pointed me in different directions for my analysis* (Hendy, professional researcher)

#### 4.5 Creating a context

Interviewees commented that research data is not always easily digestible for public consumption.

*Presenting it to the public's going to be hard ... it's a lot of machine-processed digital data – hardly sexy!* (Beck, professional researcher)

Likewise, the process of producing data for use by people who are not part of a research group is not always easy.

*The process of extracting the information [...] is really quite tricky. It's not as simple as just grabbing a drawing; it has to be put into context. But it's not insurmountable.* (Anonymous 5, professional public engagement practitioner)

Many interviewees noted the need for setting research outputs in context for public audiences; indeed that there may be a prerequisite for mediation of what may be quite complex data.

*Once [the data] is processed into a scientific form, it needs to be contextualised [...] to remove the technicalities that are barriers to comprehension* (Murcott, journalist)

*It needs to mean something to the person who is accessing it. [...] It's not available if it's there but means nothing or there's no map to navigate through it in some way* (Anonymous 4, public engagement researcher)

*You need to know the hinterland of the data, the context in which the data can be set* (Horton, amateur researcher)

However, professional and amateur scientists and members of the public equally acknowledged that such contextualisation of complex science will inevitably place demands on researchers' skills.

*Even when the learning curve is quite small [...] even so that is a huge challenge to some [...] people with no strategies for managing their own stuff, let alone for sharing it or packaging it or describing it with XML or anything else* (Millard, professional researcher)

#### 5. Conclusion

The processes and outputs of projects conducted under Open Science principles can potentially be accessed by a variety of participants beyond the research groups that generate their content, ranging from members of the public to other professional audiences. While such direct access could 'clear the stream' of communication, the sheer quantity and complexity of the process and data could 'muddy the waters', rendering navigating, interpreting and analysing the available information difficult.

Open Science can enhance collaboration and communication, both within research groups and with the wider public. However, the perceived need for mediation or contextualisation of what may be quite complex science makes demands on researchers' time and skills.

For members of the public, increasing and improving access to research outputs through Open Science can allow them to contribute directly to research but, as the quantity and variety of resources which have not been subject to peer-review grows, this raises concerns relating to quality assurance, if Open Science is not to become yet another medium for unvetted, unscrutinised commentary.

However, while acknowledging these concerns, at a time when complete openness is beginning to be demanded as an automatic right, Open Science offers a way for scientists to clear the stream of communication by presenting their work transparently, directly and completely.

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