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Open Science: A New "Trust Technology"?

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Abstract

The emerging practice of open science, which makes the entire process of a scientific investigation available, could extend membership of the research community to new, public audiences, who do not have access to science's long-established trust mechanisms. This commentary considers if the structures that enable scientists to trust each other, and the public to trust scientists, are enriched by the open science approach. The completeness of information provided by open science, whether as a replacement for or complement to older systems for establishing trust within science, makes it a potentially useful "trust technology."

Keywords

public perception of scientists, public understanding of science, scientific

Trust in science rests on a delicate structure of largely unwritten rules, based on the concepts of civility of 17th- and 18th-century England (Shapin, 1994). Through their publications, the scholarly journals that have their roots in that era provide a "virtual witnessing"—a "trust technology" that offers a powerful reassurance that things really were done in the way it is claimed that they

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were (Shapin & Schaffer, 1985, p. 60). Open science, which at its fullest extent makes “everything—data, scientific opinions, questions, ideas, folk knowledge, workflows and everything else—available as it happens” (Nielsen, 2009, p. 32), expands the concept of virtual witnessing to cover the entire scientific process. Could this emerging practice become a new “trust technology,” either as a replacement for or as a complement to older methods of sustaining trust in science?

Seigrist and Cvetkovich (2000) argued that one of the functions of trust is to reduce complexity, by enabling us to identify those in our community whom we believe to be trustworthy, and therefore in whose opinions we consider we can place confidence. Current concerns about trust reflect how the balance of power in science is potentially changing, increasingly skewing from centralized, homogenous professional contributors toward distributed, collective, sometimes amateur action (Holliman, 2011). Increasing the variety of members of the community of science, and the number of ways in which they can take part, inevitably increases the complexity—and potentially blurs the transparency—of the process.

The public images of science create the context against which that science is understood. Therefore, if mutual trust is to be enhanced, both the scientific and lay communities must have confidence in the quality of the representation of science. Scientists are known to have concerns about how their work is presented in the mass media (Suleski & Ibaraki, 2010), while respondents to at least one public survey indicated that being able to see the original work for themselves is one of the factors that would enhance their trust in scientific information (IpsosMORI, 2011). For scientists, open science could offer a novel method to represent themselves directly and communicate personally with a variety of audiences. For members of the public, it could offer a route for direct access to original work.

There are, as yet, no settled routes for open science, nor can it presently claim to be a majority activity (Research Information Network, 2010a). However, openness can encompass a spectrum of activities, and many scientists already incorporate some aspects within their existing practice. For example, they may deposit papers in publicly accessible repositories, publish in open access journals, include data sets with publications, write and collaborate through blogs, or maintain project websites. Perhaps the most complete expression of openness is open notebook science, in which “researchers post their laboratory notebooks on the Internet for public scrutiny [. . .] in as close to real time as possible” (Stafford, 2010, p. S21). These and other open modes of communication enable colleagues, other scientists, and potentially a variety of public groups to follow methodologies, analyze data, and/or replicate experimental procedures. The opportunities for transparency, authenticity, and timeliness of the record created by open science could both reveal the scientific process in real time and allow claims to be viewed within the context of their underlying data. Open science thus has the potential to contribute to the substantiation of the relationships that are central both to people's trust in science and to science's trust in people.

Although many scientists acknowledge a duty to receive as well as to transmit when engaging with public groups (Winston, 2009), there will be questions and difficult issues to be dealt with before a fully open scenario can be wholly realized. For scientists, such issues could include the highly competitive nature of many funding systems, which may make applicants reluctant to publish proposals until after grants are awarded; apprehensions about a lack of shared language between research and lay communities, which may lead to fears of misunderstandings of methods and practices; concerns that time spent blogging, maintaining a social network, or preparing data for publication is time taken away from "real" work; or the need to maintain precedence as the producer of work (and avoid being "scooped"), which is perhaps unsurprising in a profession where reputations can depend on being the first to publication. Additionally, both researchers and public groups might have concerns about the misuse of publicly available data by special-interest groups—witness the discussions surrounding the recent moratorium on full publication of research data from studies of the H5N1 flu virus (Butler, 2012).

Opening up the methods of science to wider audiences has implications not only for how science is done but also for public engagement with science. Scientists have developed many ways of sharing information with each other, through journals, conferences, symposia, and workshops, while the mass media offer platforms for wider communication. However, in the main, the scientific information thus made available arrives after the fact, finished and complete, leaving what happens while the work is being carried out as something of a mystery. The route for real-time communication presented by open science offers the opportunity for public groups to engage not just with the published outcomes of science but also with its processes, including methodologies, codes, models, and raw data. This changes the context: Rather than science being a series of definitive experiments from which emerge polished results, open science supports the understanding of science as a dynamic, tentative, uncertain, and constantly revised activity.

Priest suggested that members of the public who believe "results to be fixed, static, and certain may be confused by an ongoing series of revisions" (2001, p. 106). Yet science is precisely a series of revisions. This was positively illustrated recently by some of the media coverage of the results of the

OPERA experiment (OPERA Collaboration, 2011). The researchers in this team concluded that their results showed neutrinos travelling faster than the speed of light, a finding that, if correct, breaks a fundamental concept of the special theory of relativity. Of course, not all the coverage was positive; for some the result was deeply troubling (Daily Mail, 2011). However, at least some of the coverage went beyond descriptions of the result itself to include commentary on how the experimental data were being subjected to scrutiny, revision, and checking, publicly revealing the kind of close—and shared—analysis that is second nature to the particle physics community (Butterworth, 2011; Palmer, 2011).

To improve the quality of their result, the OPERA Collaboration (2011) has not only repeated the experiment itself but has also "gone to the community" (Brumfiel, 2011) and asked other teams to independently review their data. Admittedly, the wider community to which the OPERA team appealed was other physicists, rather than members of the public more generally, but they have deposited their paper in a publicly-accessible archive, so the possibility of public involvement exists.

Other recent events have drawn wider attention to the gentlemanly rules under which science is perceived to operate. The travails of the University of East Anglia's Climate Research Unit (CRU), following the unauthorized release of e-mails and other documents, offered an illustration of what can happen when trust between scientists and the public, either apparently or in reality, breaks down. Broadly, this issue highlighted three areas of concern. First, there were issues of data access and repeatability; other research groups, and some independent researchers suggested that the CRU's studies could not be replicated because certain data were not made available (Russell, 2010). Second, there were suggestions of data manipulation, in that the wording of certain (highly selected) e-mails allowed some critics to discern an intent to "falsify data" (House of Commons Science and Technology Committee, 2010, p. 19). Although the House of Commons Science and Technology Committee concluded that there was no deliberate attempt at obfuscation and that the researchers' data-handling procedures were reasonable and "in line with common practice" (p. 3), in the absence of raw data, relatively standard procedures of data normalization created an aura of suspicious manipulation to people unfamiliar with such processes. A third issue was the suggestion that scientists had unduly influenced peer review. This was a matter of concern because both scientists and members of the public are known to trust the process of peer review (Harnad, 2000; IpsosMORI, 2011; Research Information Network, 2010b).

It could be argued that the complex nature and vast quantity of the data produced by experiments such as OPERA, or aggregated by the CRU, may preclude all but the most interested amateur scientists from engaging with it. However, not all scientific endeavors have dense data, nor have members of the public shown themselves loath to engage with data sets. The growing numbers of "citizen science" projects attest to the willingness of members of the public to participate in data-intensive science (Ince, 2011; Silvertown, 2009). However, either the data in such projects are presented in ways that make sense to the human minds being asked to classify them (Cook, 2011), or knowledgeable volunteers are asked to follow detailed protocols that enable the collection of robust data for professional analysis (Brossard, Lewenstein, & Bonney, 2005; Worthington, et al., 2011).

Open science has the potential to enable citizen scientists' participation to go beyond counting, checking, and organizing data to involvement in the full complexities of the research process and in dialogue with researchers. However, such professional-nonprofessional alliances bring together groups that may have significantly diverse worldviews. The CRU case illustrates what can happen when different views collide and scientific knowledge must be "transported and translated across the boundaries of different worlds" (Meyer, 2011, p. 119). Where once debate among scientists occurred in the semiprivate settings of subscription journals or scientific conferences, now the ways and means by which scientists represent themselves in public may extend across many locations and involve many nontraditional agents. None the less, meetings between scientists and members of the public are often still located in privileged, bounded spaces, such as universities or learned societies. Likewise, while public-scientist events are, increasingly, at least constructed as informal and dialogic, there is considerable current debate about the extent to which this dialogic turn is authentic or whether the cognitive deficit model survives as the underlying mode for the communications taking place (Davies, 2008; Phillips, 2011; Trench, 2008; Wilkinson, Bultitude, & Dawson, 2011).

Comment and discussion need not, of course, happen only face-to-face. Books, newspapers, magazines, television, and radio are time-honored media for communication. Recent years have seen the growth of communication in the very fluid realm of websites, blogs, file sharing, and social networking: the dynamic, unmediated, uninhibited, and challenging domain of "Web 2.0." For science, Web 2.0 offers both opportunities and perils. It could be argued that public spats in the blogosphere will jeopardize science's position in society—that by exposing the argument, dissent, and speculation natural to the scientific process, trust will be eroded. However, the opposite could be the case: Practicing science in the open, facilitating access to information, processes, and conjecture as well as to data, results, and conclusions, could sustain trust through increased transparency and greater completeness. By showing all the workings in the margins and making clear the foundations—or lack thereof—on which conclusions rest, more people will be enabled to make independent judgments of those conclusions' validity.

Web 2.0 social media tools, predicated on interpersonal networking, have the potential to render the boundaries of the scientific community more porous and enable researchers to be "public figures and honest brokers" of their own dissemination ("A Question," 2010). Researchers can use social media simply, to engage with colleagues or members of the public. Or they can go further, using the transparency of process offered by sophisticated social media techniques to develop new tools and skills—or repurpose old ones—and do their science in a different way. Potentially, all the elements of the research project could be opened up, from the project proposal, to the funding, to the experimental procedures, to the raw data, to the rectified statistics, to the flux of argument, and finally, to the published, conclusive papers. As noted earlier, not all researchers will be comfortable opening the entire process to the scrutiny of collaborators, competitors, or public audiences, and understandings of what it means to be "open" will be subject to debate. However, many researchers are already opening up to some degree and may find further steps not so difficult to take.

It could be argued that such a significant change in practice cannot be accomplished without substantial investment of resources: "Open" is not directly equivalent to "free." The resources required may be monetary, such as the author-side fees levied by some open-access journals. For example, in 2011, *PLoS One* (n.d.) and *Nature* (2011) charged US $1,350 per article, although both offered discounts and fee waivers under certain circumstances. However, traditional, subscriber-pays publication is also costly: "In Britain, 65% of the money spent on content in academic libraries goes on journals, up from a little more than half ten years ago" ("Of Goats," 2011). Alternative models—the so-called green route (Harnad et al., 2008)—which require less financial commitment, none the less require researchers to commit time to undertaking the work involved in self-archiving, website maintenance, social media use, and so on.

Research communities have long maintained the structures of science, sharing and passing on practice from one generation to the next. The existence of such communities enables their members to be classified in terms of "what is known about them: whose work one can build on, whose results are 'believable,' who does one wish to 'cooperate with' and who does one 'wish to avoid?'" (Knorr-Cetina, 1999, p. 131), and undoubtedly, reliable work can come from, and reputations can be built on, these "informal trust taxonomies" (p. 131). However, the structures can also be opaque for people outside the community, who do not have access to the information on which the original community is seen to rely.

In many ways, this early part of the 21st century is the time of "open": open government, culture, archives, research, knowledge, access, source code, science, and more. The impetus toward openness is strongly reflected in one of the conclusions of the Russell review into the furor around the CRU data, which noted that demands for openness and access to data are "like it or not," indicative of a "transformation in the way science has to be conducted in the twenty-first century" (Russell, 2010, p. 15). If this is so, then membership of the research community will inevitably extend to include new, possibly public audiences, whose members may not be privy to the classifications that support judgments of reliability among existing professional members. On their part, researchers' communities may lack a framework within which they can identify those of the new, public membership whom they can believe trustworthy. In a pre-Web 2.0 era, Gieryn was able to suggest that boundaries were necessary to facilitate the separation of "real science [from] pseudoscience, amateur science, deviant or fraudulent science, bad science, junk science, popular science." (1999, p. 17). However, while such demarcations may have given scientists a legitimate place to roam, they also excluded participants with something genuine but unusual to offer. Open science has the potential to create fluid spaces within which distributed, differently peopled, and differently acting communities can work together and develop mutual trust, creating opportunities to open up "fresh interconnections between public, scientific, institutional, political and ethical visions of change in all their heterogeneity, conditionality and disagreement" (Irwin, 2008, p. 210).

Inevitably, "processes of change produce eddies of confusion" (Knorr-Cetina, 1999, p. 241). As mainstream science—and comment on science—follows the pioneers into the realm of Web 2.0, to be able to navigate the currents of the information flow in this relatively unmapped territory, scientists and members of the public will all need reliable and robust tools. The technologies we trust to help us determine our direction and find a way through unfamiliar terrain have always evolved: the compass replaced the lodestone, and the global positioning system receiver the sextant. Likewise, the tools used by scientists and public groups are evolving in response to demands for openness and transparency. The practice of open science could not only allow producers of information to map out their processes and contextualize their data, it could also support consumers in developing the critical awareness and judgment that enables us to separate pseudo-science from real. If it can achieve its aims of complete clarity and full publicly available content, open science has the potential to become a new trust technology, of benefit to both the scientific community and public groups.

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Bios

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