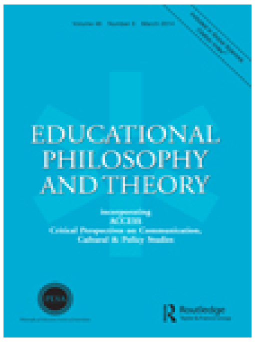

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EDITORIAL

Open Science, Philosophy and Peer Review

Open science is a term that is being used in the literature to designate a form of science based on open-source models or that utilizes principles of open access, open archiving and open publishing to promote scientific communication. Open science increasingly also refers to open governance and more democratized engagement and control of science by scientists and other users and stakeholders. Sometimes other terms are used to refer to the same or similar conceptions of science, such as wiki science or Science 2.0, which focus on 'technologies of openness' that promote not only more effective forms of scientific communication but also increasingly the deep sharing of large databases (linked data) and cloud computing.

Openness is also an essential aspect of the ethics of science. Scientists, by virtue of their professional status and membership of scientific communities, are bound by expectations to openly share their work and to make public their methods and procedures as much as the data or results. Perhaps most importantly, scientists should be open to criticism and participate in the review of scientific work. David Resnik (1998, p. 58), in *The ethics of science*, emphasizes this aspect when he writes: 'Science's peer review depends on openness. Openness prevents science from becoming dogmatic, uncritical and biased'.

The virtues of open science in so far as it draws on commons-based peer production is increasingly seen as a mode or system of production structured by large-scale collaboration, driven by motives other than profit. In this regard,

> Commons-based peer production is a socio-economic system of production that is emerging in the digitally networked environment. Facilitated by the technical infrastructure of the Internet, the hallmark of this socio-technical system is collaboration among large groups of individuals, sometimes in the order of tens or even hundreds of thousands, who cooperate effectively to provide information, knowledge or cultural goods without relying on either market pricing or managerial hierarchies to coordinate their common enterprise. While there are many practical reasons to try to understand a novel system of production that has produced some of the finest software, the fastest supercomputer and some of the best web-based directories and news sites, here we focus on the ethical, rather than the functional dimension. What does it mean in ethical terms that many individuals can find themselves cooperating productively with strangers and acquaintances on a scope never before seen? (Benkler & Nissenbaum, 2006, p. 394)

Yet the system of peer review, while the core practice of science, is also open to abuse, and there are many scholars questioning its purpose: 'Is it a filter, a distribution system, or a quality-control process?' (Wagner, 2008). Peer review evolved from a set

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of practices in the eighteenth century, especially in medicine. It was not associated with the first issues of the *Philosophical Transactions of the Royal Society*, one of the first journals established in 1665, although peer review has a history in early Arabic scientific studies of medicine, where physicians were required to take duplicate patient notes. It was really only in the twentieth century that peer review, as the process of subjecting scholarly work to the scrutiny of one's peers, became the institutional cornerstone of the scientific system and its ethical basis, although the process has come in for increasing criticism. Expert and anonymous peer review has been open to allegations of bias and suppression and criticized for its slowness, which has led some to advocate dynamic and open peer review and open peer commentary.[1]

Horace Judson (1994, p. 92) argues that in conjunction with the transition from exponential growth of the sciences to a steady state, and the appearance and development of electronic publishing and electronic collaboration, we are witnessing the structural transformation of science based on 'declining standards and the growing, built-in tendency toward corruption of the peer-review and refereeing processes'. He also acknowledges that the peer-review and refereeing systems that have evolved are 'social constructs of recent date'. Open peer review indicates that the nature of electronic media of scientific communication may also offer some extension to the peer-review system. The first journals employing these more open systems began to appear in the 2000s. While peer review is taken as the principal mechanism that enshrines the value of community self-evaluation ('criticism' in the Kantian sense) and offers the means for 'quality improvement' (in today's language) that constitutes the essential openness of scientific communities, the ideal and process are not immune to change, criticism and revision. In some ways, the development of the peer-review system echoes the history of science and the movement from the 'small science' era of Boyle's 'invisible college' of the seventeenth century, through the professionalization of science in the eighteenth century, its disciplinary formations in the nineteenth century and the scientific nationalism of the twentieth century, concluding with the 'big science' of the late twentieth century (Wagner, 2007).

Today, we face another major historical periodization or transition with the rise of global and open science (Peters, 2006) that involves the possible end of science superpowers (Hollingsworth, Müller, & Hollingsworth, 2008) and the beginning of a more articulated open system based on open-source models of intellectual property and large-scale international collaboration.

Increasingly, international scientific organizations stress open science as an efficient means of addressing scientific problems of global significance that spill across borders. Thus, Paul A. David, writing on 'The economic logic of "open science"', indicates:

> 'Open science' institutions provide an alternative to the intellectual property approach to dealing with difficult problems in the allocation of resources for the production and distribution of information. As a mode of generating reliable knowledge, 'open science' depends upon a specific nonmarket reward system to solve a number of resource allocation problems that have their origins in the particular characteristics of information as an economic good … [While 'the collegiate reputational reward system' creates conflicts over cooperation] open science is properly regarded as uniquely well suited to the goal of maximizing the rate of growth of the stock of reliable knowledge. (David, 2003, Summary, p. 0)

Five major forces are structuring the emergent science system in the twenty-first century, all pointing towards a new openness for science built upon the complexity and dynamism of open systems communications and processes and technologies that enable deep sharing: networks, emergence, circulation, stickiness (place) and distribution (virtual) (Wagner, 2007).

The emergence of Science 2.0 or open science has been noted by M. Mitchell Waldrop, writing for *Scientific American*, where he makes the following points:

- Science 2.0 generally refers to new practices of scientists who post raw experimental results, nascent theories, claims of discovery and draft papers on the Web for others to see and comment on.
- Proponents say these 'open access' practices make scientific progress more collaborative and therefore more productive.
- Critics say scientists who put preliminary findings online risk having others copy or exploit the work to gain credit or even patents.
- Despite pros and cons, Science 2.0 sites are beginning to proliferate; one notable example is the OpenWetWare project started by biological engineers at the Massachusetts Institute of Technology. (Waldrop, 2008 http://www.scientificamerican.com/article.cfm?id=science-2-point-0-great-new-tool-or-great-risk)

As the new Web 2.0 technologies develop, science can use and modify these tools directly; for example, biological research has developed with OpenWetWare, which is a wiki where researchers share expertise, information and ideas in biological science and engineering. Science 2.0 is based on the expectation that these new technologies will change how scientists communicate their work and the way in which research is done. Web 2.0, in relation to Open Access publishing, promotes live publishing, removes price barriers to communication, improves collaboration between authors, researchers, readers and publishers, and promotes a paradigm change in approach and openness (Nikam & Babu, 2009).[2]

The Organizing Committee of the International Symposium on Science 2.0 and Expansion of Science (S2ES 2010), in its recent call for papers, prefaced its remarks in the following way:

> The term Science 2.0 has been used with different but related meanings. It is usually related to *new technologies*-enabled scientific activities, specifically Web 2.0 [Shneiderman, 2008], but it has also been related to the expansion of science by means of *new concepts and theories* (Second Order Cybernetics [Umpleby, 1991, 2006, 2009], and the Systems Approach), or *new mode of producing knowledge*[Gibbons et al., 1994]. (Retrieved from http://www.iiis2012.org/wmsci/website/default.asp?vc=37, italics in the original)

In 2009, I presented a paper entitled 'On the philosophy of open science' at the inaugural Science in Society conference at the University of Cambridge, in which I maintained that open science rests on seven propositions (Peters, 2009).[3] I stated them baldly without justification or argument and I considered them, if you will, 'observations' or working hypotheses to be confirmed (or falsified). Each of these propositions has a complex and contested history in philosophy and science, and the aim of the Cambridge presentation was to scope the philosophy of open science rather than to defend the seven propositions.

(1) Openness to 'experience': this might be given a Baconian, inductive and empiricist reading with an accent on the pragmatics of the experiment (Peltonen, 1996).
(2) Openness to criticism: an extension and naturalization of the Kantian account of Reason given in the first critique which provided the tools for rational self-critique.
(3) Openness to interpretation: historically connected to self-expression, freedom of expression, rights to free speech and the other academic freedoms on which the university is built.
(4) Openness to the Other: an ethical stance that in the present technopolitical era can be construed in terms of institutionalized peer production, free sharing of knowledge and collaboration to create the intellectual commons.
(5) Open science communications technologies: this historically contingent feature, itself an episode in the history of modern science, refers to the development of open-source and open-access models of science based on the logic of distributed knowledge systems and an ethic of sharing, peer review, cooperation and collaboration.
(6) Openness = freedom: this specifically links to items 3 and 5 above, and relates to use, reuse and modification of data and information, as the basis for creativity (the Creative Commons argument) and innovation.
(7) Open science governance: I would like to give this feature a radical Republican interpretation (after Polyani's [1962] 'the republic of science') based on peer review extended to all levels of the professoriate and also to users, including the public.

These philosophical principles are not new. They developed over time to form the composite core of a responsible and public science in the service of humanity. It is the age of open science. The Royal Society's (2012) recent report *Science as an open enterprise*[4] late embrace of openness focuses on how openness defines the practice of science, provides the drivers for change, emphasizes new ways of doing science based on computational and communications technologies and encourages a greater communication with citizens allowing better scrutiny of evidence that underpins scientific work but also reclaiming something of the public purpose of science from the hands of experts. Increasingly open science defines the future of science in the networked era and the nature of peer review.

Notes

1. Open peer review (OPR) began trial in 1996 when a number of journals, including the *Journal of Interactive Media in Education*, began experimenting with OPR. This was followed by *PLoS Medicine*, published by the Public Library of Science and Atmospheric

Chemistry and Physics. *Nature* launched its own experiment in 2006 with mixed success. *Philica*, an online journal launched in 2006, publishes all articles immediately, which are then reviewed after publication by reviewers on a voluntary basis. *Biology Direct* is another journal that experiments with OPR as an alternative to traditional blind peer review. Open peer commentary is another innovation in the review process that promotes expert commentaries on published articles.
2. See the following science blogs for a discussion of the advantages and current difficulties facing Science 2.0: http://www.spreadingscience.com/our-approach/what-is-science-20/ and http://openwetware.org/wiki/Science_2.0/Brainstorming
3. See http://science-society.com/
4. See http://royalsociety.org/policy/projects/science-public-enterprise/report/

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