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Editorial

SPECIAL ISSUE ON PEER-TO-PEER AND USER-LED SCIENCE

Users and peers. From citizen science to P2P science

ABSTRACT: This introduction presents the essays belonging to the JCOM special issue on User-led and peer-to-peer science. It also draws a first map of the main problems we need to investigate when we face this new and emerging phenomenon. Web tools are enacting and facilitating new ways for lay people to interact with scientists or to cooperate with each other, but cultural and political changes are also at play. What happens to expertise, knowledge production and relations between scientific institutions and society when lay people or non-scientists go online and engage in scientific activities? From science blogging and social networks to garage biology and open tools for user-led research, P2P science challenges many assumptions about public participation in scientific knowledge production. And it calls for a radical and perhaps new kind of openness of scientific practices towards society.

When we first started thinking about a special issue on science done outside the boundaries of scientific institutions, we thought that communication tools and practices had to be given the appropriate importance: in JCOM's view, science can be understood as a communication enterprise, even beyond internal communication practices in the scientific community. Indeed, science is increasingly being produced and discussed by way of online cooperative tools by web users and without the institutionalized presence of scientists. Citizens become volunteer scientists and conduct or discuss research outside the once called ivory tower of science. Thanks to the Internet, citizen science is becoming more diffused. But it is not just a matter of diffusion: web tools are creating and facilitating new ways for lay people to interact with scientists or to cooperate with each other. What they do can be referred to as «user-led» or «peer-to-peer» (P2P) science.

It is well known that the Internet has changed some crucial mechanisms of science. For example, it has permitted and expanded phenomena such as the open access movement in scientific research. The latter has surely been a response to the wave of enclosures established in science with the strengthening of intellectual property rights. This began in the 1980s in the USA and quickly spread all over the world with the expansion of patents and copyrights. But the open science movement is also part of a much broader open source, social production or peer-to-peer movement, which has now spread to almost every possible domain of knowledge production. Some of the best known examples of this new movement are projects such as Wikipedia and Linux. In science this movement has opened up new forms of online sharing, collaboration and cooperation between researchers. But what happens when lay citizens or non-scientists go online and engage in scientific activities?

The emergence of P2P science

«Popular science» or «Citizen science» are two traditional ways of defining grassroots science produced outside the walls of laboratories. The history of citizen science can be traced back to the very beginning of scientific knowledge production. See for example *A People's History of Science* by Clifford Conner,[1] a long account of lower class innovation from prehistory to computer hackers. Social studies of science and technology include an entire wave of studies on user-led innovation or lay and popular knowledge. Following political traditions we could go back until the 19th century and consider Pëtr Kropotkin and his *Fields, Factories and Workshops,*[2] in which the famous collectivist anarchist proposed his peculiar vision of integration of manual and brain work, knowledge, and nature against bureaucratic centralisation.

But the Internet has changed the way of collecting, sharing and organising the knowledge produced by people — peers — who do not belong to the established scientific community. Obviously it is not just a

technical matter. If these emerging practices are still immature and difficult to grasp it is because they are the fruit of the recent convergence of several technical, cultural and social phenomena. The first example is the emergence of a technical and legal infrastructure which enables free online cooperation. The Internet is characterized by horizontal and pervasive diffusion, open protocols and collaborative tools such as web 2.0, enhanced by open licenses such as Creative Commons or common pools of knowledge resources freely available online. Second, we are witnessing the spread of a maker culture ranging from free software to open hardware projects, from hacker communities to open design and community gardens. This layer is where online social production can move «from bits to atoms» and be embedded in material goods. Finally, a political layer: the diffusion of a request for participation in science's dynamics which dates back to the 1960s and which is still growing. The latter is an important topic for science communication, and it was acknowledged by means of a shift towards more participative, multidirectional and inclusive communication practices. This convergence results in the increase in the number of people who can produce or discuss scientific knowledge without any formal recognition as scientists, and the way the Net enables collaborative systems for them to interact and participate in these activities.

A personal and partial map of user-led and peer-to-peer science would include very diverse ways of engaging in scientific knowledge production. Other accounts and collections of experiences or maps of citizen science are available online at p2pfoundation.net,[3] scienceforcitizens.net,[4] the Citizen science projects blog,[5] Wikipedia[6] and many other websites.

The first type of P2P science is the online discussion about science. It can be done via web tools such as blogs, independent forums of patients, activists or amateur scientists, social network sites. These spaces can be hybrid forums where citizens talk with scientists, or P2P spaces where non-experts freely have discussions, exchange information and produce knowledge. Other examples are open online encyclopedias such as Wikipedia, where anybody can contribute to a scientific entry without needing any formal qualifications. A final example is open textbooks and notebooks where lay people can contribute to the stabilizing of knowledge.

The second area of P2P interaction with science is represented by data collection, processing and analysis for a centralized institution. This includes the sharing of personal data, for example, websites such as Google Health or social networks for data sharing such as those implemented by personal genomics companies like 23andMe or other providers of medical and health services. In other cases, netizens are asked to give some of their computers' computational time to process data within distributed computing projects. Examples are Folding@home, which analyses protein structure, or the famous SETI@home, devoted to the search for extraterrestrial intelligence. Other types are based on a request for distributed and active participation to the analysis of data that are collected and processed in a centralized way. For example, projects such as Galaxy Zoo, where volunteers are asked to classify galaxies. Galaxy Zoo has produced several scientific papers. Finally, centralized projects ask citizens to collect independent and original data to help researchers. This is the case of the BioWeatherMap Initiative, run by the Personal Genome project but rooted in a broad network of volunteers.

The third area of user-led science is composed of completely independent and community-driven P2P science projects which design research, perform experiments and analyse data with the support of distributed networks and platforms. A few examples are CoCoRaHS (Community Collaborative Rain, Hail and Snow Network), in which thousands of volunteers gather rainfall and weather data across the USA or the projects of the hobbyist scientists network DIYbio, which attempts to hack biology and promote garage biotechnology.

Authors' contributions

Obviously, the essays we gathered here are partial and diverse. They are often based on a small number of case studies, and they are surely not sufficient enough to draw a complete map of grassroots science done on the Internet by users and non-expert peers. We are not entering a well-established world, but rather an emergent phenomenon still looking for stability. Nevertheless, the material collected for this issue is enough to trace some general indications about the main problems we are facing, and hopefully it will be a starting point for a deeper future debate.

The first set of questions this issue tries to tackle is related to a classical problem of the relationship between science and society: participation. It is easy to state that web tools and P2P practices are changing and increasing the ways of participating in the production of scientific knowledge. But does

this increase consist of a real shift towards democratizing science? Does it actually affect the asymmetrical relationships between citizens and experts? What legal, social, political and technical strategies are needed to make this shift effective beyond participation rhetoric? Another question is related to the way in which academic and private scientific institutions are appropriating the knowledge produced by users and citizen scientists and its value. Do we need a new model to understand these ways of appropriation? Are they part of a deeper change in knowledge production paradigms which can change the way we relate to our world in order to understand it and change it? All these questions point to a basic problem that many essays in this special issue highlight: the problem of power redistribution and its relations with the mechanisms of knowledge production.

Are online interactions a space for real peer-to-peer and horizontal dialogue? In her study of comments on science news articles, «Changing the meaning of peer-to-peer? Exploring online comment spaces as sites of negotiated expertise», Marie-Claire Shanahan takes into account how different types of expertise interact. Her conclusions underline that the still present distance between personal and scientific expertise prevent dialogue from being horizontal. The salient expertise is the scientific one, and the possibility to peer-to-peer interaction between different kinds of experts is not realised.

A similar conclusion is reached by Inna Kouper. In her article «Science blogs and public engagement with science: practices, challenges, and opportunities» she analyses some science blogs and their role in the promotion of interactive forms of science communication. She points to some blogging practices and to the asymmetrical relation between bloggers and their public, asking for more openness in order to favour laypersons' participation. Blogs are not *per se* an opportunity for public engagement with science, but rather they represent a challenge to be faced.

One of the main arenas of public communication is the health and medical information system. Henry Ko analyses the role of Australian patient associations, peer tutoring groups, independent organisations and consumer networks in promoting a user-led approach to health communication. In his article «The public production and sharing of medical information. An Australian perspective» Ko concludes that negatives such as prejudices or abuse of positional power do not invalidate the possibilities of reaching higher levels of public scrutiny and empowerment for people who actively share medical knowledge.

But the sharing of medical data has another side. According to Marina Levina, participating in a network is one of the duties of a new kind of citizen of the network society. Personal genomic companies use this civic norm to collect data they can exploit. «Googling your genes: personal genomics and the discourse of citizen bioscience in the network age» focuses on discourse produced by the American genomic start-up 23andMe. The rhetoric of democratisation, equality and sharing is related to the distribution and organisation of power, and the role of the bioscientific citizen has to be problematised.

A much more optimistic point of view on peer-to-peer science is offered by Richard Watermeyer. In his article «Social network science: pedagogy, dialogue, deliberation» he explores the nexus between social web and learning. Social network sites are «relational gateways» that enable social learning and are changing the way individuals actively interact with each other and with their environment. Openness, informality and interactivity give social networks the possibility to foster a relation between scientific knowledge and individuals rooted in dialogue.

Indeed, openness is one of the core legal implications and needs of user-led science. In «Open science: policy implications for the evolving phenomenon of user-led scientific innovation», Victoria Stodden analyses citizen science in relation to access and sharing of knowledge. Public involvement and collaborative models between scientists and non-scientists need policy solutions that support not only data and knowledge sharing, but also the sharing of benefits deriving from it. Indeed, drawing from computational science examples, Stodden points out that the incentive model of citizen science is closer to that of open source software than to that of big science.

In the commentary, we collected three essays from authors who tackle the problem from different perspectives. They analyse the problem of power, participation and cooperation in peer-to-peer science, and their contributions give a more political and critical point of view on the themes developed and analysed in the research articles of this JCOM special issue.

Michel Bauwens wonders: «Is there something like a peer to peer science?» His answer, rooted in his activity within the P2P Foundation, is positive. Thanks to open and free input of voluntary contributors, participatory processes of governance, and universal availability of the output, it can prove to be more productive than centralized alternatives. Furthermore, in Bauwens' view P2P science is founded on a epistemology of participation which includes a shift towards a new vision of the scientific subject-object

division. It would be a dialogic practice, both because of its P2P dynamics between individuals and because of its relationship with the world of non-human objects.

Christopher Kelty's essay is titled «Outlaw, Hackers, Victorian Amateurs: Diagnosing public participation in the life sciences today». It focuses on some of the most famous American do-it-yourself biology groups, a new phenomenon which has been strongly covered by the media. Kelty argues that the public can be not passive, but «aggressively active». Do-it-yourself science challenges mainstream science, asking for more access and involvement. Garage scientists depend on big science but try to live beyond its frontiers, in no man's land. They are also redefining what being «the public» means in the current configuration of science/society interaction.

Mathieu O'Neil writes about a different aspect of P2P science. In his «Shirky and Sanger, or the Cost of Crowdsourcing» he analyses how two online encyclopedias, Wikipedia and Citizendium, deal with the problem of expertise. Wikipedia's choice, namely to favour interaction and openness over credentialism, results in extraordinary costs such as fights, authority clashes or uncertainty. This urges us to rethink the easy enthusiasm for collaborative production. According to O'Neil, the relation between scientific experts and amateurs is far from being horizontal, and crowdsourcing cannot give birth to a fully horizontal and frictionless form of production.

The special issue is concluded by a review of a science fiction book. Cory Doctorow's *The Makers*[7] is a novel set in the 2010s that describes the impact of the migration of modes of production that have emerged online into the sphere of material production. A P2P world in which a movement of active knowledge creators uses 3D printers to produce material goods. In his review, Adam Arvidsson argues that the cause of the failing of this movement seems to be economic. A capitalist society of abundance cannot sustain a world of makers because it does not equally distribute the value created by their work.

Conclusions

This can be a lesson about science done by peers and users, by the collaborative makers this issue is focused on. If they are to be placed in a more productive ecosystem of knowledge creation and diffusion, if we want them to sustain themselves and contribute to the world we live in, political, economic and scientific institutions will have to take into account their needs and interests. Apart from the legal system and the technological infrastructure, P2P science is looking for a model which can redistribute the economic and social value produced by peer production. Companies and scientific institutions are asking citizens to contribute by crowdsourcing knowledge, sharing and analysing data, or performing scientific research. Will they be able to open themselves up to a more inclusive relation with P2P science?

Well, if they won't, they might have to face rebellion. The «Biopunk Manifesto»[8] writer and DIY biologist Meredith Patterson pompously (and ironically) states:

> We the biopunks are dedicated to putting the tools of scientific investigation into the hands of anyone who wants them. We are building an infrastructure of methodology, of communication, of automation, and of publicly available knowledge. (…) We reject the popular perception that science is only done in million-dollar university, government, or corporate labs; we assert that the right of freedom of inquiry, to do research and pursue understanding under one's own direction, is as fundamental a right as that of free speech or freedom of religion. (…) The biopunks are actively engaged in making the world a place that everyone can understand. Come, let us research together.

With its radical requests for openness and inclusivity and with its rejection for institutional prerogatives and constraints, P2P science challenges many assumptions about public participation in scientific knowledge production. Citizen scientists and users contributing to science claim to be part of the scientific process on almost any level. They point to a problem in the current distribution of power over knowledge. Distributed social production has proven to be enormously productive in many fields of human knowledge. But if a positive change is to be favoured and Kropotkin's horizontal utopia is to emerge again, user-led and peer-to-peer solutions will need to be accompanied by a redistribution of that power.

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