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Connecting the building blocks of Open Science: an ecological approach

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Abstract

Open Science covers a large panel of activities aimed at making research more transparent and collaborative. Several definitions provide lists of different components of open science, which creates the need to imagine how to connect these components together. However, the necessary work to interconnect open science services and tools must be completed by a holistic approach that considers open science as an ecosystem producing a "milieu" of knowledge and supported by a vibrant community gathered around shared values. It leads to an ecological approach to open science where the web of interactions within the ecosystem defines its elements rather than the opposite.

Keywords

open science, community, assessment, infrastructures, knowledge

Introduction

"What is open science"? When looking at the various definitions that can be found on the web or in the literature, it is striking to see how composite those definitions are. Beyond the generic idea that open science is the movement that aims at making science more transparent and collaborative, most of these definitions are composed around lists of its different components.

The definition provided in 2015 by the OECD in its pioneering report, *Making open science a reality*, is a first example: "The term refers to efforts by researchers, governments, research funding agencies or the scientific community itself to make the primary outputs of publicly funded research results – publications and the research data – publicly accessible in digital format with no or minimal restriction as a means for accelerating research; these efforts are in the interest of enhancing transparency and collaboration, and fostering innovation. The report focuses on three main aspects of open science: open access, open research data, and open collaboration enabled through ICTs. Other aspects of open science – post publication peer review, open research notebooks, open access to research materials, open source software, citizen science, and research crowdfunding, are also part of the architecture of an "open science system"" (OCDE, 2015).

The "open science" article in Wikipedia identifies six different elements: open methodology, open source, open data, open access, open peer review, open educational resources («Open Science», 2022).

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This particular nature of open science as a composite of different elements is so prominent that the FOSTER program that aims at providing training materials and toolkits on open science even elaborated a taxonomy at several levels of granularity, presenting a list partially different from the OECD report: open access, open data, open reproducible research, open science evaluation, open science policies, open science tools (Pontika et al., 2015).

And finally, the recent UNESCO recommendation on Open Science sets up an even more complex and diverse framework that encompasses: "open scientific knowledge, open science infrastructures, science communication, open engagement of societal actors and open dialogue with other knowledge systems" (*UNESCO Recommendation on Open Science - UNESCO Digital Library*, 2021).

This is a situation well known in other domains. For example, several researchers in digital humanities (DH) represent the scope of their field with the metaphor of the "big tent" (Pannapacker, 2011)). At its widest definition, the DH "big tent" is quite simple to present: everything that articulates the humanities and digital technologies can be deemed part of the digital humanities. And then start the lists and their inevitable taxonomies, such as The Taxonomy of digital research activities in the humanities, also known as Tadirah (Borek et al., 2016). To a certain point, the open science field looks similar: everything that articulates "openness" with science can be deemed "open science", and here are the lists and taxonomies.

The inclusive and flexible approach of the big tent is quite convenient for an emerging field, as it welcomes everyone in an inclusive movement, avoids asking difficult questions and can be adapted to many situations. It is also a way to explore the many different ways of practicing openness in the different dimensions of research. But it also has an inherent weakness, a lack of substance that can turn to be a threat to the consistency of the movement itself as it could be seen in the digital humanities field (Terras, 2011). The risk inherent to working with a too weak or encompassing scope is to lose focus. It is not so much a question of perimeter or border; it is not about drawing a red line and deciding by an authoritarian gesture what is in or out, because it is not useful for a field that has its own dynamic and expands rapidly to a point that nobody can predict. If open access, open data, open peer-review, open methods, open infrastructures are not just juxtaposed elements but the "building blocks" of open science, then the question is rather: what is it exactly that they are building? What is the purpose of it? How to define substantially rather than functionally the objective of "connecting the building blocks" of open science? In other words, what could be discussed is the "why" rather than the "how". I would like to propose a reflection upon this question on three different levels: systems, actors and knowledge.

Connecting the technical building blocks: open science as a *milieu*

At this level, the main challenge is to improve interoperability between technical systems that support open science in its different dimensions. How to connect open repositories hosting research data with open access publication platforms, how to make openly available the softwares that are used to analyse the data and enable the users to run them on their own datasets to reproduce the experiment, how to interconnect the preprint servers with the publication workflows and support the adoption of open peer review? The technical answers to those questions are already well-known: PIDs, standard metadata, APIs on all platforms, open licences, open linked data, amongst others (*From Open Research*

to Science 2.0 – Alexander Refsum Jensenius, 2021). But there is still an open question: working on improving the interoperability across systems, working on developing an open graph of interlinked scientific digital objects is certainly necessary; but what for?

The obvious answer was already provided by several authors in the last years (Bilder et al., 2015): we should ensure that open science builds upon open infrastructures. The objective here is to prevent any particular actor to lock-in research in a proprietary, consolidated environment that would create again, at a different level, the enclosures of knowledge that we wanted to remove with open science. This effort to improve general interoperability and development of open tools, indexes and graphs is already under way with the development of fundamental open science infrastructures such as Crossref, ORCID, OpenAlex, EOSC, OpenAIRE, DOAJ, DOAB, and many others.

But there is a dimension that is not well-addressed yet, in my opinion, and it concerns the way the user experience still has to be improved. The reality of the researchers' experience, when they move across the different stages of their research, is currently quite shaky in the open science context. In most cases, they have to use a multitude of tools and platforms (Bosman & Kramer, 2017) and handle manually the breaches that prevent information from travelling across systems. There is a specific challenge here: having all the platforms interconnected through their different APIs and enabling the migration of data across them thanks to standard metadata, versioning and permanent identifiers is necessary, but not sufficient. What is missing yet is the implementation of this interconnection at the level of the user interface. In most cases, designers model their interfaces upon the user journey *within* the platform they design, but rarely *across* the different platforms the users may have to use all along their journey. The result is a kaleidoscope of interfaces representing data, publications and other pieces of information in many different ways, with endless variations from one place to another, which leads to questioning if this supports the production of knowledge, or leads to a fragmentation of cognition.

Does all this make any sense for the researchers, does it fit with their knowledge production workflow? This is something we don't know well, as the open knowledge practices are yet to be studied in detail. But this is important, because the small "crystals of knowledge" (Stern et al., 2015) that flows freely in the new digital open environment are mere meaningless pieces of information as long as they don't find their place in an organised cognitive environment that allows for a controlled activity of interpretation and the organisation of a scientific discussion that leads to a better and steadier constructed knowledge. This seamless cognitive environment researchers probably need in the open science context is still to come. "Connect the building blocks" of open science starts with driving the places of knowledge such as platforms, tools and services to work together, adapt to each other, up to a point where they can develop some sort of symbiotic relations to offer, all together, a fertile and meaningful "*milieu* of knowledge" (Dumas Primbault et al., 2021), rather than chaos. This is a topic we, at OpenEdition, are planning to work upon, thanks to the COMMONS project that we just launched with two partner infrastructures, Huma-Num and Metopes, in the domain of open humanities. In this project, our aim is to work on technical interoperability, but also and jointly on the development of a "seamless" research environment that encompasses open data and publications, and to understand better the open research practices in those disciplines *across* the tools and platforms (OpenEdition, 2021).

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Connecting the social building blocks: open science as a community

I come from a sector, in the humanities and social sciences, where the main challenge is to overcome the fragmentation that impedes the actors in their transition towards the adoption of open science practices. This is what we identified first when we started to develop OPERAS, the distributed European infrastructure dedicated to open scholarly communication in the humanities and social sciences. In this domain, the fragmentation of research across multiple disciplines and linguistic areas leads to having many small communities scattered in small organisations that would require a particular effort in terms of coordination to support them transitioning to open science (Giglia, 2019). But the fragmentation is not only horizontal across disciplines and linguistic areas. It is also vertical across the whole governance structure of academia, where there is poor or even no coordination between the policy-making and funding bodies on one hand, and the research teams and their supporting staff that perform research on the ground, on the other hand. The fragmentation is transversal as well, with too much ignorance and lack of recognition between researchers, librarians and publishers, and also people working in the infrastructure (IT staff, administrative staff, information specialists). This lack of knowledge, recognition, and communication between the different professions that, together, make science on a daily basis was identified by OPERAS as a major obstacle to the adoption of open science in the humanities and social sciences communities.

As a matter of fact, the fragmentation issue is not so specific to the SSH disciplines. It is probable that the issue is particularly acute in these disciplines, but clearly not an exception, and in particular when it comes to open science. The most striking example of this lack of coordination between the different concerned actors across the academic field can be seen in evaluation. The gap between open science practices and their lack of recognition that can have a deterrent effect, is a well-known and documented issue (Saenen et al., 2019) (Martínez Samper, 2022). In fact, lack of alignment and discrepancies are everywhere and at all levels when it comes to policies: between grant and position assessments, between institutions and funders, between countries within and outside of the European Research Area, between policies and infrastructures. Similarly to platforms that design their interfaces internally and independently from their larger context, science organisations have a tendency to design their policies independently. The same way they move between tools and platforms along their research journey, researchers have to move between different institutional policies and contradictory rewards and incentives all along their career when they apply for project funding or for hiring, when they change affiliations, when they publish data, a book or a paper, when they perform assessment themselves. And, as, most of the time they participate in transnational networks, they move across borders as well, where the poor coordination between actors inside a country is multiplied accordingly. Here, the issue is not only a classical “collective action problem” where it would be difficult for the actors to decide to transition to open science, as a growing number are going in this direction. The real issue is that they usually focus on some parts of open science, different from each other, rather than adopting a global approach.

There are a number of initiatives that identify the gap and aim at aligning open science policies across European countries. However, the coordination and alignment is often partial and limited to a certain country or a certain type of organisation. The UNESCO recommendation on Open Science helps as it provides a global framework that all actors can take up to develop their own policies and strategies. The development of cOAlition S,

CoNosc, and more recently CoARA are encouraging because they are evidences of a collective effort to address the coordination problem and provide better alignment at policy level. Beyond these useful initiatives, however, remains the main issue of coordinating the different types of actors and across the different professions that compose the scientific community.

But precisely, is there such a thing as the “scientific community”? The term, often used, is rarely questioned; science itself is indeed a very composite sector where the disinterested objective of producing knowledge is not the only driving force that shapes its activity. Science has always been linked to multiple vested interests that participate in research not only for the sake of advancing knowledge as a common good, but because knowledge can give them an advantage over their competitors. But at the same time, science cannot exist without knowledge sharing and a form of open cooperation between those who produce it. The scientific field is thus structured around a tension between, on the one hand, a set of core Mertonian values where communalism and openness are strongly articulated, and, on the other hand, many different forces that participate in the making of science, but for whom lack of sharing has its own advantage (Chubin, 1985). This is a paradox, but also the essence of science, to be supported and threatened at the same time, and often by the same actors, that are torn apart between the necessity to cooperate and open their doors to others, and the opposite pressure to compete and keep their treasures for themselves. In other words, the “scientific community” is not given as a natural circumstance of science. If it exists, it is rather the result of laborious efforts to preserve certain types of relations, to pursue a certain ideal, and to overcome all the adverse circumstances that lead invariably to ruthless competition. In this context, open science can appear as a rallying cry around the core values of science, and as a way to build the collective of all those who concur to knowledge creation, primarily as a community, and not only as competitors (Neylon et al., 2019). It is a way to reassert the centrality of knowledge as a common good for the benefit of all and not as an asset for the exclusive advantage of some.

Beyond the building blocks: towards an ecology of knowledge

In many texts about open science, starting with the definitions, there is often a versatile usage of “science” and “knowledge” that can be mentioned as if they were perfect synonyms. The UNESCO definition of open science is on the contrary very precise on this, considering science (or “scientific knowledge” as they put it) as one of the many types of knowledge that are produced in human societies. Hence, this challenging objective to “open dialogue with other knowledge systems”, which touches upon several dimensions of scientific communication: citizen science, DEI (Diversity, Equity and Inclusivity), education, societal engagement. If everyone agrees that open science is ultimately for the benefit of society, it is often conceived as a basic right for non-academic actors to access the results of academic research, or as an active action to disseminate the outputs of research to the society through various channels. But, by no means this is what we could consider as “an open dialogue” that would require, at least, bidirectional communication. It thus implies to consider science on an equal footing with other types of knowledge (produced by practitioners, journalists, educators, amateurs, communities for example) to contribute to a common good that extends beyond the borders of academia (Okune et al., 2019). In my opinion, this is the most uncomfortable and difficult challenge for academic actors who often consider themselves as holding a sort of monopoly over knowledge production. I do not want to discuss the pros and cons of this position at this point. I just want to highlight

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that practising open science in its full fledge goes well beyond connecting academia and society. It leads to considering science from a larger perspective and including it in the larger realm of knowledge, where academia is only one of the many "places of knowledge" (Jacob, 2014) that exist in human societies. And to participate, amongst others, to the growth of a common multi-dimensional, multi-situated knowledge.

"Connecting the building blocks" of open science is thus much more than just creating connections: it is more than ensuring technical interoperability between different systems, more than coordinating various stakeholders, more than disseminating science in society: it is to create a *milieu* of knowledge, to build the community that supports it and to open it beyond the limits of academia. In other words, it is to consider that the sum is superior to the addition of its parts, and to adopt an encompassing approach that supports open knowledge as a whole. That is why I would like to submit to discussion the relevance of adopting an ecological approach to open science. The main consequence of it would be to focus primarily not on the "blocks" taken individually, and not even primarily on the individual interactions between them, but on the systems of interactions that structure open science. The proposition would be to start from open science considered as an ecosystem supporting the creation of open knowledge, and then look at the elements from that perspective. What is in focus then, is the web of communications and interactions that compose the ecosystem. The objective is no more to "connect the building blocks" of open science, as bricks are assembled in a wall, but to support symbiotic systems of relations between initiatives, platforms, tools, communities and practices that thrive for and by open knowledge.

Winch means, when considering or even evaluating open science initiatives, projects, services and tools, to flip the order or priorities and to pay attention first to the way they move in their ecosystem: how do they nurture from it, how do they fertilise it, how do they cooperate with others, rather than other criteria that are usually considered as more important; such as innovation, efficiency, excellence. And then, when we have a comprehensive representation of the full web of interactions and interdependencies, maybe we could start asking the right questions: is it sustainable? Is it inclusive? Is it creative? Is it alive?

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