The Open Science Revolution

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Science and knowledge are day-by-day more open to. No one precisely knows when this process stared, but nowadays everyone all around the word can access data and scientific results without any fee or pre-paid subscription. This phenomenon, known as "open science or open research", is due to the diffusion of social media dedicated to science and the development of new techniques and instruments that are able to produce huge amount of data. All of this data, that individually represents a little piece of the puzzle of knowledge, once pieced together, can potentially allow the comprehensive understanding of the mechanisms of nature as a whole, producing a real social and technological progress.

A practical example of open science is represented by the Human Genome Project, an international research effort to sequence and map the *Homo sapiens* genome. This project, completed in 2003, let us read nature's code that regulates all the aspects of the human being. Since this information is enclosed inside the genetic material of the whole population, it must be known and disseminated to the entire humanity. This is so important especially because the full understanding of this code will allow the entire scientific community to unravel physio-pathological mechanisms, and then to fight and solve diseases and health problems more efficiently, as supposed by the new prospective given by precision medicine. To reach this goal, all the information must be accessible and free to everyone, to save time and money through a global organization of the scientific research. Indeed, the huge amount of data produced by the "omics era" requires great computing capacity, whose cost can be waived only by sharing big cluster facilities and by adopting shared programs.

Open science is tightly linked to open data because they represent the same cultural shift towards more open research practice and both aspects are dependent on each other [1]. The higher the amount of available data, the higher the research shared amongst scientists, and vice versa. At the same time, if results and corresponding data are really visible to the entire community, these findings can be validated and confirmed by other groups, or, on the contrary, fake outcomes can be easily unveiled. Thanks to this mechanism open science can lead to a higher quality in the scientific research. Very often funding and careers depend only on the number of publications achieved by a researcher, instead of the real impact or quality of their work. This means that the majority of scientists try to publish their work in journals with the highest possible impact factor, despite the general condemnation of this policy that causes various detrimental effects. Due to this trend, an increasing number of rushed and messy papers were published in the last decade, even in renowned journals, resulting in a large amount of retracted papers, due to the presence of misconduct experiments, low reproducibility or even manipulated datasets and images. Without any doubt, none of these practices can lead to a real improvement of sciences and knowledge. For this reason, in 2016 the American Society for Microbiology (ASM) decided to remove the impact factor from their journals, proud of the idea that these numbers cannot assess the real significance of a research [2]. Hence, open science can be fundamental to invert this trend.

The concept of open research is then changing the way scientists collect their data, present and share their research, publish their findings, and assess the impact of their work. One of the main outcomes of this transformation is that international co-authorship is increased, because open science means also collaboration for starting new projects and for their development. At the same time, even if someone thinks that this kind of policy will be detrimental for domestic collaborations and for the economic development of single nations, the open science revolution facilitates the evolution rather than hinder it. This kind of mechanism is fundamentally evident in those research fields that have been seen as a challenge only a few years ago. For instance, now it is possible to sequence complete genomes, or to compare massive biomedical databanks, not just investigate single genes or individual cases. The unquestionable value derived by the "big data" collected by various databases spread over the globe, became then the real spring for the future of medicine, and this is plain to all. However, all

of these aspects apply also to smaller and specific databases or to other fields. Certainly, environmental research is one of the other main fields that gained resources and results from the open science approach. Global warming and consequent climate change studies are the examples everyone can think about. Indeed, researchers involved in these topics were amongst the first that made use of open science and data sharing. The Intergovernmental Panel on Climate Change, or IPCC, since its establishment in 1988 gave the unique opportunity to provide rigorous and balanced scientific information related to climate change to decision-makers. The results obtained during the last thirty years would have been impossible if the environmental issues grouped under the climate change flag haven't been treated by this global community that share data and findings.

In conclusion, open science is reducing the overall costs of research activities, by making unaffordable studies and research challenges more feasible. By combining these aspects with the new methods used by researchers to share and support their results, which guarantee higher transparency but also visibility, the open science revolution is truly paving the way for the next generation of scientists and for the higher quality needed by the scientific research to solve incoming challenges.

References

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