26 The Academic, Industrial and Societal Impacts of Open Research

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Nowadays, open research practice has garnered massive attention from various academic and research institutions globally. Open research has become more mainstream ever since web-based platform such as Figshare and Researchgate continued to grow in term of users and research output numbers. The term 'open research' itself means conducting research within free and open source platforms, where transparency and openness of scientific information sharing are the main principles. The purposes of this practice are to provide open access scientific information as well as enhance collaboration and engagement with wider audiences.

While open research deviates from traditional research secrecy habits, its application is necessary in this increasingly globalized world. Everything is connected via the Internet and things move more rapidly now compared to former times due to more advanced technology. Therefore, in order to keep up with this fast-moving and high demand world, faster application of research discovery in various sectors is required. One example is in the medical research field. A massive growth in human populations and higher life expectancy has created a jump in disease incidences worldwide. The most common one is cancer, a highly complex and multifactorial disease which is very difficult to eradicate. If there is only one research team working on it, the progress will be very slow. Open research practice allows methodological and data sharing, enabling teams all over the world to build on previous findings and even test them on multiple types of cancer at once. This way, formulations of new cancer treatments would become much faster. Multidisciplinary collaborations among different specializations could also be achieved, creating more holistic approaches. As a result, the transition from preclinical to clinical studies will be easier, since wider research coverage will make the data more convincing and conclusive. Early and successful clinical trials increase the possibility of mass production, which in turn would be beneficial for patients and the pharmaceutical industry.

Not only consumers or patients, but also the researchers themselves get advantages from open research practice. Increased visibility, citation rates and discoverability of their publications will lift the researcher's reputations internationally, therefore enhancing their chance for job promotions as well as funding opportunities. Researchers in developing countries, who might not have

enough funding to subscribe to high impact journals can also participate and contribute to the project. Starting from 2017, many organizations such as the Wellcome Trust, Medical Research Council (MRC) and National Institutes of Health (NIH) accept preprint submissions for grant applications. Moreover, in the same year, the European Commission published guidelines entitled "Evaluation of Research Careers fully acknowledging Open Science Practices" [1], indicating increased demand for open research in science community worldwide. Soon, reproducibility and open science will become standard practice and hold a more important role for scientist career advancement.

The impact of open research could also be felt by the wider community, given that much taxpayer money is used to fund government research grant. The public health field is one of the key areas in community-based research, where the implementation of multi-sectoral public policies is one of its objectives. Open research practice could easily influence policymaker's decision-making processes due to faster online data sharing and accessibility. This could be highly beneficial during a disease outbreak, which requires faster intervention.

In fact, open research is not a totally new thing in science, technology, engineering and mathematics (STEM). Platforms such as arXiv and bioRxiv have already existed for several years, providing preprint sharing options in topics including physics, mathematics and computer science. Feedback from other readers could help improve manuscript quality and also ensure originality of the research ideas. Additionally, digital object identifiers (DOI) assigned to each manuscript would facilitate citation of preprints, even before the peer review process.

I think it is important to integrate science in daily life, where citizens could participate and produce their own research project. Web-based service such as Crowdcrafting open the opportunity for citizens to contribute intellectually to others' research projects, share resources and opinions, even starting their own projects. All services are 100% free, permitting people from various backgrounds to join. By bringing science to people, we could encourage critical thinking and an innovative mentality in young generations.

Last but not least, industry participation is a key link for research promotion and mass production. In order to manage research data at industrial scales, big data analysis skills hold a vital role. Besides, legal issues involving Intellectual Property (IP), licensing agreements, and state policies also should be taken into account from the beginning of collaborations between scientists and industry. Those abovementioned data science and science policy fields will be desirable career alternatives for STEM graduates with the growing importance of open science.

A number of tech giants such as Google, Apple, Samsung, Microsoft etc. are starting to use open science approaches in their research and development (R & D), and business models. Fast and agile innovations are required if they want to stay on top, since competitors arise all the time. Massive research collaborations of industries, academia, and corporation partners have led to many technological breakthroughs, enabling their brands to flourish in the market. The latest trend is the race for Artificial Intelligence (AI) apps, hence many brands have set up AI labs in various countries, most notably Canada. Amazingly, local professors and students are also invited to develop the algorithms in joint AI research with industry. Consequently, new technology upgrades more rapidly, every year new AI models with better specifications are produced. This speed is only made possible through open research collaborations. When costumers are satisfied with the product, companies' revenue will increase; thus higher funding could be allocated for R & D activities.

To put it briefly, open research practice has clearly proven to be beneficial for all sectors of society. It is time to prioritize collective science advancement, not only individual interest in scientific research. Mindset revolution in academia is a must in this increasingly globalized world. By developing standardized guidelines, hopefully the transition to open research will be smoother for scientists worldwide.

References

1. European Commission. Evaluation of Research Careers fully acknowledging Open Science Practices. Rewards, Incentives and/or Recognition for Researchers Practicing Open Science. Publications Office of the European Union: Luxembourg, 2017. Available online: https://ec.europa.eu/research/openscience/pdf/os_rewards_wgreport_final.pdf (accessed on 11 September 2018).