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EDITED BY
Ai Sugiura,
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REVIEWED BY
Peter McGrath,
InterAcademy Partnership, Italy
Otmane Azeroual,
German Centre for Higher Education Research and Science Studies (DZHW), Germany

*CORRESPONDENCE
Ali Talha Khalil
alitalha.khalil@lrh.edu.pk

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Fostering openness in open science: An ethical discussion of risks and benefits

Ali Talha Khalil[1]*, Zabta Khan Shinwari[2] and Arshad Islam[1]

[1]Department of Pathology, Lady Reading Hospital Medical Teaching Institution, Peshawar, Pakistan, [2]Department of Plant Sciences, Quaid-i-Azam University, Islamabad, Pakistan

Transformation of science by embracing the concepts of open science presents a very attractive strategy to enhance the reliability of science. Open science policies embody the concepts of open data and open access that encompass sharing of resources, dissemination of ideas, and synergizing the collaborative forums of research. Despite the opportunities in openness, however, there are grave ethical concerns too, and they present a dual-use dilemma. Access to sensitive information is seen as a security risk, and it also possesses other concerns such as confidentiality, privacy, and affordability. There are arguments that open science can be harmful to marginalized groups. Through this study, we aim to discuss the opportunities of open science, as well as the ethical and security aspects, which require further deliberation before full-fledged acceptance in the science community.

KEYWORDS

open science, ethics, dual-use dilemma, security, privacy

Introduction

The replicability of scientific results on all levels is considered a major pillar in all research subjects. Academia of the modern day suffers from a phenomenon, often referred as hyper-competition, in which the quality of academics is mostly judged by quantitative parameters such as the number of impact factor publications, h-index, and citations. Such indicators are known to influence appointments and promotions and have given rise to a perceived publication pressure, i.e., "one has to publish for staying in the academia." Such pressure on academics can generate high-quality articles. But, on the downside, if the focus becomes centered on quantity, it can be disastrous and may lead to the low quality of research articles (Haven et al., 2019), as the focus is centered on quantity. This has eventually caused a concern, which is now known as a replication crisis or reproducibility crisis in science. Failures in the replication of the experimental work are detrimental to science as they create mistrust on science and scientists. There can be many reasons, i.e., from data fabrication to erroneous methods or protocols that are used in the research. The replication crisis has propelled the idea of shifting toward open science that is believed to restore faith in the research conducted. Open science constitutes a diverse range of practices for making research more reliable and includes sharing of data and research materials (Allen and Mehler, 2019; Harremoës, 2019).

Generally, the concept of Open Science relates to strengthen good scientific conduct, as well as communication, by making the scientific processes transparent and increases the visibility of results to the scientific community and general public (Besançon et al., 2021). The umbrella term of Open Science embodies visibility, reproducibility, replicability, reliability, transparency, and rigor in scientific research and encompasses concepts of Open Access (open access relates to the free access of scientific articles), Open Data (relates to open access to data, related methods, experiments, procedures, data sets, etc.), and Open Peer Review (relates to the sharing of reviewer reports and reviewer information publicly) (Ross-Hellauer, 2017; Sarabipour et al., 2019; Besançon et al., 2021).

Promises of open science

The most lauded argument by the proponents of Open Science has been that open practices and open sharing of data shall galvanize scientific integrity, speed up scientific progress, avoid duplication of scientific work, and henceforth scientific resources, and bring transparency. Another argument widely presented is the obligation to reciprocity. In the context of science, reciprocity merely reflects that scientific results are the product of the research that has been funded from the public or taxpayers' money, and the results should be made available to those who paid for it in the first place (Parker, 2013; Tubaro, 2021).

The need for a reliable and robust science infrastructure is strongly felt in view of the expectations of the society, increasing demand for R and D, and the promotion models in academia, which basically relies on the number of publications. Most recently, there has been an increasing trend in the retraction of papers owing to methodological weakness or false claims that have adverse consequences (Besançon et al., 2021; Yeo-Teh and Tang, 2021). Data integrity-related retractions from elite journals during the COVID-19 pandemic are witnessed and have raised concerns from the scientific community as well as from the public (Ledford and Van Noorden, 2020). Such incidences not only damage the reputation of science and waste resources but also have a dreadful impact in terms of science-informed policies that are based on knowledge or claims emerging from scientific knowledge. In this context, the movement of Open Science is getting popularity and overwhelming response as it addresses the complexities of research and provides a model for data validation and re-analysis, as well as for making scientific knowledge and discoveries more accessible (Mohamed et al., 2020). In addition, the Open Science models will provide opportunities for the democratization of the science knowledge and enhance their visibility and accessibility to institutions with meager resources (Holbrook, 2019; Brabeck, 2021).

The concept of openness in scientific data is interwoven in FAIR principles, i.e., making the data Findable, Accessible, Interoperable, and Reusable. Findability is the first step in the access to the data that relates that the data are available after searching on the web. Accessibility relates to the authorization for access to the data. Interoperability relates that the data should be able to integrate with other data. The reusability principle relates that the data should be usable, combined, and extended in different settings (Hasselbring et al., 2020). Simply, open access to the data is not enough, rather the data should be intelligently made open after thorough scrutinization (Boulton et al., 2012). Despite crucial advantages like the increase in the reliability and validation of scientific data, there are legitimate exceptions where there are breaches of privacy, safety, and security.

The work of Robert Merton (Merton, 1973) that reflects the five norms of science, collectively referred as CUDOS, can be used to guide open science. Mertonian principles are universalism, communality, disinterestedness, and organized skepticism. Universalism reflects impartiality and generalization of claims. Communalism refers to the precedent that scientific work is collaborative in nature, and therefore, everyone should benefit from the research. Disinterestedness reflects the scientific rigor and the role of the scientists in technically sound research work. Organized skepticism relates to the awareness of controversial issues from research (Smart et al., 2019; Conley, 2021).

Perils and ethical considerations of open science

At the first sight, the promises of Open Science, like enhancing the accessibility, authenticity, replicability, visibility, and democratization of knowledge, are laudable goals with goals accepted unconditionally across the science community (Düwell, 2019). On the contrary, however, scientists are voicing their concerns over the hurried embrace of Open Science as it raises intricate societal and ethical challenges across different areas of medical, educational, behavioral, and social sciences.

Concerns over stigma and privacy in open data

One of the major concerns regarding the open science models relates to the violation of fundamental ethical principle of the privacy of the uninformed and/or nonconsenting individuals and communities (Hartter et al., 2013). The societal benefits of open data sharing come with an inherent risk of leaking sensitive information. Sharing of data constituting sensitive information can have negative consequences, and in many cases, it is illegal (Dennis et al., 2019). For example, releasing results of certain surveys that reflect personal opinions

or views can be misused, or releasing results about some specific medical conditions can influence employability or can lead to some sort of discrimination or stigmatization (Beauvais et al., 2021). Already marginalized communities bear a significant risk of further marginalization through the data available or retrievable by the public (Sweeney et al., 2018). Other authors have reported their concerns over sharing the data publicly that include victims of trauma, such as those who suffered sexual violence (Campbell et al., 2019). Another example is that research on schizophrenia among certain communities may result in discrimination. The stigmatization often results from those segments of the public who are not well versed in scientific knowledge or are not aware of the context of research that results in misinterpretation (Illes et al., 2010). Henceforth, good research communication strategies should be adapted to avoid any sort of stigmatization and discrimination.

Similarly, sharing genomic research also presents a substantial risk. In genomic research, it is possible to infer the phenotype of individuals from their genomic sequences, and it can help in the re-identification of personals even if the data have been scrubbed off explicit identifiers (Malin and Sweeney, 2004). In one of the studies, researchers were able to identify people by predicting their phenotypic traits through whole-genome sequencing (Lippert et al., 2017). There are substantial privacy concerns on the long-range familial search in which the DNA sequences deposited in the publicly accessible database can be used to identify people within wider families. Despite applications in DNA-based forensic investigations, it bears significant privacy concerns (Callaway, 2018). Even if someone's genomic record has not been generated, their traits can still be revealed using a shared genotype of their relatives (Wan et al., 2022). Moreover, the openly available genome sequences have the risk of dual use. With advanced technologies, like synthetic biology, it is now possible to create a potential virulent agent as a biological weapon (Koblentz, 2017; Sun et al., 2022).

The considerable inherent risk of data sharing is yet to be properly resolved in the Open Science models. While the proponents claims that the data can be anonymized or de-identified, however, there are instances in which the anonymized and de-identified data have been re-identified revealing study settings and individual participants. Similarly, it is proposed that relational studies are at higher risk of re-identification even if the data have been without the known identifiers (Ross et al., 2018). With very few data attributes, researchers are able to identify 99.8% of the participants (Rocher et al., 2019).

At present, the data de-identification practices are in their infancy or are insufficient, while the researchers are not adequately trained for the safe handling of the data. It is often assumed that the data are anonymized after removing the distinct identities; however, identification and de-anonymization of the data can be possible after linking them through different datasets (Fox et al., 2021). All discussions related to privacy also involve a fundamental question about the actual ownership of the data, and whether the data are owned by the institute, the researcher, or the participant. The institutional ownership and corporate ownership of the data remain controversial. The infamous Cambridge Analytica and Facebook scandal, in which the data of 87 million Facebook users were exposed for political motives, necessitates a more robust infrastructure that protects and respects individual privacy (Dennis et al., 2019).

Despite the need for open data has been trumpeted, it bears an inherent trade-off with individual privacy and possesses a dual dilemma. It is clear that open science policies have benefits; however, opening the data bears significant risks to privacy and confidentiality. The information openly available on the internet and open databases increases its visibility, persistence, and accessibility to an unknown global audience (Trevisan and Reilly, 2014), which may use this information for nefarious purposes. Control over privacy shall have detrimental effects on the social wellbeing.

Concerns over open review

Publications are the cornerstone of the entire scientific enterprise, and for that matter, the editorial board of the journals subjects the submitted manuscripts to a rigorous peer-review process, which traditionally involves sending the manuscript to anonymous reviewers. This model has been adapted by a major proportion of scientific journals. One of the drawbacks of the anonymous review is related to the systematic bias against authors. For example, regional and gender-based bias has been reported in the peer-review processes (Wold and Wennerås, 1997; Link, 1998).

Open review is one of the flavors of open science that intends to open the peer-review process in academic publishing for ensuring transparency and improve the quality of peer-review process (Nature., 1999). The open review reflects that the author, handling editor, and reviewer are aware of each other's identity. It is believed that such a review mechanism shall increase transparency, speed up the overall peer-review process, incentivize reviewer ship, and invite stronger criticism over the submitted articles for improving their quality (Barroga, 2020).

On the downside, there are concerns over the open review mechanisms; for example, it is believed that open review may contribute to increase nepotism (Nature., 1999). For example, there can be possibilities where influential authors may be favored because of their positions or there can be expectations for certain benefits like reviewing of grants, honors, etc. Authors and reviewers while knowing each other can set some mutual trade-offs. Unethical practices may include conditional favorable reviews, opposing ideas of others, etc. Open review may also discourage young scholars from reviewing the research work of already established scholars because of the fear of having a negative impact on their career (Wendler and Miller, 2014).

Distinguished authors will enjoy benefits as compared to the junior authors who may utilize such opportunity to build their career. There can be instances where the less established authors try to mold the negative reviews by adding citations of known reviewers.

Extensive research is required in the context of searching the ideal models for peer review. Both the anonymous and non-anonymous peer-review systems have their own benefits and drawbacks. The desirable and unwanted impacts of the open review and their overall efficacy in improving the publication system are yet to be determined. Some authors suggest that the effect of open review can be exactly the opposite with least openness and honesty (Park, 2020). It shall be justified to infer that the abuse of the reviewing system, whether open or close, is largely driven by personal motives and behaviors. While there is no consensus on the best review models, it is important to create awareness among the science and academic community regarding the responsible conduct of reviewers and ethical practices in peer review, which may help to mitigate the abuse of peer review.

Affordability of open science

Open access to knowledge is one of the pivotal concepts of open science that relates to the free availability of knowledge, i.e., journal articles without subscription, payment, or registration (Björk, 2017). Accessible knowledge is the foremost step in knowledge translation that benefits the society, policymakers, or other quarters that make use of it (Smith et al., 2017). The ethical argument for the need of open access is that the knowledge generated from the taxpayers' money should not be concealed from them (Ware and Mabe, 2015). There are also arguments for open access to the empirical research data that have their own benefits and risks already discussed. The open access is interwind in the problem of affordability and accessibility. The open access may solve the accessibility issues but the affordability will remain a problem. For example, for a journal following a closed access model, the readers of the journal subscribe by paying a certain amount of fee, making the journal visible only to those readers who are willing to pay. Even the wealthiest universities cannot afford to subscribe to every journal, and therefore, the subscription model is considered unsustainable (Poynder, 2014). On the contrary, the open access models rely on the authors to pay for their articles to become freely available to the readers, and the article processing charges paid by the authors are usually too high which can barely be afforded by the scientists, especially in the global south. This will broaden the inequity regarding knowledge dissemination between the developed and under-developed world. The open access model shall lead science to restrictive publications if the barrier of the article processing charges (APC) remains too high to afford (Schroter et al., 2005). Now many funders across many regions provide special grants for publishing results originated from the grant as open access. Countries in the south should encourage the funders to allocate budget for the open access publishing. However, in economically challenged settings, it is regarded as very difficult. Equity and fairness in the open science relate to equitable benefits, and the open science may contribute to another digital divide between the north and south (Aubry et al., 2022).

Other pertinent concern relates to double dipping which is applied on the publisher's gaining income from two streams from the same customers. There has been an ongoing debate that the subscription charges for academic institutes should be lowered with the rise in the APCs. It is imperative that the total cost of publishing should be understood (Pinfield et al., 2016).

To avoid the scientific divide and ensure equitable access, multilateral strategies with cooperation from the academic community are considered crucial. One of the recent statements by the TWAS Young Affiliates Alumni Network (TYAN) urged to make equitable access by encouraging a global financial network aiming to support the R&D activities and encourage non-commercial-based open access publishing (https://tyan.twas.org/news/article-processing-charge-apc-policies-on-open-access-oa-publishing-model/).

Predatory open access journals

Since open access journals rely on the APCs submitted by the authors for making them freely available, it has created a profitable niche for publishers (Green, 2019). As a result, different publishers while offering relatively less APCs publish articles with no proper peer review. Such journals have been termed as predatory journals and are considered by-products of the open access movement. Such publications are driven not only by monetary benefits but also by major contribution from the reward systems that merely rely on quantity and not quality (Beall, 2017; Kurt, 2018). Mostly, young scholars, doctoral students, and academics in line for promotions/awards/honors are tempted by publishing in predatory journals. Publishing more and more journal articles in open access journals effectively relates to higher income in the form of APCs. Predatory journals have emerged as a grave concern in the science community because of their unreal nature, pseudoscience, no peer review, and compromised quality (Duc et al., 2020; Krawczyk and Kulczycki, 2021).

Discussion and recommendations

Generally, the open science movement that is interwind in the concept of knowledge sharing and accessibility is critical to harvest the benefits of science, education, technology, and innovation. Open science aims to

incorporate credibility to the scientific enterprise by adding dimensions of reproducibility, rigor, and transparency and to encourage collaboration for sharing data, tools, and content (UNESCO., 2021). On the contrary, the hurried embrace of open science can be detrimental to the society and should be treated in the context of duality. Some of the recommendations in this regard are given as follows.

Encourage ethical embrace of open science

In the context of the earlier discussion, open science policies can raise ethical issues like compromising the privacy, thereby accessing the open data. Even, it has been reported on different instances that the anonymized data have been re-identified. The open access models should not allow a breach of the privacy and confidentiality except for special cases; otherwise, it may open a gateway for privacy abuse. The trade-off between openness and privacy should be balanced, monitored, and regulated.

Develop open science infrastructure

Adaption of open science policies shall greatly depend on the SETI infrastructure and R&D capacity of countries. Creating a shared knowledge repository, shared physical resources, shared facilities, and continued efforts for sustainability shall require commitment and support from the highest levels and international organizations. Additional research-related resources may be required to ensure a transparent flow and knowledge sharing. Alternative open science evaluation mechanisms need to be designed for recognition in academia. New ways need to be identified through which open science can be funded.

Inclusive policy-making

The values of open science are based on participatory approaches, collaborative work, and mutual cooperation, and the aim is to expand the harvests of science beyond race, color, ethnicity, region, social status, and all such social determinants. Therefore, policies and regulatory frameworks regarding open science must reflect a color-blind commitment for respecting diversity, minorities, marginalized groups, economically compromised regions, etc. Furthermore, for making coherent and robust policies, all stakeholders (researchers, academic/R&D institutes, publishers, public, government ministries, etc.) in the ecosystem need to be involved in policy-making.

Incentivize ethical practices

Widespread acceptance and applications of open science are dependent on the fact that open science needs to be done ethically. It is important to develop an academic culture in which open practices, academic integrity, and ethics are incentivized. For example, the promotion models in academia and research may be tailored in a manner that weighs open science practices in promotions, awards, and honors. There is a dire need for the stakeholders and institutions for taking up an inclusive approach and engage with researchers to devise policies aiming at encouraging incentives for open science.

Making open science affordable

A grave concern over open science practices relates to their cost; for example, open access journals request for payments in the name of the APCs that are afforded only by wealthier institutes. This creates a massive hurdle for scientists in the relatively poorer regions, which leads to a dichotomy, inequity, and a scientific divide between wealthier and non-wealthier scientists, institutions, or regions. Consequentially, this divide resulting merely from economic privilege kills the essence of open science. Efforts and policies are required to make open science an affordable science enterprise, as already many of the scientists from the poorer regions face different hardships.

Monitoring and evaluation

Rigorous and periodic monitoring and evaluation frameworks shall be extremely important in the acceptance and prioritization of open science. Designing effective tools and strategies shall provide continued oversight regarding open science. Monitoring and evaluation of the scientific record and integrity should be considered. A recent study on the vanishing of open access journals indicated that few of the open access journals across different disciplines were not available anymore. Efforts need to be strengthened for persevering the knowledge on open platforms (Laakso et al., 2021).

Awareness

Steps should be undertaken that aim to raise awareness on local, national, and regional levels. Frequent dialogues regarding the benefits of open science-related costs and ethics by inviting different stakeholders, especially from the young generation, will help in the

widespread understanding of open science and its processes and values.

Conclusion

Open science is an emerging science enterprise that embodies the core values of knowledge sharing, accessibility, and reusability. However, open science has a dual side and raises numerous ethical and security issues. The duality of open science necessitates meaningful ethical, social, and economic debates before embracing the open science models across the larger diaspora of science and academic communities.

Author contributions

AK and ZS conceptualized the manuscript. AK prepared the draft article. ZS and AI reviewed the final draft and provided suggestions for improvement. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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