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Removing Barriers: Open Science for Climate Change Solutions and Social Justice

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Abstract:

Open science, which by necessity involves open access, is a meaningful way to bring research and insights to a global population. While seen as an expensive option in the past, new customs for sharing are evolving and preprint articles have taken on a greater role in the open science dialogue. The rapid development of a vaccine for COVID-19 can in large part be attributed to open science. Based on this success, we can anticipate that open science and open access when applied broadly and specifically to urgent issues such as climate change and social justice would produce similar breakthroughs. Libraries has long been proponents of open access; however, they are often seen as book repositories. Recognition of libraries are integral to the success of their communities and attention to the role of libraries as partners in the Sustainable Development Goals would lead to greater achievement of these goals.

Keywords: Open Science, Open Access, Libraries, Sustainability, Social Justice

Introduction

With so many large-scale issues pressing on us as a global community, the ideals of sharing data, articles, textbooks, code, and other research products, have taken on more meaning and more real-life application. We saw the benefits of rapidly sharing information whether it be genome sequences, data tools, or publications in our international efforts to understand and protect ourselves from the deadly COVID-19 pandemic (Le Guillou, 2020). The early success in the development of a vaccine implores us to ask what else could we accomplish if we

adopted the principles of open science more universally. Certainly, we have other urgent issues such as climate change and social inequity that could benefit from the same attention to collaboration that open science provides.

Open Science

Open science includes shared notebooks, data tables, data tools, figures, charts, graphs, reports, articles, and textbooks. Each format can illuminate understanding in another investigator, be they in the next office or across the globe. Open science furthers equity by sharing information about diseases for which cures are hampered because they are rare in the global north. An estimated 241 million people worldwide were infected with malaria in 2020 and approximately 627,000 people died. According to the World Health Organization (WHO), 96% of these deaths occurred in the WHO African Region (WHO, 2022a). In October 2021, a vaccine for malaria was approved following 30 years of development; however, it has moderate efficacy of 30% after four doses (Maxmen, 2021).

We saw the power of open science to accelerate the development of a vaccine for the COVID-19 virus, which is highly effective after two doses with an efficacy of 94-95% for both Moderna and Pfizer (Olliaro, 2021). COVID-19 spread rapidly around the globe and as of June 15, 2022 has killed over 6.3 million people worldwide (WHO, 2022b). The seriousness of this disease was recognized early on. The Shanghai Public Health Clinical Center & School of Public Health posted the full genome for COVID-19 from the first patients in early January 2020 on an open access platform, virological.org, as well as to GenBank, a U.S. genetic sequence database (Cohen, 2020).

Premier journal publishers such as Elsevier and Springer Nature eliminated paywalls to allow the sharing of research about COVID-19 to accelerate the development of vaccines and treatments (Arrizabalaga et al., 2020). Elsevier created the Novel Coronavirus Information Center, which was last updated in November of 2021 (Elsevier, 2021). Springer Nature created a similar resource, Coronavirus (COVID-19) Research Highlights for the rapid and open sharing of COVID-19 research information (Springer Nature, 2021).

In response to the pandemic, open data, open science, and platforms for sharing genome sequences have made international collaborations much easier (Le Guillou, 2020). The need for open sharing has not ended with the advances in combating the COVID-19 pandemic. The latest posts to the free and open viral genome repository, virological.org, reveal that MonkeyPox is an emerging disease of concern. The whole genome of MonkeyPox has been posted to this online forum, in addition to a paper expressing an urgent call for non-stigmatizing and non-discriminatory language for the MonkeyPox virus (Happi et al., 2022). To stress the point about how diverse voices are needed to further efforts of equity and inclusion, the first author on this preprint is from Nigeria.

When research is shared it can have a real-world impact that helps inform human, environmental, and scientific issues that need attention and answers (Jones & Campbell, 2021). Our experience with open science through the COVID-19 pandemic has shown us, more than ever, the potential that freely and openly sharing information can have on the development of new knowledge and in this case, vaccines to prevent a deadly disease.

Communally developed knowledge can be applied to rapidly developing situations for the common good. We live in a time when we are aware that we share one vulnerable planet and

that our decisions do not exist in isolation. Open science can engage researchers in global issues such as climate change that require multidisciplinary approaches and international collaboration (Jones & Campbell, 2021). Ultimately research regarding our most pressing issues and societal challenges must shape policy decisions that make a difference on the global stage.

Libraries and Sustainability

Libraries contribute to the UN Sustainable Development Goals (SDGs) across a broad spectrum of countries in Africa including Ghana, Kenya, Nigeria, South Africa, Tunisia, and Namibia as evidenced by the literature and the International Federation of Library Associations and Institutions SDG Stories Map (Lynch et al., 2021). However, libraries in these countries are rarely recognized as community partners, which makes it difficult to get the funding necessary to maintain and grow programs. The potential for libraries to contribute to the SDG is substantial and has been articulated since the 1953 UNESCO Public Library Manifesto, in which UNESCO agreed to partner with African libraries to support formal and informal rural education programs. Unfortunately, efforts toward this partnership were stymied in the 1970s when a shift in philosophy emphasized information for the purposes of development. Libraries also suffer from a misunderstanding that they are book repositories instead of active contributors to the wellbeing of their communities. Awareness of the potential of libraries to contribute to the SDGs remains low; therefore, more advocacy and greater visibility of African libraries and their contributions is much needed (Lynch et al. 2021).

Libraries are important contributors to solutions that further sustainability efforts. In the U.S., there are many projects and organizations working directly with libraries to establish sustainable practices and assist in the development of community collaborations (Tanner et al., 2022). For example, the Sustainable Libraries Initiative is a member organization that maintains a Sustainable Library Certification program and pairs participants with a mentor to guide them through a review of their organization and identify ways they can become more sustainable (Sustainable Library Initiative, 2022).

Additional programs found in U.S. libraries include hosting Repair Cafés, disaster preparedness events, seed libraries, and designing green library projects such as planning building upgrades for greater energy efficiency. In a recent book on sustainable practices in libraries there is a call for a new circular economy, which was inspired by Doughnut Economics (Raworth, 2017), and articulates seven ways libraries can help society transition to a more just and life-sustaining economy (Tanner et al. 2022).

Preprints

Another interesting trend that preceded COVID-19, but has only grown and expanded as the result of the success attributed to the rapid exchange of health information during the pandemic, is the publication of preprints to open digital repositories (Harris, 2022). Traditionally published articles typically take months to publish (Le Guillou, 2020). On the other hand, preprints are manuscripts that authors prepare for submission to a journal. They can be published before submission to a journal and therefore, have not gone through the editorial or peer-review process at the time of open access publication. To track these documents, they are assigned a Digital Object Identifier (DOI), an open license, and citation information. This makes them easy to locate and bibliographic measures such as downloads

and citations can be easily measured (Harris, 2022). One well known free and open digital repository, arXiv, is provided by Cornell University and houses well over 2 million scholarly articles, which are not peer-reviewed by arXiv (arXiv, 2022). While it has been a practice in fields such as physics, computer science, mathematics, and quantitative biology to share preprints, this practice is less common in other fields such as medicine, but is rapidly growing in importance (Harris, 2022).

The role of preprints to share information globally and rapidly is beneficial for both prosperous and under resourced countries. The continental preprint archive AfricaArXiv was released in 2018 and has articles from 33 African countries (Harris, 2022). This archive has the potential to increase research visibility, data sovereignty, and bring greater awareness of indigenous knowledge. This archive can also further equity in research by increasing the distribution of regional knowledge and in a variety of languages (Harris, 2022).

A publisher of open access biomedical and life science manuscripts, eLife, announced in July 2021 that authors would be required to submit their preprints to an open archive before consideration by the journal (Harris, 2022). Additionally, eLife now publishes the reviews alongside the preprint, which essentially shifts eLife to a reviewer of previously published research. In addition, many funding agencies require or encourage the deposition of preprints prior to acceptance by a journal (Harris, 2022). This new and exciting trend can change peer-review as we know it.

While peer-review is changing and the order of tasks can be shifted to move peer-review after publication, peer-review is still a valuable contribution to the credibility and rigor of the publication process. One challenge with the proliferation of preprints is that the peer-reviewed version, or version of record is not consistently linked to the preprint version. Moreover, most preprint servers do not have an automated way to link to the published version. A failure to connect the two can result in a preprint that continues to be cited even though the journal-published version was retracted (Avissar-Whiting, 2022).

Barriers to Sharing

To enjoy the benefits of open science, we must remove the barriers to sharing, which include rewarding novelty and competition. The preference for novel findings in the literature is well documented and makes it less likely that experiments will be repeated and thus have high power (Tiokhin et al., 2021). Strength in our understanding and trust in our findings occurs through replication of experimental results. The sharing of data and methods helps increase the reproduction of results and when replication is lacking, we have less confidence in the results of the research. A recent paper on the topic by Tiokhin et al. (2021), demonstrates that rushing to be the first to publish can lead to smaller sample sizes and errors. Smaller sample sizes reduce the reliability of the findings and reduce the overall quality of the research. The authors support a variety of reforms, including preregistration research plans as protection against scooping. Interestingly, the authors found that encouraging and rewarding the publishing of negative results, which has been suggested as a reform, would exacerbate the problem, and once again result in smaller sample sizes as the goal would essentially shift to getting published no matter the outcome of the study (Tiokhin et al., 2021).

Another barrier to sharing is article processing charges (APC), which often accompany open access publishing. These fees vary by publisher and are paid by the author and can range from several hundred to several thousand U.S. dollars (Jain et al., 2020). Some solutions to

overcoming this barrier include Green and Platinum models of open access publishing. Green open access refers to self-archiving by the author of a preprint to an open repository. Platinum open access refers to a model where there are no APC for the author and the published work is permanently and freely available to readers (Jain et al., 2020). Efforts to overcome the barriers to sharing are evolving and well worth the effort.

Research also shows that articles that are published open access have a citation advantage and are shared more widely through social media platforms than articles behind paywalls (McKiernan et al., 2016). While there is some variability in the size of the advantage based on the discipline, what is even more interesting is that the advantage can occur for fully open-access journals, partially open-access journals (hybrids), and open repositories where papers are self-archived (McKiernan et al., 2016). Clearly, open access is what makes the difference and not the platform the article is shared through.

Open Textbooks

Open educational resources (OER), which include open access textbooks, can help increase college course pass rates (Smith et al., 2020) and decrease withdrawal rates (Clinton & Khan, 2019), which may be due to removing the financial burden of textbooks and ensuring that all students, regardless of financial assets, get the information they need to be successful in their courses. A recent study of faculty motivation to use open textbooks revealed that while they were most motivated by the ability to save students money, they also valued the ability to ensure all students had access to the course content, the ability to repurpose materials so that content could be modified and customized for specific purposes, and lastly all this could be provided without compromising on quality (Ozdemir & Hendricks, 2017).

In the U.S., the Department of Education administers an Open Textbook Pilot program funding by Congress (SPARC, 2022). Begun in fiscal years 2018 and 2019, the program dedicated \$5 million to the effort as part of an overall budget of \$2 billion for college completion and affordability. The first of the funding was awarded solely to LibreTexts, a large consortium, and the second round, which totalled \$2.5 million was awarded to Chippewa Valley Technical College and Arizona State University. As of 2022, 16 pilot projects have been funded and \$35 million dollars have been appropriated. The goal of organizations such as SPARC (the Scholarly Publishing and Academic Resources Coalition) is to create a permanent appropriation of funds for this effort. Grantees estimate that the Open Textbooks Pilot has saved students over \$200 million dollars, which is a sizeable return on investment and will grow with time (SPARC, 2022).

Less than a decade after offering its first free textbook in 2012, OpenStax documented saving students over one billion dollars (Falk, 2020). The availability of programs such as OpenStax, with its peer-reviewed textbooks, have improved access to course readings without sacrificing quality (Falk, 2020). Imagine the potential savings possible and how this can spark innovation in teaching with the ability to reuse and remix content, and, without reservation, require that students consult a textbook for a course even if only a small portion will be used. Lack of access to textbooks due to financial need is a barrier to equity among students.

A recent conversation with students in a class about social justice demonstrated that even students who have the means to purchase textbooks are concerned about the cost of textbooks and realize that this impacts their fellow students. They are supportive of open access

textbooks and would like to see real traction in this area. Some think they have found ways around these expensive purchases by downloading the full-text from questionable online sources. Other students who are either unaware or wary of this option have employed other tactics such as waiting to see if the professor will use the textbook in the course, trying to make do with out-of-date textbooks, or going without completely.

Conclusion

Open science lowers the barriers to information access and helps the fruits of research to be shared more broadly. The equitable distribution of research papers, data, and methodologies increase inclusivity and distribute the opportunities that knowledge provides (Grahe et al., 2020). Sharing research data also helps others apply new questions to the data and may give it new life. Sharing findings also increases the generalizability. For instance, when a wider array of individuals have access to research, data, and methodologies, they apply their diverse experiences and perspectives to this information and bring new perspectives to the knowledge they discover (Grahe et al., 2020).

By design, open science is transparent and through open science we can explore solutions to some of our most pressing issues, which extend beyond pandemics to include climate change and social injustice. To enjoy the benefits of open science, we must remove the barriers to sharing, which include rewarding competition and novelty by overvaluing the “first to discover” and undervaluing those who replicate results (Tiokhin et al., 2021).

Open science can transform lives, create more equity in the world, and decrease suffering. Academic libraries have a role to play in educating their faculty about open science and curating the findings produced. Of the hesitations that researchers have expressed regarding engagement in open science is fear of being scooped; however, a recent article in *Nature Human Behaviour* finds that rushing to publish creates sub-standard methods (Tiokhin et al., 2021) and one solution that is gaining traction is Registered Reports that allow research proposals to be submitted and peer-reviewed for acceptance as publications prior to engaging in research (Chambers & Tzavella, 2022). The “group think” that is possible through open science is critical for the scale of issues we are facing and incentives for sharing will need to continue to be developed to encourage acceptance of the principals and processes of open science. As academic librarians we are in a unique position to facilitate wider adoption of open science at our institutions and beyond.

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