Digital Communication

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Open science in the digital age

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Open science provides faster, easier access to data, technologies, and tools that can be used to drive innovation and accelerate research and solutions to ongoing or future social crises. When combined with the myriad of digital communication tools and platforms available today, the effects of open science can be amplified even further. This article explores how open science has evolved in the digital age and gives a closer look at the role digital communication, mainly social media, has played in pushing forward the open science movement within the scientific community and beyond its borders.

Open science

To some, open science may seem like a novel, modern-day concept, given its fitness to the digital age. But open science dates back to the late 1600s, around the time of the first scientific journal. During this time, scientific theories were openly questioned and experiments frequently repeated to test the reproducibility of results. As many of us will recognise, this practice has faced challenges in the not-so-distant past, primarily due to more and more elements of scientific research being closed, including access to data, methodology, and publications. Such a lack of openness in research impedes not only the scientific process but also the scientific discourse needed to produce scientifically sound, reproducible, and relevant results. It furthermore unfairly limits certain members of society, like the general public, from learning about and being a part of conversations around the latest research and discoveries.

As the Age of Information began, more advanced technology became available to share information and build networks, bringing digital communication to the forefront and alongside it the open science movement. In 2017, Bradley Voytek from the Department of Cognitive Science at the University of California argued that open science, data science, and social media are all inextricably linked, sharing underlying social and technological transformations that have in one way or another influenced the practice of science in recent years.[1] Some of these events include:

1. The launch of *PLOS Biology* in 2003, an open access pioneer which boosted open-access publishing
2. The critical article by John Ioannidis in 2005, "Why most published research findings are false"
3. The launch of *PLOS One* in 2006 to facilitate post-publication peer review
4. The launch of GitHub in 2008 to make scientific version control easier.[1]

Of course, the Budapest Open Access Initiative (BOAI), developed in December 2001, played, perhaps, the most important role in rebooting the open science movement. The initiative was created by people from around the world and from different academic disciplines. It called for the old tradition of researchers publishing their findings (free of charge) in scientific journals to be combined with the new technology of the Internet – removing access barriers to accelerate research, enrich education, and connect humanity in a common intellectual conversation and quest for knowledge.[2] Two subsequent initiatives, inspired by the BOAI, were critical in broadening and strengthening the support base for open science, namely the Bethesda Statement (April 2003) from Howard Hughes Medical Institute and the Berlin Declaration (October 2003) from the Max Planck Society.

Open science today embodies many different components, but at its centre, it involves open access, open methodology, open data, open source, and open peer review. It enables the critical evaluation of the major components of scientific research, facilitating collaboration in relevant networks, and sharing essential knowledge with all levels of society whether amateur or professional.

Open access

Since the milestones in the open science movement in the early 2000s, over 18,000 high-quality, peer-reviewed journals have become open access. That number grew from a mere 300 open-access journals in 2003 (see: https://www.doaj.org/), opening up science like never before and bringing an unprecedented level of transparency to research.

In the scientific community digital communication, especially social media, has become a research tool scientists use to leverage their work. Having a strong online and social media presence gives journals, scientists, and companies a platform to raise their profiles and promote their content. For anyone who is interested in science, social media is an ideal dissemination tool and source of information given its affordability, convenience, and ease of use. Through digital communication, users can access and share information on many different topics and from various sources, give opinions, and gain a better understanding of current events. But how have digital communication platforms like social media benefited the open science movement? And how have open access and social media combined impacted society?

A matched-pair analysis of links to open-access vs. paid scholarly articles on social media assessed the effect of open access on the reach of scientific information.[3] Unsurprisingly, open-access links were found to perform better than paid content links, as measured by a higher number of post clicks. These results would suggest that combining social media with open-access features enhances the reach of scientific information, and that social media exposure to scholarly articles likely promotes the use of research outputs.[3] Indeed, the use of professional social media platforms like ResearchGate, LinkedIn, and Publons have become immensely popular among scholars. Even healthcare providers and public health organisations make regular use of digital communication platforms like social media, online forums, messaging apps, websites, video conferencing, and blogs. The inherent openness of these platforms to wider audiences and the possibility to communicate bidirectionally has, among other things, helped make science more inclusive and strengthen relationships between different groups within and outside of the scientific community.[4] In addition to improved visibility of their work, scholars can also receive informal/public reviews and blind peer reviews – the analytics of which can be used to support their professional/academic careers (e.g. job and funding applications).[4]

Spending time on social media undoubtedly allows users to acquire transferable skills to boost digital literacy that can be applied to other online environments, further enhancing the open science experience. Successfully reaching wider audiences on digital platforms requires finesse. In this way, open access has pushed scientists to broaden their expertise and improve their science communication skills to produce widely appealing and understandable communications (e.g. plain language/lay summaries, newsletters, and blogs). Favourably, numerous journals have embraced the incorporation of digital features (e.g. videos, infographics, graphical abstracts) to complement published articles, which require the use of specialised graphic design and/or video editing software, and, in some cases, social media performance tracking capabilities to assess impact (e.g. PlumX Metrics).

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In many ways, the COVID-19 pandemic confirmed the scale and speed with which open science combined with social media and other digital communication channels can benefit society.[5] Throughout the pandemic, both open science and social media played crucial roles in facilitating scientific exchange that supported diagnostic and drug/vaccine development and ameliorated the public health response.[6,7] Reportedly, over 100 organisations, including journals and funding bodies, committed to opening access to COVID-19 research data, including articles and protocols, which were made freely available through the COVID-19 Open Research Dataset CORD-19.[5] In January 2020, scientists from China published the first whole-genome sequences of SARS-CoV-2 on the Global Initiative on Sharing Avian Influenza Data repository – an open-access data repository for genomic data of influenza viruses (GISAID). Australian virologist Eddie Holmes went one step further, sharing (what he referred to as) the initial genome sequence of the coronavirus on Twitter, linking to the discussion forum for the analysis and interpretation of virus molecular evolution and epidemiology Virologist.org. [8] These, and other similar events, gave scientists around the world access to the initial data needed to understand the virus and combat its spread and associated disease. Holmes, in an interview from 2021, reiterated "the importance of global research collaboration and open sharing of findings, which makes science faster, more efficient and more accurate", when referencing the more than 400,000 research papers that have been written on COVID-19 since the start of the pandemic and the lightning speed at which new COVID-19 tests, treatments, and vaccines were created, saving millions of lives.[9]

Social media has also grown to be a useful source of data to answer a wide range of research questions from various disciplines, to better understand societal phenomena. For instance, social media monitoring and analytics can be used to evaluate how public health recommendations are being perceived or even how they are influencing people's behaviour. To this point, a German study demonstrated the effectiveness of social media in promoting COVID-19 vaccination among migrant communities.[10] With their dedicated social media campaign, they reached over 1 million Facebook users within a 27-day period – 17,000 of which followed their advertisement for booking a COVID-19 vaccine appointment, with an estimated 1800 people receiving a vaccine. Overall, their findings (click-through and conversion rates) were on par with the average user engagement rate of online advertising in healthcare. It also highlighted the usefulness of social media marketing in driving action in healthcare and social media metrics in understanding associated behavioural trends.[10]

It's evident that the communication of science on digital platforms can be beneficial. But it's not without drawbacks, and more information is not always a good thing. Keeping in mind that audiences are immensely diverse and that not all information is credible or reliable, the communication and consumption of science on social media can be tricky. This was very much the case during the COVID-19 pandemic and the associated infodemic, where an overload of information as well as copious amounts of mis- and disinformation negatively impacted public well-being and contributed to disruptions in public health efforts to control the spread of the virus and manage the disease.[11] Since then, tackling mis- and disinformation online has become a top priority for many organisations, including the WHO.[12]

Open data, source, and methodology

Great strides have been made toward storing and sharing data online. In the digital age, it is no surprise that much of the work done in research relies heavily on the use of computers and

appropriate software. Technology is constantly evolving to improve and support how we analyse, simulate, calculate, and even visualise especially large sets of data. It's not enough that the data is available, the software used to view, handle, and transfer data also needs to be freely available and user-friendly, and most important of all, the data should be of high-quality. To this effect, the OpenScience Project has been creating free, easy-to-use open-source scientific software to make available to "anyone who wishes to discover or explore something new about the natural world".[13] Furthermore, the findable, accessible, interoperable, and reusable (FAIR) guiding principles promote good data management and data stewardship practices to ensure that researchers produce high-quality data for wide dissemination and utilisation. Interestingly, a cost-benefit analysis by the European Union in 2018 showed that not having FAIR research data can be expensive, costing the European economy at least €10.2 billion every year.[14] Regarding open methodology, I think we can all agree that, in certain instances, it can be incredibly difficult to replicate an experiment from the methods and materials described in an article. Open electronic lab notebooks can be a highly beneficial complement to an article by offering more insights into a particular method. It's also not uncommon for journals to request that detailed protocols of methods are made available to their readers. For clinical trials, detailed information about a trial can be found on, for example, the US clinical trial repository ClinicalTrials.gov and the EMA's website Clinical Data, and is available to anyone with access.

Despite its speedy evolution over the last two decades and many clear advantages, open science still faces significant challenges, including financial constraints, intellectual property barriers, impact on academic advancements, prestige, and more. Ultimately, all stakeholders in the open science ecosystem have a responsibility to be aware and help create awareness of the incredible benefits and the challenges of open science.[15] It's also clear that digital communication is an unbelievably valuable tool in this movement. Use its power to spread the word, and share resources that ensure that open science is credible and of high quality. Together, and especially as medical/ science communication professionals, we can elevate open science even more, harnessing the expertise, data, and awareness needed to optimally tackle society's most pertinent issues.

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Disclaimers

The opinions expressed in this article are the author's own and not necessarily shared by their employer or EMWA.

Disclosures and conflicts of interest

The author declares no conflicts of interest.

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