

Next generation scholarly communication: A researcher's perspective

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Accessing scientific information

Only a couple of decades ago, searching and accessing scientific articles in order to remain up to date in one's field of research was very time-consuming, as it required access to a well-supplied, specialized, physical library (within a university, research institution, hospital, etc.). Nonetheless, the retrieval of some articles was not immediate because they had to be transferred from another library, which implied a delay of several days or even weeks. Fortunately, many changes have occurred since then; indeed, those times are gone and almost forgotten. Among these changes, in the 1990s it became clear that the current model of scientific publishing, which is still the one that prevails, was not only extremely irregular but also raised many ethical issues. The idea of Open Access (OA) that developed in response paralleled similar movements in many other fields, such as Open Source, which advocated free open software. One of the strongest arguments in favor of OA is the following: if scientific research is mainly paid for by citizens, in the form of taxes, why are its results not freely available to this same society? And why are the rights to disseminate these results in the hands of private commercial publishers? [5]. However, despite the obvious validity of this argument, OA has been struggling for more than a decade to compete in a world still dominated by the traditional subscription model of scholarly publishing.

The director of the Harvard OA Project, Peter Suber, defined OA as "literature that is digital, online, free of charge, and free of most copyright and licensing restrictions." In a previous article in this journal [1], Ernest Abadal precisely dissected the key concepts of OA, its two different forms, i.e., the gold and green ways, the controversy elicited by the Finch report [3], which overtly advocated the gold way (in which OA journals are sustained by the authors) over the green way (mainly based on freely accessible institu-

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tional digital repositories). Abadal also pointed out that the latter strategy has advantages in countries where there are both good digital infrastructures for establishing these repositories and few and relatively modest science publishers, as opposed to countries such as the UK, the USA, Germany, and the Netherlands, where the largest science publishing companies are concentrated. The Finch report has been accused by some OA supporters of serving the interests of the publishing industry. However, as Abadal noted, many voices of authority consider the two ways to be complementary and that both need to be fostered if OA is to succeed. In the present article, I first offer my personal view, as a researcher, in commenting on some of the factors that may delay the spread of OA in scholarly publications and then speculate on the future of scholarly communication.

In the long history of science, significant leaps forward have often been made in the form of breakthroughs that completely changed the way things were seen or done. Also very often, and almost as an inflexible rule, these revolutions and the people who have led them have been fiercely attacked by those representing mainstreams of conservative opinion. The invention of the printing press by Johannes Gutenberg in the 15th century is an often-cited example of one such breakthrough. The Internet is another, obviously much more recent example, and it has deeply changed the world in just two decades. But the Internet is not only a revolution by itself, it is also a tool that has catalyzed revolutions in other fields. Among them is scholarly publishing, and OA is probably the movement that will change it forever. The Internet and related advances in media distribution have made the print versions of journals unnecessary for a growing number of people all over the world. Similar to what has happened in many other markets that make use of contents that are or have the potential to be virtual, including software, music, books, and movies, the Internet has turned the world of scientific publications on its head. However, for the former markets the change is largely in the way their contents are sold and distributed, while the transformation in scholarly publishing is much deeper, as it is not only formal but also conceptual. And this has to do with the fact that the *status quo* of scholarly publishing, which is still dominant in 2013, is a tremendously peculiar one. Let's consider why.

Reasons for a change

In the academic world, researchers generally must compete for funding of their scientific projects, with the funds most

commonly provided by public local, regional, national, or supranational agencies and ultimately financed by taxpayers. Funding allows researchers to carry out their research and the generated results must be disseminated. Until recently, this last step necessarily involved publication in subscription based journals that, in addition to charging fees to subscribers, often also charged authors to publish or, in some cases, even to submit their manuscripts. Furthermore, the copyright for the published articles was not held by the authors nor by the funding agencies or learned societies that had financed the research, but by the publishers. Although researchers are both the authors and the main target of scholarly publications, and thus, together with taxpayers, the main players in this market, they were left out of the game, as publishers were the recipients of the entire economic profit and held the rights to continued gains. Today, at the beginning of the 21st century, this model of scientific publishing continues to thrive.

Over the last decade, institutional subscription fees for academic journals have risen so rapidly that they are making academic libraries, even those of the wealthiest institutions, unsustainable. For instance, institutional subscription fees to the print + online *Journal of Comparative Neurology* are more than 23,000 euros for countries in the Euro zone. It is therefore not surprising that, in 2012, a faculty council at Harvard University asked students and professors to no longer make use of scientific journals with the highest subscription fees. The recognition of this atypical structure of scholarly publishing and that journal subscriptions are progressively becoming unaffordable has served as a point of no return for the current scholarly publishing system. As for the emergence of the OA movement, the key to its rapid, unstoppable run is the Internet and its limitless potential. Nowadays, many believe that the future of science communication is OA, as its growing rates of implementation seem to show. Will OA fully replace the current subscription-based system? And how long will this take? Nobody yet has the answers to these questions, but perhaps the best indicator of the long-term success of OA is the clear support it has received not only from the governments of the, scientifically speaking, most relevant countries, but also from an increasing number of academic and private institutions. Of course, these institutions have powerful reasons for supporting OA, including ethical ones. Access to research publications is a tremendous limitation for many researchers and health professionals, mainly in developing countries. In this regard, OA is already contributing to democratizing science; more importantly, it is accelerating scientific progress, as an increasing number of people, including scientists, gain free, immediate,

and online access to the latest research articles published on any possible subject. OA publishing is especially valuable to scientific enterprises in countries that lack the economic resources to allow their professionals to access subscription-based scientific publications.

As for the representation of OA in the global scholarly publishing market, in December 2013 there were 9804 gold OA scholarly journals, according to the Directory of Open Access Journals [<http://www.doaj.org>]. A list with links to more than 1000 OA journals can be found at [<http://www.science-media.de>]. However, a report in 2012 noted that gold OA journals represented only 11 % of all scholarly journals [8]. Approximately 17 % of the 1,66 million articles published in 2011 and indexed in Scopus (a comprehensive article-level index of scholarly articles) are available by OA through journal publishers, either immediately or after an embargo of 12 months following publication [8].

Despite the optimism that OA generates, its undeniable advantages, and the support it has received from the majority of the most relevant players in science communication, its progress has been surprisingly slow. Many questions regarding the implementation of OA must still be answered, and there is some resistance to its broad acceptance, and not only from publishers. In my opinion, two main reasons explain the reluctance of authors to submit their articles to OA journals: (1) the greater prestige of many of the traditional subscription journals and (2) the perception that publishing in gold OA journals is expensive. Researchers tend to be very conservative, and, understandably, most authors aspire to publish their works in the most renowned journals. This is partly because the majority of their colleagues tend to believe that articles published in these journals, which typically have high impact factors (IFs), are intrinsically better than those published in journals with lower IFs, as is the case with most of the current OA journals. This belief is widely shared by media professionals, the average citizen and, even more worrisome, the people responsible for assessing the researcher and his or her research. In fact, as scientists, we and our work are currently evaluated mainly based on the number of authored or co-authored publications and the IFs of the journals in which they were published. In peer evaluations, the articles written by the target researcher are rarely read, nor are his or her possible scientific contributions analyzed. Usually, evaluators simply count the number of papers on the researcher's CV and the IFs of the journals in which they were published. The use of such metrics is easy and tempting, but it poisons and devaluates the research process and ultimately the results of research. It is like judging people

according to the brand of the cars they drive. As the practical value of a research work is no longer defined by the intrinsic contributions it makes, but by the IF of the journal in which it is published, the goal of many becomes publishing more articles, and the higher the IF of the journal that accepts those articles, the better. Fortunately, digital communication allows the use of alternative types of measurements and metrics to assess the impact of an article, ones that are much more immediate and directly related to the article itself and not to the journal that publishes it. These "altmetrics" are able to collect all sorts of references to individual scholarly papers from all across the Internet, by gathering information from blogs, tweets, newspapers, and any other digital source [7].

Peer review and Open Access

A related concern is the misconception that peer review in OA is more relaxed than in conventional subscription journals. This idea is probably fueled by the fact that the acceptance rates for submitted articles are usually higher in many OA publications, as space is not a limitation. Another factor that erodes the trustworthiness of OA is the emergence of "predator" publishers, i.e., illegitimate or blatantly corrupt operators whose sole aim is to make money from authors through articles processing fees, which have largely emerged under the gold OA market. An updated list of suspicious or questionable publishers can be found at [<http://scholarlyoa.com/publishers/>]. To counteract these threats and to maintain or gain confidence and prestige, OA will have to uphold and strengthen rigorous peer review policies and offer high-quality publishing, so that a significant number of OA journals are at least as reliable, prestigious, and of the same impact as their top conventional subscription-based counterparts. The fact that some OA journals have already gained a strong reputation, with high IFs, in a relatively short period of time indicates that these goals are attainable. In the long term, the best solution will be a progressive change in the mentality of authors, publishers, journalists, and other players in scholarly publishing. This will lead to changes in the distorted current system of research assessment. An example is the Research Excellence Framework, the current UK system for assessing the quality of research, which in 2012 stated that no grant-review panel "will make any use of journal impact factors, rankings, lists or the perceived standing of publishers in assessing the quality of research outputs" [<http://www.ref.ac.uk/faq/researchoutputsref2/>].

An additional, important concern is the perception that

publishing in gold OA journals is costly. For a journal to persist, it has to be sustainable, no matter whether it is OA or not. If the articles are to be made freely available, the costs of publishing them must somehow be covered. One possibility is for authors to pay a fixed amount per article. This is the model adopted by many OA publishers, including the Public Library of Sciences (PLOS) and BioMed Central. Since PLoS launched its first journal, *PLoS Biology*, in 2003, it has published more than 100,000 articles. Its journal *PLoS One*, launched in 2006, is the largest gold OA journal worldwide. PLoS uses the Creative Commons Attribution License (CCAL) for all of the articles it publishes. Under this license, authors retain ownership of the copyright for their articles, but they allow anyone to download, distribute, reuse, modify, reprint, and/or copy them, as long as the original authors and source are cited. When, in November 2013, Creative Commons announced a new generation of open licenses (version 4.0) PLoS decided to incorporate them in all of its journals [<http://www.plos.org/plos-welcomes-cc-v4-0-licenses>].

PLoS One has an acceptance rate for all submissions of almost 70 % (data for the period July 1, 2010–September 30, 2010) and charges 1350 USD per article. The average fee for publishing an article in an OA journal is 900 USD [10], but it may be as high as 3900 USD. It is true that these amounts of money are not negligible, but the fees can be reduced, e.g., in the case of *PLoS One*, to 500 USD for authors from countries of lower middle income or even waived for authors from low-income countries. Some institutions also partially or totally cover the costs of publishing articles by their staff researchers in OA. Other models can include authors being subsidized by funders of research. An example is *eLife*, an OA publication founded by the currently doubly famous (because his 2013 Nobel Prize and his speaking out against “luxury” journals [9]) Randy Schekman in 2012. The exclusively online journal *eLife* is sustained by the Howard Hughes Medical Institute, the Wellcome Trust, the Max Planck Society, and others. Several current OA journals are subsidized or funded by a variety of institutions and they do not charge authors for submitting their articles. Another relatively new OA publisher of research articles in the biological sciences, medical sciences, and health sciences, *Peer J*, requires that all authors become members, with pre-paid (before acceptance of the first manuscript) fees ranging from 99 USD (one paper per year) to 299 USD (unlimited papers). An additional concern for many authors who are willing to publish their articles in OA is the fact that some funding agencies, universities, and research institutions do not facilitate the payment of author fees from the projects’ budgets. If publication fees have to be

taken from grants, then publication in that journal will have to be seriously considered; otherwise the resources available for research projects will be further reduced, and this at a time of shrinking funds for research. Funding agencies and research institutions will have to be flexible enough to allow payments for publications arising after the investigator’s grants have expired. To gain a foothold in the OA revolution, an increasing number of traditional paid subscription journals have adopted a hybrid model that allows authors to publish their articles as OA upon payment of a fixed fee, usually about 3000 USD. However, although this OA option is likely to increase the number of citations [4], it is only chosen by a small minority, about 1–2 % of authors [2]. The number of gold OA journals varies enormously among countries. The USA leads, with 1214 OA journals, followed by Brazil, with 911 (which represents 90 % of all scholarly journals published in that country). Spain is fifth in the ranking, with 522 OA journals (data as of December 2013) [<http://tinyurl.com/p7fcc67>].

Digital repositories

In the OA green alternative, most experts agree that self-archiving scientific documents in institutional digital repositories can reduce the costs of publishing, which could easily be covered by universities or research institutions. In the biomedical sciences, the largest digital archive of full-text scientific articles is PubMed Central, developed by the US National Library of Medicine, which offers articles that can be read for free, with varying conditions for their reuse. Some participating publishers delay the release of their articles on this database for a period of time after publication in print (usually from six months to one year). PubMed archives, which in May 2013 contained over 2.7 million articles, is growing by around 70,000 articles per year. Another option for the retrieval of full-text OA articles is PubGet [<http://pubget.com/>].

In addition to providing free access, digital repositories offer the advantage that they store not only traditional but also non-traditional scientific texts, including Ph.D. dissertations, patents, conference proceedings, seminars, presentations, and other kinds of scientifically relevant digital information, collectively known as the “grey literature.” However, in countries with strong science publishers, experts tend to endorse the gold rather than the green way of OA, partly because it is less disruptive with respect to their own interests and allows them to eventually adapt to the new scenario, as they are already doing. On the other hand, in countries like

Brazil or Spain, with a relatively short history of science publishing, OA proponents favor the green way. In November 2013 there were more than 2500 OA digital repositories (an updated list can be found at <http://www.opendoar.org>), and they were in various ways promoted by public research funding agencies (by requiring that their research institutions have their own digital repositories to be eligible for receiving grants). Yet, for areas such as biomedical sciences, digital repositories are still relatively underdeveloped, because authors in these disciplines who choose OA clearly prefer the gold way. For other disciplines, such as mathematics and physics, the situation is different, perhaps because the markets are smaller and authors are much more receptive to green OA.

In fact, the digital repository [arXiv.org] has become the most strongly preferred tool for communicating mathematics and physics results. But for those researchers with limited access to the scientific literature such that they cannot readily obtain the article they are looking for (usually in their attempt to remain up to date in their specific disciplines or topics), there are not many alternatives. Either they have to pay the downloading fee, typically about 30 euros per article (if they have access to a good librarian they can obtain the article through the library), or they can request an electronic reprint by directly contacting the authors (whose email addresses can be easily found through the Internet), or they can try to find colleagues with access to the article, etc.

The long road to Open Access

Most subscription-based publishers must see a future dominated by OA because they are rapidly adapting to it by adopting either the hybrid model system (today there are more than 4000 such journals) or a direct, “pure” gold OA model. A remarkable recent development is the dramatic increase in these publications, as evidenced by the 13,400 OA articles in 2005 to the 119,900 in 2011. Indeed, the majority of OA articles are published by subscription-based publishers [8]. Nonetheless, in spite of the ethically and non-ethically related reasons that make OA theoretically superior to the traditional model of science publishing, OA is facing tremendous challenges that are slowing its progress.

As mentioned above, one of them is the prejudices and attitudes of the scientists themselves. Since journal subscription fees are usually covered by institutional libraries, researchers tend to perceive access to articles as free merchandise, whereas the cost for publishing in OA journals, often

hundreds or thousands of dollars per article, comes directly from their own funds or their research grants.

Moreover, some authoritative voices have substantial doubts about the future of OA (citing reasons such as poor sustainability and the eventual loss of quality). In 10 or 15 years, perhaps most scientific information will be OA but it is likely that, of the many OA journals and initiatives that arise, only a few will survive. However, it is also possible that the OA and non-OA worlds coexist in this future market, at least for a while. The outlook is uncertain and difficult to predict, and there is no guarantee that any particular format will succeed or prevail in the long term as the only one standing. For the moment, as authors continue to submit their research articles to reputable subscription journals, these publishers will lack incentive to turn their traditional model into OA. Still, most people agree that the future of science publication will be better than the *status quo* [6].

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