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Abstract

We present emerging models of publishing which have grown from the phenomenon of open access, the changing role of peer review in the scientific process and the new position of the impact factor. We juxtapose the new models of paid review, eponymous review, no review, post publication review and light review with the classic model which has dominated for a century, detailing advantages, problems and examples of each model to provide a comprehensive overview of the changing landscape of scientific publishing.

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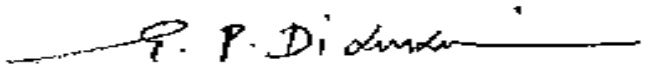
Dear Editor,

We are submitting for your consideration a review article entitled "The emerging landscape of scientific publishing". As you know, scientific publishing is currently undergoing major changes in various fronts. In this paper, we review the current situation and future trends. We have no doubt that this paper will be of interest to your wide readership.

We hope to hear from you soon.

Sincerely,



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The Emerging Landscape of Scientific Publishing

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Abstract

We present emerging models of publishing which have grown from the phenomenon of open access, the changing role of peer review in the scientific process and the new position of the impact factor. We juxtapose the new models of paid review, eponymous review, no review, post publication review and light review with the classic model which has dominated for a century, detailing advantages, problems and examples of each model to provide a comprehensive overview of the changing landscape of scientific publishing.

Introduction

In the world of biomedical sciences, publishing papers in a scientific journal is the path to sharing research with the world and receive recognition for hundreds of hours of work, research, writing and contributions to science. Published papers are the core of grant applications, prizes, employment, and in many ways, a scientist's career.

The first English-language scientific journal *Philosophical Transactions* was published in 1665 (http://rstl.royalsocietypublishing.org/) and since then scientific publishing has grown to encompass thousands of journals with topics ranging from all of life such as *Nature* to specific organs like *Kidney International*. Some journals are published weekly while others are published only once or twice. Some journals such as *The New England Journal of Medicine* have been published for over 200 years (http://www.nejm.org/page/about-nejm/history-and-mission.), while new journals are founded every year. Some journals are distributed by print while virtually all are available online. Some are only accessible through a subscription (closed access) while others can be read by anyone with an internet connection (open access).

In this paper, we would like to elucidate the changing landscape of scientific publishing as it stands in 2017. We describe the impact factor and its relevance, different types of publication (classic, preprints, light peer review, post publication peer review, open access, closed access) while commenting on the evolution of peer review in the scientific process. We believe our analysis is of value because it details a fundamental purpose of science: sharing discoveries and knowledge with the world.

The journal impact factor

Conceived of by Eugene Garfield in 1955, the Journal Impact Factor (JIF) has been used by the scientific community as the ubiquitous yardstick of publication quality for decades (1). The impact factor calculation is simple and unnuanced: the number of citations accrued by the journal's papers over a specified period is simply divided by the number of papers published in the journal (2).

Researchers across the scientific world clamor for acceptance into 'high impact journals' creating fierce competition. *The New England Journal of Medicine*, *Nature* and a few other journals have very high impact factor (>35) with a corresponding rejection rate of >90%. Publication in these extremely selective and prestigious journals is often a catalyst for career progression, performance pay and research grants.

Over the last decade, the impact factor has garnered a significant amount of contention and criticism from researchers who argue their work is judged not by their writing and results, but by the impact factor of the journal it is published in (3-6). They argue the metric is simple, crude and misleading with a disproportionate impact on scientists' position in the field (6-8).

Furthermore, the prevalent use and perceived value of the JIF fuels the myth that publication in a high impact journal correlates to a high impact paper. In fact, a 2016 study by Curry et al of citations of 2013- 2014 papers published in 11 journals (including *Nature*, *Science* and *PLOS*) revealed that three quarters of the published papers gathered fewer citations than the impact factor of their journal: 74.8% of *Nature* papers received fewer citations than its impact factor of 38.1 while 75.5% of *Science* papers were cited below its impact factor of 34.7. Highly cited papers in these journals explained this disconnect: one *Nature* paper was referenced 905

times while another *Science* paper amassed 694 citations, inflating each journal's impact factor (9).

Despite these fundamental problems, the JIF continues to hold sway. According to freelance Indonesian science journalist Dyna Rochmyaningsih, this mindset exacerbates publishing problems in the developing world. In Indonesia, scientists who publish in international journals can receive up to 100 million rupiah, correlated with the journal's impact factor. Equivalent to US $4700, this is ten times the monthly pay of a scientist in a government agency. Though these grants allow scientists to invest in long term projects, bureaucracy means the money can arrive many months late, forcing scientists to struggle to produce research which would qualify them for grant money the next year. Instead of blind reliance on the impact factor, Ms. Rochmyaningsih is advocating for a stronger connection between researchers and policy makers which she believes will not only increase Indonesia's weight in the scientific community but fuel research addressing domestic issues such as filariasis and malaria (10).

In response to all these concerns, the scientific community is beginning to move away from the impact factor towards other metrics (11), including article specific metrics such as PDF downloads or views (12). In December 2016, Elsevier, publisher of over 2500 scientific journals (https://www.elsevier.com/connect/elsevier-publishing-a-look-at-the-numbers-and-more) introduced CiteScore as a competitor to the JIF. It uses the same calculation as its rival however it counts all documents as potentially citable; not just journal articles but editorials, corrections and letters to the editor. However, these items are much less cited, lowering the score of many journals. Under the JIF metric, *The Lancet* scores 44 however in CiteScore it plummets to 7.7. Some scientists worry this will stem the publication of non-research documents for fear of

lowering journals' CiteScore index while others are skeptical because it was created by an influential publisher (13). Others question whether it is of any use at all.

Classic closed access publishing process

The publishing process researchers are familiar has been around since the twentieth century, about as long as the impact factor. Authors submit their paper to a scientific journal, then the editor sends it to two or three experts in the field (14). These "peer reviewers" are the hallmark of this publishing process; their job is to carefully read the manuscript, looking for adherence to ethical/ scientific standards, quality of research and writing and the significance of results. Finally, they write a report detailing whether the paper should be accepted, published with revisions or rejected. This report is sent to the journal editor to make the final decision which in our experience is almost always in agreement with the reviewers (14). Often a paper must be submitted to several journals before it finds its haven, and this process can take years (15).

This "classic" system has been traditionally considered the gold standard of scientific publishing (16). At its finest, peer review is a detailed, holistic process: a carefully considered, timely analysis of the quality of the research and writing by a fair, unbiased expert reviewer. The data, citations and analyses are poured over and the reviewer provides constructive feedback to the paper's authors (16). When done consistently and correctly, peer review forms the cornerstone of scientific publication (17) and upholds science's self-critical, self-assessing nature, serving as a golden seal to protecting journals from unethical, incorrect or just irrelevant science (18).

Eponymous vs anonymous review

Peer review of a manuscript can take anywhere from three to beyond twelve hours, however experts are rarely credited for their work (14). In virtually all "Classic" journals, peer review is anonymous (single blinded) and the pages of insight and commentary written by the reviewer do not go beyond the authors and the editor. Advocates for this system argue it protects the reviewers, allowing them to give an honest review without fear of repercussions or bias. One author, Karim Khan, compares closed peer review to democracy, describing it as "almost fatally flawed, but better than any alternative" (19).

After receiving significant amounts of reviews with discriminatory and biased comments based on the authors gender, ethnicity and institutions, *The BMJ* began pushing for open peer review as the fairest system and mandated signed reviews in 1999 (20). Despite initial concerns that reviewers would not say anything definitive, the experiment was a success and the journal continues to use this system almost two decades later (http://www.bmj.com/about-bmj/resources-authors/peer-review-process) however the vast majority of traditional journals have continued using single blinded review.

Rewards for peer review in closed access journals

Another trademark of the classic system is its' reliance on volunteer labour. However, this status quo has been challenged by scientists who want credit for their hours of unpaid work. In response to the criticism, Publons was launched in 2012 as an online platform to "track, verify and showcase your peer review contributions across the world's journals…to speed up science and research and give the experts involved in peer review the recognition they deserve" (http://home.publons.com/). The site has accrued thousands of members however most journals

do not allow scientists to post the text of their reviews; only allowing users to post review receipts.

This is part of an ongoing movement towards rewarding scientists for their unpaid work. Scientists point out closed access journals requiring expensive institution or personal subscriptions make a substantial profit (16) while scientists are just supposed to review for free in exchange for others to read their paper when they want to publish (14). For some high impact journals, such as *Nature*, the prestige is considered payment enough; however reviewing for lower impact journals is considered by many as a chore (14).

As the need to publish papers and write grant applications becomes more and more pressing, fewer and fewer scientists will be able devote their time to peer review. This could result in a dearth of reviewers for smaller journals (14).

To address these problems, one of us wrote a paper advocating paying for peer review, suggesting a $200 fee paid by the author. This would benefit young researchers beginning their career and seeking to earn some money, or retired scientists looking to supplement their income. Paying for peer review would increase the quality of the review because the reviewer now has financial responsibility and motivation to produce a quality review; the process becomes more like a business transaction than a favour (14).

Other suggested rewards include the creation of a Reviewer Index; every time experts review a paper within a certain time period and to certain standards they would get points. After a certain number of points, reviewers could become eligible for rewards such as listing on websites, letters to their institutions or free attendance at publisher events. Other suggestions include giving priority to reviewers' papers or even induction on an editorial board after writing

a certain number of reviews (21). In the future, we do not exclude the possibility that reviewers could collect Air Miles[R] from publishers for their contributions!

In January 2015, the University of California Press announced a new, open access mega journal, *Collabra* that would pay reviewers for their time. We are hopeful that paying for peer review will create better quality, more useful feedback to produce meaningful scientific literature.

Problems with peer review

Though rewards may incentivize more peer reviewers to do a better job, peer review will never be infallible. It is a human process, subject to bias and prejudices. It is inconsistent, flawed and sometimes downright fails.

There are several highly-publicized incidents in which falsified experiments got through the seal of classic peer review into publication in very prestigious journals. Norwegian oncologist Jon Sudbø published an influential paper on oral cancer in the prestigious medical journal *The Lancet* before he admitted the results were fraudulent in 2006 (22).

In a 2006 paper, Richard Smith described several fascinating experiments he did as editor at *The BMJ*. He described sending papers with major errors to many reviewers to gage the effectiveness of peer review for detecting fraud and bad science. Most reviewers only spotted about a quarter errors while some did not notice any. No one found them all, leading Dr. Smith to conclude that peer review was not adept at one of its main and least nuanced functions: detecting errors (16).

Earlier this year, one of us wrote about the peculiarity that your best work by virtue of going to an expert for peer review often goes to a competitor in your field. There is the not

unthinkable possibility the reviewer may steal your work or write a scathing review to delay or even reject the paper. This situation would be most likely in high impact work that can lead to large grants or prizes such as the Nobel (14).

Even with plagiarism cases aside, there are still problems. Despite spending months in review limbo, our laboratory found our papers did not become better, wasting time our colleagues could spend doing other things, like making new discoveries. Some experiments or verifications required for acceptance were nitpicky or irrelevant, inflicted by an overzealous reviewer, holding back publication for months.

Most scientists have at least one anecdote about their work being unfairly judged by poor peer review, indicating the reviewer did not even have a superficial grasp of the paper or was completely biased (14).

Scientists have complained for many years about the excruciatingly long process of peer review and revisions. Though the internet has sped up publication times, review times have stayed constant (15). One study even indicated it is taking longer, revealing review times at *Nature* have leaped from 85 days to just over 150 days over the past decade (15). It is common to wait for months for a paper to be reviewed and then have it rejected, leading the unfortunate scientist to restart the lengthy process at another journal. Long review times become not just frustrating but hamper graduation or career progression (15). They can also even be harmful, especially in fields that have immediate relevance, such as advances in combatting an epidemic (23).

All these problems have led academics to question whether peer review is as integral as "the practice of peer review is based on faith in its effects, rather than on facts," (24) which is disconcerting as the last tenet modern science should be based on is faith.

New publication models

In response to all these issues, alternative forms of scientific publishing that modify, reduce it or eschew peer review entirely have been rising in popularity. They rely on the internet, which provides flexibility for page budgets and text allocations. We discuss the benefits, disadvantages and implications of several of these new platforms (preprints, light review and post publication review) in the next section.

Preprints

Despite their novelty to the biomedical sciences, preprints, the immediate online publication of completed manuscripts before peer review are rapidly growing in popularity. Originally created in response to the lengthy peer review process, preprint repositories have been widely used by physical sciences for two decades and are just making their debut in the life sciences (23).

Advocates speak to this growth as an evolution of publishing made possible by the widespread use of the internet. Though many journals offer publishing ahead of print, preprints allow one to post immediately, useful in highly competitive fields with massive rejection rates and long review processes. Preprints are open access, allowing the scientific community to use and give feedback on the information right away, providing more insight than just two peer reviewers (23).

Preprints are meant to coexist with journals and the peer review process, not replace them. A 2014 study in the Journal of the Association for Information Science and Technology found that that 73% of papers posted to arXiv (the physical sciences preprint repository)eventually get published in journals and much of the left-over work are theses or conference proceedings (25) showing compatibility between preprints and journals. Thus, preprints form an intermediate step between posting and peer reviewed publication with the advantage of getting ones' work out very quickly.

This system is still very new, and there are still important caveats that need to be worked out. Major issues include the conundrum of multiple versions and copyright. Journals policies need to allow publication of preprint manuscripts although the material has already been available to the public (23).

Critics point to the dangers of having unchecked biomedical science freely available, citing concerns about unverified health claims, ethics violations and conflicts of interests (23). Currently, many authors are reluctant to post their preprints as they are unsure about these gray areas and do not want to risk discounting their hard work.

Nonetheless, proponents are optimistic that once the life scientific community becomes familiar with the process, these problems will be ironed out. Multiple biology preprint depositories have sprung up, a marked contrast to the physical sciences where one repository, *arXiv*, is almost exclusively used. A coalition of scientists and funders (including the UK Medical Research Council and the Howard Hughes Medical Institutes) are supporting a central platform for all biology preprints to stem confusion and make it easier to mine their knowledge (26). This backing of preprints sends a strong message to the scientific community, however many life scientists will need to show their support for preprints to become widely used.

Light review

Some platforms have gone a step further from the Classic model by dramatically reducing peer review, such as the *Public Library of Science* (*PLOS*) journal family, founded in 2001 (https://www.plos.org/history). Papers published in *PLOS* are completely open access, however authors shoulder the hefty publication costs, paying between $1495 and $2900 USD depending on the journal (https://www.plos.org/publication-fees). These journals will publish anything their (unpaid) expert reviewers find to be scientifically and ethically sound (http://journals.plos.org/plosone/s/journal-information.). However, they do not judge whether the paper will have any significance to the field, stating, "these subjective judgments can delay the publication of work that later proves to be of major significance…" and choosing instead to leave the determination of value to their readership, "who are most qualified to determine what is of interest to them" (http://journals.plos.org/plosone/s/journal-information).

Much of the contention around *PLOS* involves its charging of fees. Though *PLOS* does automatically waive or reduce the publication fee for manuscripts submitted from many developing countries and has an application-based financial aid system (https://www.plos.org/fee-assistance.), it is still a marked step away from traditional journals where submissions are free. Some journals have even become "predatory" (27) - unscrupulous companies have created sham journals, abusing the model by charging authors exorbitant fees and not peer-reviewing their papers (28,29).

PLOS seeks to have the best of both worlds with the quality control provided by review for scientific and ethical adherence but also the rapid publication of knowledge. However, this can create a potentially harmful illusion of quality; even if the paper is accepted, the review is superficial and the paper may be of not any value to the field.

Careful monitoring and analysis of this relatively new way of publishing and the quality of papers is essential in revealing whether this model can contribute to the changing landscape scientific publishing.

Post publication review

Founded in 2000, *F1000 Research* (*Faculty of 1000 Scientists*) turns life sciences publication norms backwards and upside down. Peer review happens not before, but after publication on an open access website. After the author submits the US $ 150 -$1000 publishing fee (dependent on word count), the papers are quickly screened for scientific and ethical correctness, then published online, awaiting peer reviewers (https://f1000research.com/about). It is important to note that like *PLOS*, the publication fee can be waived or decreased to support authors with financial need (https://f1000research.com/for-authors/article-processing-charges).

F1000 advocates for an author controlled publication process, so authors are encouraged to nominate reviewers (assuming no conflicting interests). Peer reviews on *F1000* are public, eponymous and citable: experts' reviews, names and institutions are posted under the paper. As payment for their time, reviewers receive 50% off the publication fee for any work they choose to submit to the journal. After the paper is approved by two reviewers, it is indexed to PubMed (https://f1000research.com/about).

Authors are encouraged to post updated versions of their work in response to feedback or criticism; those are indexed separately. The version number and the status such as 'awaiting review' placed right after the title so users can easily determine the stage of the paper (https://f1000research.com/faqs).

F1000's approach is novel in many ways. Not only is publication more dynamic and author control is central, they are committed to transparency, collaboration and openness (https://f1000research.com/faqs). They welcome all findings including negative and null investigations. They do not consider themselves a journal as the peer reviewers, not editors, make the final publication decision. They also consider the JIF "problematic", using article specific metrics such as number of views or PDF downloads instead (https://f1000research.com/faqs).

Their online medium allows the publication of full colour illustrations and diagrams for no extra fee as well as the inclusion of data and procedures; they believe having the complete data set available is also a safeguard against plagiarism as well as providing guidance to those who wish to replicate or build on the findings (https://f1000research.com/).

Some fascinating work has been carried out to study these new methods. Interestingly, unlike the classic model, the impact factor of an open access journal does not contribute to citations. In classic closed access journals, their published paper citations are positively impacted by the JIF of the journal because libraries with limited budget prioritize high impact factor journals for their institutions. However, open access journals are free so scientists can choose to cite articles from a much wider variety of choices. Generally, the higher impact the open access journal, the higher the publishing fees. Thus, it might not be worth paying the expensive author fees for publishing in high impact open access journals if there is minimal gain (30).

Open access and peer review after publication has been supported by some major funders including the Wellcome Trust, the UK based nongovernmental funder of biomedical research. The trust already has an open access journal, *eLife,* and it is launching another open access

journal which will use exclusively post publication review, open to the thousands of scientists funded by a Wellcome grant. All author and publication fees will be covered for this journal.

Funders' support for open access have created clashes with the traditional system. In January 2017, the Bill and Melinda Gates Foundation barred Gates funded researchers from publishing with journals that do not comply with their open access policies for unrestricted reuse and immediate open publication of papers and data sets. Some of the affected journals are very influential; they include *Nature, Science* and the *New England Journal of Medicine* (31).

Whatever ones' perspective, these new post publication open access platforms are creating an indelible impact on the landscape of scientific publishing and attracting increasing number of scientists to submit their work. It will be interesting to see how they continue evolving.

Outlook: A brave new world

Just as biological science is evolving at a rapid pace, so is the landscape of scientific publishing. Authors have more options than ever before, to show their work.

As preprints, modifications of peer review and even open publication continue to be finessed, it is likely that these methods are here to stay. The Classic model will become one of many choices for your work, with its positives and negatives, just like the others described in this paper.

Methods need to keep being tested and evaluated to ensure they keep providing the highest quality options for publication of science.

Traditional emblems of science such as classic peer review and the impact factor will not hold complete authority; they will make way for the development of other systems created to address their short falls however will bring modifications of their own.

The actions of the members of today's scientific community will determine which systems will hold the most sway in the future. It comes down to individual members choosing to submit their work to open access or closed access journals, write eponymous or anonymous reviews, supporting or modifying traditional peer review, shaping the scientific literature landscape that will host the next generation of scientific breakthroughs.

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Table 1: Characteristics of the publication models discussed in this paper.

	Examples					
	Classic (*Nature*, *The Lancet* etc.)	***Collabra***	***The BMJ***	***F1000 Research***	***PLOS***	**Preprints (Bioxiv, arXiv, etc.)**
Open Access		✓	✓	✓	✓	✓
Publication Fees				✓	✓	
Prepublication Peer Review	✓	✓	✓		✓	
Complete Peer Review	✓	✓	✓	✓		
Anonymous Peer Review	✓	✓			✓	
Paid/ rewarded Peer Review		✓		✓		

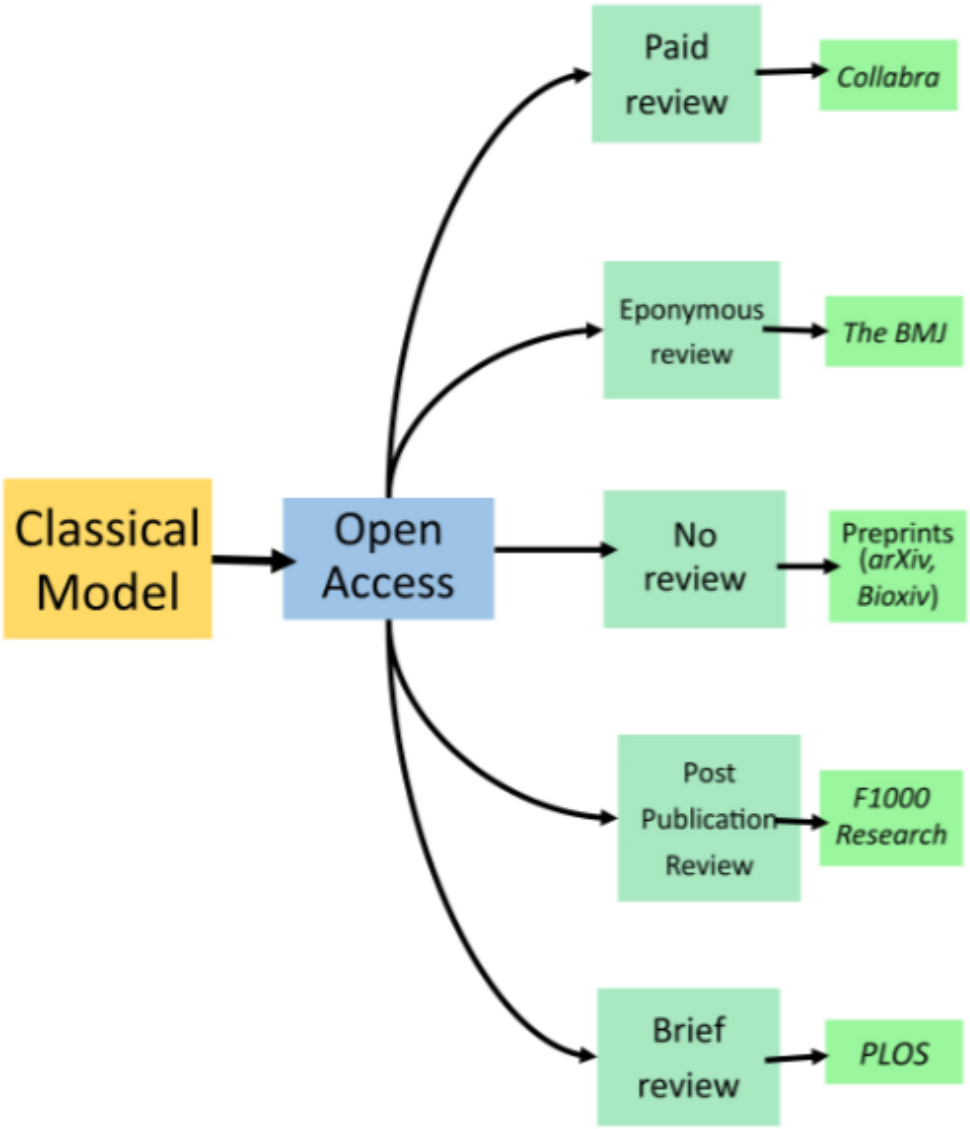

Figure 1: Characteristics of publication models discussed in this paper