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Exploring new frontiers of electronic publishing in biomedical science

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ABSTRACT

Publishing is a hallmark of good scientific research. The aim of publishing is to disseminate new research knowledge and findings as widely as possible in a timely and efficient manner. Scientific publishing has evolved over the years with the advent of new technologies and demands. This paper presents a brief discussion on the evolution and status of electronic publishing. The Open Access Initiative was created with the aim of overcoming various limitations faced by traditional publishing access models. Innovations have opened up possibilities for electronic publishing to increase the accessibility, visibility, interactivity and usability of research. A glimpse of the future publishing landscape has revealed that scientific communication and research will not remain the same. The internet and advances in information technology will have an impact on the research landscape, scholarly publishing, research policy and funding, dissemination of knowledge, and the progress of science as a whole.

Keywords: biomedical science, electronic journal, electronic publishing, online publishing, open access, scholarly publishing

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INTRODUCTION

Publishing is a hallmark of good scientific research. The aim of publishing is to disseminate new research knowledge and findings as widely as possible in a timely and efficient manner.⁽¹⁻³⁾ However, scientific publishing today is still less than ideal. Traditional print journals have passed their golden age despite failing to achieve the Utopian ideals that the scientific publishing world envisioned, viz:

- Online availability of the entire full-text refereed research corpus.
- Availability on every researcher's desktop, everywhere, 24 hours a day.
- Interlinking of all papers and citations.

- Fully searchable, navigable, retrievable, impact-rankable research papers.
- Access to research data.
- For free, for all, forever.

EVOLUTION OF ELECTRONIC PUBLISHING

The term, "Electronic Publishing", is primarily used today to refer to the current practice of online and web-based publishing. However, it is also used to describe the development of new forms of production, distribution, and user interaction with regard to computer-based production of text and other interactive media. Electronic publishing also includes the publication of ebooks and electronic articles, as well as the development of digital libraries and catalogues.^(4,5)

Electronic publishing has become common in scholarly publications where it has been argued that this mode of publishing is in the process of replacing peer reviewed scientific journals. Although network distribution today is strongly associated with electronic publishing, there are many non-network electronic publications such as encyclopaedias on CD and DVD, as well as technical and reference publications.

As new research findings and scientific discoveries are being produced in laboratories and clinics at a faster pace than ever, print journals are not an ideal medium for disseminating the latest information, as there is usually a delay of up to a year after an article is written and before it gets published. However, scientific journals still play an important and unique role in quality control, archiving papers and establishing scientific credit and credibility.

Traditional scholarly publishing systems, until now, have failed the academic and research communities because of their high costs and restrictive policies. These factors have resulted in limited access to information, research, innovation, academic discussion and exchange of ideas. It has also given rise to the general perception of monopoly and high profitability by publishers.

There is also the perpetual issue of copyright transfer where publishers do not pay academic authors; instead they often require authors to transfer copyright when they submit their work. Publishers therefore gain a free benefit

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Table I. List of advantages and disadvantages of electronic publishing.**Advantages:**

- Speed and efficiency: Faster dissemination of scientific information by expediting entire publishing and management processes (submission; communication between authors, reviewers and editors; production process, including layout and galley proof).
- Hypertext and hypermedia links: Linking to other electronic information.
- Innovative use of multimedia: To present research findings and other forms of data and information using sound, movies and simulation.
- Improved access: Ready access to information through electronic search engines.
- More efficient dissemination of research findings: Services such as abstract alert, advanced notification of publications, and matching articles of interest with readers' profiles.
- Interactivity: With applications such as Java and common gateway interface (cgi) programmes and forms, CME credits can be offered through online tests or images can be presented that can be manipulated by users.
- Public peer review: Linking readers' comments, authors' responses and evaluations.
- Enhanced discourse: Enables expanded and facilitated scientific discourse about research, online letters to the editor and discussions.

Disadvantages:

- Readers without laptops do not have access to articles on the go, e.g. on a commuter train.
- Readers who have to access the journal over a modem may be hindered by the slow acquisition of large image or movie files.
- Electronic journals and articles are considered as non-permanent, perishable citations that could change their URLs or disappear from cyberspace.

in which they claim copyright and they sell it back to its originator, i.e. the academic community, who, incidentally, also provide free services for editing and refereeing. This has always been a touchy feature of scholarly journal publishing, but it has particular implication now with the development of alternative electronic publishing.

In the current information technology era, researchers have greater expectations that electronic publishing will be able to solve some of the problems discussed above. However, it has instead been perceived to be driving the costs up further, while not making information available more widely or quickly enough. This has led to the perception that publishers are standing in the way of the advancement of science.

STATUS OF ELECTRONIC PUBLISHING

When the World Wide Web (WWW) became popular, there was a big rush into electronic publishing with its promises of speed, efficiency and limitless accessibility. Lawrence provided statistical evidence that electronic publishing enabled wider dissemination of information.⁽⁶⁾ A number of journals have, while retaining their peer review process, established electronic versions or even migrated entirely to electronic publication.

Lambert reported on developments in biomedical electronic publishing since the mid-1990s. These include the HighWire, PubMed Central, BioOne, the Public Library of Science, E-BioSci and BioMed Central services. The issues raised by these developments include the need to attract good quality papers, the ownership of copyright, how developments are funded, the question of whether a distributed or centralised system is adopted and preservation of content.⁽⁵⁾ The extent of electronic journals can be ascertained from the Ulrich database. There are 25,000 peer-reviewed academic/scholarly journals, whereby 16,875 (67.5%) of these have online full-text or online full-content, and the number is increasing rapidly.⁽⁷⁾

Electronic journals can potentially offer several advantages and a few disadvantages over traditional print journals (summarised in Table I). Notable advantages are the speed of publication and ease of communication offered by electronic publishing, which promotes a more interactive and participative journal in which one's publication may attract rapid responses from the research community and even non-researchers and the public. Furthermore, with the placement of historically important papers, such as the classic paper by Watson and Crick, on the discovery of the double helix structure of DNA on the web,⁽⁸⁾ it makes them easily accessible to millions of people – something totally unimaginable in the good old days of pen and paper.

PEER REVIEW

There have been concerns that peer review could be compromised in electronic publishing. However, it should be noted that peer review does not depend on the medium of a journal, and that it can be as honest a system as traditional print journals. Several authors have argued for the need for rigorous systems of peer review in scholarly work, and considered possible futures for journals in the digital environment.^(9,10) But the peer review system in one form or another is here to stay.

PUBLISHING MODELS

Traditional publishing model: paper-based and electronic publishing

Print journals have long been the principal means by which scientific knowledge is disseminated. The various types of access models that characterise the traditional publishing model and the various problems encountered are summarised in Table II.^(5,11)

Commercial electronic journals

Commercial electronic journals published by institutions, learned societies and/or commercial publishers aim to

Table II. Access models and ensuing problems of traditional publishing.**Access models:**

- Authors or sponsors pay through page or handling charges.
- Free to readers (e.g. BioMedCentral).
- Institute/society/university pays, through increasing charges for other services, advertising and subscription savings.
- Government funding or other grants.
- Institutional e-print archiving.
- Reader or institution pays subscriptions or licences; e.g. most established print journals.
- Free to members of societies.
- Imposition of access toll.
- Differential charges to different readers.

Problems encountered:

- Various barriers to access by scientific communities.
- Not able to produce benefits for scholarly communication, due to slow and expensive production.
- Monopoly by publishers in dictating subscription prices.
- Substantial price disparity between commercial journals and non-commercial journals.

provide access to information for a cost, either through subscriptions, a pay-per-view fee or a pay-per-issue fee. Bundled subscriptions via aggregators, such as ScienceDirect or SpringerLink are very popular. However, institutions like universities often offer access to these journals gratis for students and researchers.

Conflicting and overlapping interests

- Publishers: concerned with publishing costs, changing readership, changing user expectations, copyright management and archiving.
- Authors and learned societies: self-publishing, new models for scholarly publishing, quality assurance, copyright management and archiving.
- Researchers: want simple access to complex information cyberspace, including easy access to full text and reference linking.
- Aggregators: managing content from multiple sources, providing reference linking not just within their own service but to other content providers, ensuring completeness, and archiving.
- Libraries: challenges of keeping up with the flood of new titles, new content and new options, providing users with easy access to information wherever they happen to reside.
- Consortia: become very influential through cooperative purchasing and negotiation of licenses; they are concerned with assured access, copyright management and archiving.

OPEN ACCESS INITIATIVE

Budapest Open Access Initiative (BOAI) was convened by the Open Society Institute in December 2001 with the purpose of accelerating progress in the international effort to make research articles in all academic fields freely available online. The outcome was the launch of the Budapest Declaration, dated February 14, 2002. It has been signed by a large number of institutions and researchers. The declaration does not oppose commercial publishing, but seeks an alternative system of free access journals and self-archiving set-up in parallel.⁽¹²⁾ Open access journals

are defined as journals that use a funding model that does not charge readers or their institutions for access. From the BOAI definition of "open access", a journal must provide users the right to "read, download, copy, distribute, print, search, or link to the full texts of these articles".⁽¹³⁾

To date, there are more than 3,906 open access journals listed in the Directory of Open Access Journals (DOAJ).⁽¹⁴⁾ On April 1, 2009, DOAJ and the National Library, Netherlands (KB)/e-Depot announced the long-term preservation project, sponsored by Swedish Library Association. The aim of the project is to get the content of journals in DOAJ archived for the future.

Two commonly-discussed means of achieving the open access goal are: (1) establishment of "a new generation of journals" that do not charge subscription or access fees (known as the "gold" road), and (2) author self-archiving and/or commitment to deposit a digital copy of a publication to a publicly-accessible website (known as the "green" road).

Open access journals

Research content is freely available in electronic form, which is achieved by creating new journals whose content is freely available, or by encouraging publishers to make their content freely available. Examples of open access resources/organisations are SPARC, Public Library of Science, PubMed Central, Highwire Press, BioMed Central and Open Access Initiatives.

- **SPARC** (www.arl.org/sparc/) or the Scholarly Publishing and Academic Resources Coalition, is an international alliance of academic and research libraries working to correct imbalances in the scholarly publishing system. Originally US-based but SPARC is now also active in Europe.
- **Public Library of Science (PLOS)** (www.plos.org/) is a non-profit organisation of scientists and physicians committed to making the world's scientific and medical literature a freely-available public resource. They produced an open letter urging publishers to allow their journal content to be distributed freely by independent, online public libraries of science. It urges

scientists and libraries to support the journals that have adopted the policies being advocated. Some major open access journals are PLoS Biology, PLoS Medicine and PLoS Clinical Trials.

- **PubMed Central** (www.pubmedcentral.nih.gov/) is the U.S. National Institutes of Health (NIH) free digital archive of biomedical and life sciences journal literature. It is developed and managed by NIH's National Center for Biotechnology Information (NCBI) in the National Library of Medicine (NLM). With PubMed Central, NLM has taken the lead in preserving and maintaining access to electronic literature, just as it has done for decades with printed biomedical literature. PubMed Central aims to fill the role of a world class library in the digital age. It is not a journal publisher. NLM believes that giving all users free access to the material in PubMed Central is the best way to ensure the durability and utility of the archive as technology changes over time.
- **HighWire Press** (highwire.stanford.edu) is a division of the Stanford University Libraries. It hosts the largest repository of high impact, peer-reviewed content, with 1,232 journals and 5,667,311 full-text articles from more than 140 scholarly publishers. It hosts the largest free online archive of articles in the life sciences. It began in early 1995 with the Journal of Biological Chemistry (JBC), and now comprises journals contributing free full-text articles, including Science and Proceedings of the National Academy of Science.
- **BioMed Central** (www.biomedcentral.com/) is a commercial publisher that publishes the Current Opinion Journals and others. It hosts to date more than 200 online, peer-reviewed journals in biology and medicine. The journals are available by subscription but the commitment to free availability of original research means that the research articles are deposited in PubMed Central, and can be accessed by non-subscribers.

Authors self-archiving / institutional depositories

In this system, authors deposit copies of their papers in an electronic archive. It could be a pre-print of the article that subsequently appears in a traditional journal, or it could be the final version of the printed article appearing with the consent of the publisher. Many universities are now encouraging self-archiving of publications by operating depositories as knowledge banks.

Since its conception, open access has generated a lot of controversies among the stakeholders, especially the publishers, librarians, scientists, funding agencies and consumers. Its implications have been hotly debated.⁽¹⁵⁻²⁰⁾ Interest in open access has also spawned lots of conferences and symposia.

INNOVATIONS IN ELECTRONIC PUBLISHING

The online medium has opened up many possibilities that have increased the accessibility, visibility, interactivity and usability of research.⁽²¹⁻²³⁾ Several innovations in electronic publishing that have been developed and refined are:

- Personal websites (editors, reviewers, authors, readers).
- Blogs: personal entries in diary style.
- List servers and discussion forums.
- Wikis: online reference works (encyclopaedias) with contributions by anyone in the online community.
- RSS feeds (or really simple syndication feeds) deliver summaries of web content together with links to the full versions of the content.
- Bibliometrics: automatic statistics on downloads, citation count to quantify the impact of an article.

Open discourse is a relatively new feature in electronic publishing for enhancing communication.⁽²⁴⁾ Most journals encourage open review and discussion, such as BioMed Central publications, that invite interested participants to submit comments using the "Post a Comment" function, as well as rate/rank the paper.

One such example is JournalReview.org,⁽²⁵⁾ a website forum for open peer review and discussion/criticism of medical literature. It is essentially a free-membership, online journal club which provides a venue to improve communication among physicians and scientists, and foster comment and criticism about published scientific research. The goal is better understanding and interpretation of the medical literature.

The journal, Medical Physics, uses the electronic physics auxiliary publication service (EPAPS).⁽²⁶⁾ It is an electronic depository for material that is supplementary to papers appearing in journals published by or through American Institute of Physics (AIP). Appropriate items for deposit include multimedia (e.g. movie files, audio files, animated gifs, 3D rendering files), colour figures, data tables, and text (e.g. appendices) that are too lengthy or of too limited interest for inclusion in the printed journal.

The Journal of Visualized Experiments (JoVE)⁽²⁷⁾ is the first video journal for biological research. JoVE publishes video demonstrations of biological techniques and methods, as applied in the laboratories of leading academic institutions, including Harvard, MIT, Stanford, Berkeley and others. Hundreds of peer-reviewed video-protocols, demonstrating experimental techniques in neuroscience, cellular biology, developmental biology, immunology, bioengineering, microbiology and plant biology are available, free of charge, on the JoVE website.

THE FUTURE AND BEYOND

It is rather difficult to predict precisely the future direction of electronic publishing as it is evolving rapidly in tandem with advances in electronic and internet technology.

What is certain is that we will witness the transformation of electronic journals to information portals. Some of the innovative products are just mind-boggling, and the myriad of uses are waiting to be explored.

A glimpse of the future publishing landscape has revealed the following:

- Greater exploitation and utilisation of multimedia capabilities.
- Various publishing models co-exist and continue evolving.
- Publishers are changing their traditional roles in becoming electronic service providers.
- Institutional depositories will be strengthened and become more popular.
- Researchers and authors are becoming major stakeholders in publishing.
- Copyright issues continue to be debated.
- Peer review is here to stay while attempts are being made to improve the system.

The internet and information technology are sure to have an impact on the research landscape, scholarly publishing, research policy and funding, dissemination of knowledge and the progress of science as a whole. However, one question remains: what constitutes a publication in the digital environment?

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