Publishing Scientific Papers in the Developing World

TWAS/BioVisionAlexandria.NXT 2010

Ismail Serageldin & Ehsan Masood
with
Mohamed El-Faham & Heba Maram

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An Overview of Scientific Publishing

Dianna Derhak, Founder and chief executive of the DNA International Consultancy

Over 34,000 years ago Cro-Magnon man was scratching images onto cave walls to communicate. Today anyone with an Internet connection and basic skills with a computer has the global capability to publish instantly on any subject through electronic media. The most potent changes in publishing have occurred in the last decade with the increasing decline of print in favour of rapid expansion of electronic capabilities, content, and the importance technology companies. In science, there is no going back to the uncontested pre-eminence of the paper journal. We live in the midst of a paradigm shift in publishing driven by innovation. The question for consideration at the dawn of the 21st century is whether scientific publishing is undergoing an evolutionary change of the present model or if it is at the start of disruptive change leading to a radically different architecture. Ideas drive innovation. In either scenario, the present timeframe is ripe with potential for deliberately harnessing the power of imagination as we move forward in this century. Now is a time of great opportunity for those willing to master new technologies and experiment courageously with new ways of seeing, thinking and doing things.

We live in an extraordinary time of exponential change. A vast accumulation of knowledge is available at the touch of a button and the process of change continues to accelerate. We "cracked" the DNA code. We harness particles at the nano-scale. We explore space to expand our earthly horizons as well as share our most mundane and profound thoughts in real time across the globe. All this is the starting point for this century. The story of scientific publishing in the 21st century is part of the overarching story of innovation in the production of knowledge. The dynamism and rate of innovation in the first ten years of this century gives us a tiny hint of the possibilities before us.

Publishing through the centuries in the context of innovation

The time span from 32,000 BC to 1450 AD was characterized by incremental innovation. We saw the evolution of written language with important contributions from the Sumerians, Ancient Egyptians, Phoenicians, Greeks, Romans, Chinese, Korean and from those in the Islamic world. Printing materials advanced from clay, papyrus, stone, vellum, wax and eventually to paper. Chinese woodblock printing and Korean moveable type were significant inventions pre-paving the way for the invention of the Gutenberg Press (1450 AD) which revolutionized printing and enabled the advent of the scholarly (paper) journal, we recognize today.

To better understand the context of scientific publishing today, we can fast- forward through more than 350 years in its evolution and see the steady role of innovation in the organization of effort, processes, technology and materials. The earliest research journals such as Philosophical Transactions of the Royal Society and Journal de Scanvans of Paris (1655 AD) became a means for learned societies to record proceedings of their meetings and summarize scientific and technical information.The first formal peer review processes were introduced at this time and eventually evolved to the process we have today. As scientific knowledge grew, specialization became the innovation to deal with the growing abundance of technical information and scientific discovery. Specialized journals proliferated through the 17th and 18th centuries.

The 19th century witnessed an unprecedented growth in specialized scientific journals as the pace of scientific discovery continued to accelerate. The model of publishing under the auspices of learned societies continued to dominate but started to show strain. Concurrently, innovation during this century occurred in several domains: printing technology evolved, cheaper pulpwood paper appeared on the market while the learned societies began struggling under the pressure to keep up with reporting more and more rapidly-increasing scientific developments. These dynamics changed the nature of scientific publishing by creating both a need and opportunity to address challenges in the sector and opened the door to private-sector commercialization. Elsevier Scientific Publishing (1884) entered the scholarly publishing arena and others followed. Domination of the sector continued by the learned societies, but the private sector established an important foothold and increased its share of the market throughout in the 20^{th} century.

The 20^{th} century marked the rise of mass commercialization fueled by inexpensive mass commercial publication pioneered by the publisher Robert Maxwell. In the 1950s, along with Paul Rosbaud, Maxwell founded the Oxford based scientific publishing house Pergamon Press. In parallel, Elsevier continued to grow. In the 1960s and 70s mergers and acquisitions became the innovation process of the times and commercial publishers began in earnest to acquire and consolidate smaller specialized journals. This marked the arrival of commercial publishers as leading players in scientific publishing, out-positioning learned societies for the first time in the sector. Ironically, Pergamon succumbed to the trend and was absorbed by Elsevier.

Simultaneous to the merger and acquisition fever sweeping the scientific publishing industry, interesting but seemingly unrelated innovations in electronic communications were percolating. In the 1960s, the US government began funding a research project to develop computer networks. In 1985, the National Science Foundation was commissioned to construct a University based network (NFSNET). In 1988, the network was expanded to commercial interests. In 1991, the World Wide Web was released to the public and the first generation of the Internet also known as Web 1.0 was born. New players vying for a role in the technologically driven electronic communications landscape emerged. Companies such as Microsoft and Apple and entrepreneurs such as Bill Gates and Steven Jobs came into view and soon became brand names. The era of the dot.com arrived along with a proliferation of companies jumping into the fray, with many disappearing into oblivion. We will later understand that this volatile period was critical and fertile ground for making the next leap forward in electronics and the evolution of the Internet.

The first decade of the 21^{st} Century

Millennial celebrations announced the arrival of the 21^{st} century. The Web continued to evolve and gain in popularity. The first iteration was but an inkling of the breakthroughs to come in 2004. With Web 2.0, the next generation of the Internet arrived offering interactive information sharing and user-friendly design. We experienced a sea change in how we acquire information (Google, Wikipedia, You Tube), transact business (Amazon), network (Facebook, LinkedIn), communicate (Skype) and much more. Instant electronic communications became accessible to almost anyone with Internet access. Business cards worldwide started routinely including email addresses and mobile telephone numbers. Phones have become "smart" and blurred the line between telephone and computer (Blackberry, iPhone). In short order, inexpensive mini-laptop web browsers (ACER) have become available globally. Electronic tablets (iPad) and readers (Kindle, Nook) forever changed the way we thought of publications. Individual computer programmers, as well as large and small companies began churning out micro-sized computer programs called "applications" to feed the frantic demand for software for the ever-changing products and versions being launched. Our lexicon, led by the twenty-somethings and younger, expanded to accommodate the new communications modalities. Seemingly overnight a wide cross section of the population around the planet from Nobel Laureates to the neighbor next-door started blogging, posting, tweeting, texting, instant messaging, skyping or connecting through social networks.

Arrival of the electronic journal

A crisis in the print-based scientific publishing industry was brewing and coalesced almost in tandem with the public launch and growth of the Internet. The number of print journals and articles were steadily increasing, production and subscription rates were rising rapidly while academic libraries experienced budget freezes or cuts. Access to print journals suffered. In 1997, frustration birthed the Scholarly Publishing and Research Coalition (SPARC) spearheaded by libraries, librarians and prominent scientists calling for changes and "open access" to scientific articles. Scholars around the world mobilized. Opportunity met need in the dovetailing of crisis and technological innovation. The Public Library of Science (PLoS) was created and quickly became an online open access publisher. While Open Access journals started populating the virtual landscape, the story is still unfolding dynamically with some facing challenges of financial viability and long-term sustainability. Within the traditional scientific publishing community, the debate on the implications of the technology revolution coupled with the economics and pressure from within the sector, resulted in a wave of innovation through expansion into electronic formats.

Paradigm shift: evolutionary change or disruption of the industry?

We appear to be in a bridge period of a paradigm shift in publishing from paper to electronic but uncertain where we will end up. Will the change be incremental and thereby evolutionary in character or point in the direction of a radically different architecture and a disruption of the industry? Scientific publishers are in a challenging place between longstanding tradition based on a peer review model, library subscriptions, experimentation with electronic journals and competition of Open Access journals. Some industry leaders are adapting, adding technology savvy professionals and departments and modifying the model. Time will show if the electronic journals and Internet products of current publishers are keeping pace with change.

Perhaps we can learn some lessons by analogy from the print newspaper industry and record companies. Print newspapers particularly in the US used to dominate news communication. Now online news is overtaking as a news source and there is an increasing trend toward individuals providing content and images directly to the Internet rather than journalists reporting events and editors screening and overseeing the process. While debate over the future of newspapers and journalism rages, change is occurring in real time without abatement. Formerly, record companies used to dominate the music business, now technology companies (Apple/iTunes) with downloadable music from the Internet challenge their position. Leaders in both the disrupted industries were slow to recognize the tsunami of change approaching perhaps because the new technologies did not look promising in the early stages. It is very difficult for incumbents who have longstanding traditions to marshal the internal will and resources to dramatically change their paradigms.

Times of disruption are unsettling. The path forward is not clear-cut and the early signs of disruptive change are mere glimmers on a crowded radar screen. In his blog, Michael Nielson[1]identifies the characteristics of disruption.

- New technologies are unimpressive at early stage
- Start up organizations serve an overlapping need
- Radically different business models unfold
- Finances start flowing to start-ups
- Most start-ups fail
- Valuable lessons are learned in the process of failure
- Slow response by incumbent industry ("immune response")

Conclusion

The 21st Century publishing is technology centered. Ten years into the century, we have witnessed an accelerated rate of change in the production of knowledge unknown in the last 34,000 years combined. It is likely that this exponential change will continue and that we will eventually see a radically different architecture emerge in scientific publishing. The mantra of the times may be "adapt or perish".

Many characteristics of disruption are already part of our current landscape. Computer science and technology are rapidly advancing. Business models are evolving. New players are emerging. Experimentation and innovation in thinking, products, processes and organizations are developing. Social networking is ubiquitous and continually expanding. Translation tools, collaboration and collaborative platforms are improving and new ones on the horizon. New avenues for communicating science are developing including an increase in scientific blogging for communicating research.

Some traditional publishers are adapting to the pace of innovation while others are struggling to become technology centered. We have gone from dominance by Learned Societies to dominance by publishing companies. Perhaps in the age of the Internet, technology companies will dominate the next incarnation of scientific publishing.

1 Michael Nielsen Blog: Is Scientific Publishing about to be Disrupted? June 29, 2009, Filed under The Future of Science.

Bridging The North-South Knowledge Gap

Rola Naja

The knowledge divide between the North and the South results from the substantial difference in accumulated scientific knowledge about the two regions and their current unequal capacities for generating new knowledge. The knowledge divide and its consequences cannot be considered a problem of the South alone, but rather a collective problem for the international community, since the North and the South are ultimately part of the same world. Any serious approach to addressing the knowledge divide should consider not only the goal of making global environmental governance more equitable and more broadly knowledge-based, but also the deeper underlying issue of what it means for people to be involved in the generation of knowledge about their own realities. This paper evaluates the main problems encountered by researchers in low-income countries, among others the knowledge and digital divide. Strategies are discussed for mitigating some of the restrictions faced by scientists in developing countries.

Introduction

The developed world is truly changing fast due to research development and to advances in diverse fields and especially in genetics, computer sciences, networking and telecommunications. The progress that has been achieved represents only partial success that needs to be spread over the developing world. The point is that the scientific success of developed countries should not overshadow the scientific stagnation in developing countries. The global scientific community should care about countries that remain scientifically deficient. In fact, enabling global science to truly flourish will require making one world of science.

The "One world of Science" concept, which supposes the absence of development hierarchy, requires identifying research problems and challenges facing researchers in developing countries in a first step. In a second step, new approaches and strategies should be adopted in poor countries in order to bridge the knowledge gap between the North and the South. Research in developing countries is compromised by multiple factors: resources are limited, equipment less than optimal, and basic infrastructure, such as electricity supplies, unreliable.

In our world, imbalances in physical access to technology as well as the imbalances in knowledge, resources and skills should be removed in order to enable each researcher to participate as a digital citizen.

This paper is organized as follows. Problems facing researchers in developing countries are discussed in section II. Strategies and new approaches are detailed in section III. A conclusion in section IV finalizes the study.

Developing-World Research Problems

Developing countries are suffering from multiple problems that are considered obstacles to scientific research and can be summarized as follows: A knowledge divide; a digital divide and continual growth without sustainable development.

Knowledge dissemination and e-skills are two means for mitigating some of the restrictions faced by scientists in poor countries.

Knowledge divide

In many international settings, developing economies are in danger of declining due to the knowledge divide. This decline attacks the very fabric of cohesion and purpose for these regional societies delivering increased social, health, economic and sustainability problems. The knowledge divide describes the gap in living conditions between those who can find, manage and process information or knowledge, and those who are impaired in this process. As specialized knowledge becomes an ever-increasing component in society, and the spreading of this knowledge becomes ever faster with modern technology, the people who cannot take part in this development will be increasingly isolated and marginalized.

During the Biovision conference 2010 held in Bibliotheca Alexandrina, young researchers, from developing countries, identified research problems related to knowledge divide. Among these problems, young researchers highlighted the lack of awareness (calls for papers, calls for proposals, etc.), research findings visibility, journal visibility. One crucial obstacle facing young researchers is the relative unavailability of academic journals. While the number of specialist academic journals continues to rise, the average price of a science journal has risen four times faster than inflation for the past two decades, resulting in an 'access crisis' in which libraries are forced to cancel journal subscriptions. This worldwide problem is magnified in low-income countries; even public institutions are often unable to meet the rising costs of journal subscriptions.

	Population (2009 Est.)	Internet Users Dec. 31, 2000	Internet Users Latest Data	Penetration (% Population)	Growth 2000-2009	Users % of Table
Africa	991,002,342	4,514,400	67,371,700	6.8 %	1,392.4 %	3.9 %
Asia	3,808,070,50	114,304,000	738,257,230	19.4 %	545.9 %	42.6 %
Europe	803,850,858	105,096,093	418,029,796	52.0 %	297.8 %	24.1 %
Middle east	202,687,005	3,284,800	57,425,046	28.3 %	1,648.2 %	3.3 %
North America	340,831,831	108,096,800	252,908,000	74.2 %	134.0 %	14.6 %
Latin America/Caribbean	586,662,468	18,068,919	179,031,479	30.5 %	890.8 %	10.3 %
Oceania / Australia	34,700,201	7,620,480	20,970,490	60.4 %	175.2 %	1.2 %
WORLD TOTAL	6,767,805,20	360,985,492	1,733,993,74	25.6 %	380.3 %	100.0 %

Table1. Internet Usage and World Population Statistics. http://www.internetworldstats.com

The fundamental cure for poverty is not money but knowledge. Knowledge makes significant progress in improving economic growth, poverty reduction and environment sustainability. This fact raises an important question: What kind of flow information is useful for researchers? And how knowledge should be shared? The flow of information coming from North to South is important for South as research advances and finding in the developed countries can be exploited by researchers in the South.

The flow of information from the South to the South is also important as contexts are more relevant. Finally, we should not neglect the flow of information from the South to the North. This kind of exchange is definitely important for the North. The point is, in our world, improved scientific capacity anywhere has the potential to help everyone everywhere. One illustrating example is the Southern African Large Telescope (SALT) near Cape Town, South Africa. SALT is the largest single telescope in the Southern Hemisphere, that has boosted research in astronomy and astrophysics internationally since it became operational (Hassan, 2008).

Sharing and exchanging knowledge is of crucial importance in our global world. Sharing knowledge is not about giving people something, or getting something from them. That is only valid for information sharing. Sharing knowledge occurs when people are genuinely interested in helping one another develop new capacities for action; it is about creating learning processes.

Sharing e-knowledge sounds very interesting for publishers and end users especially in the developing countries, due to the unlimited space, lower costs (printing, distribution), free or low price for user and more material widely available all over the world. This fact raises an important question: Is it the end of journals? And do we really need journals in the post-Gutenberg age?

However, e-knowledge is possible if an appropriate communication infrastructure is implemented in developing countries. This leads us to the second problem facing poor countries: digital divide.

Digital divide

Digital divide is closely related to the knowledge divide as the lack of technology causes lack of useful information and knowledge. The Organization for Economic Co-operation and Development (OECD-Paris) has defined the digital divide as the gap between individuals, households, businesses and geographic areas at different socio-economic levels with regard both to their opportunities to access information and communication technologies (ICTs) and to their use of the Internet for a wide variety of activities (OECD, 2001).

In fact, the digital divide is the gap between people with effective access to digital and information technology and those with very limited or no access at all.

Digital divide compromises researchers in poor countries and creates an additional barrier: the access to current research and electronic journals which is quite impossible for a great number of researchers.

Table 1 exhibits a statistical survey that shows number of Internet users and the penetration rate. One can see that the least penetration rate is achieved by Africa, followed by Asia. And the highest one is in North America.

One way to address the imbalance in physical access to technology is to raise the penetration rate and enhance the information technology (IT) infrastructure in low-income countries. In fact, IT supports economic development, contributes to the promotion of economic productivity, develops career opportunities and solves the problem of knowledge divide.

The power of internet and the diffusion of collaborative practices provide new tools to build and share knowledge. In principle, the internet has the capacity to collect and store all knowledge, to make it instantly accessible by anyone and anywhere, to convey discussions and present debates. To bridge the gap between North and South, we have to start by bridging the digital divide. This will effectively link innovation to people.

Strategies For Reducing the North South Knowledge Gap

Acknowledging the existence of a knowledge divide between the North and the South and its consequences prompts the question of what can be done to address the situation. Over the long term, bridging the North-South knowledge divide will require measures aimed at reducing the divide itself.

This section will focus on challenges, methods to increase scientific output, new approaches, academic publishing and open access publishing.

Facing publishing challenges

An important challenge to face is the importance of changing an old-fashioned journal system into a modern one as highlighted in (Thulstrup, 2010/1). This issue is the most cost-efficient way to strengthen research in many developing countries.

In poor countries, although the number of research journals is increasing, the average quality tends to be correspondingly low. This makes it difficult to provide qualified reviewers, avoid delays in publishing, and ensure that a large number of relevant readers are reached.

In order to face this challenge and to improve this situation, we have to think about how to publish knowledge that can be used and applied in our life. On the other hand, we have to realize that the in-lab research has become the on-line research. Consequently, the so-called ''Publish or Perish" concept became ''Adapt or Disappear" as pointed out in (ElZaim, 2010).

Increasing scientific output

In order to increase the scientific output, strategies have been undertaken by editors such as those at the publishing company Elseiver. Elsevier has worked very closely to support researchers in developing nations through the Research4Life programme. Research4Life involves three public-private partnerships which seek to help achieve the UN's Millennium Development Goals – these programmes are the Health Access to Research Initiative (HINARI); Access to Global Online Research in Agriculture (AGORA); and Online Access to Research in the Environment (OARE). Through these programmes, researchers at 4,500 institutions in 108 developing countries have access to over 7,000 journals to assist them in their research (Schwartz, 2010).

Adopting new approaches

New approaches should be adopted by researchers in developing countries.

The first approach is to publish in high quality journals. In fact, it is more important to correct own mistakes and misconceptions than it is to impress non-experts in the long run. Thus, one should publish in journals that provide competent and helpful reviews, rather than produce a long publication list of papers in obscure journals. Researchers being evaluated are asked not for their complete publication list, but for their most significant publications. Citation counts are also becoming part of evaluations (Thulstrup, 2010/2).

A second approach is to promote efficient collaboration and provide funding for researcher mobility from the South to the North. This will definitely help achieving scientific data that stand a chance of getting into major journals and enable scientists from developing countries to become authors, in international journals (Rook, 2010).

A third approach is to reach politicians and decision makers as highlighted by (Afzal, 2010). As a matter of a fact, scientists' knowledge, experience, and research findings fail to reach influential audiences and, consequently, are not used to shape policies in developing world. In order to fill this communication gap, scientists should:

- Be familiar with the policy process and the information needs of policy makers.
- See the policy relevance of their own knowledge and experience.
- Make extra effort to communicate in non-technical language to policymakers or to shape messages specifically for policy audiences.

Academic Publishing

Regarding academic publishing, junior scientists should learn good publishing practices and writing skills in university education (Castellanos-Serra, 2010). Training courses should be planned in order to highlight basic principles that are accepted in most disciplines. This will help junior scientists and students to prepare manuscripts that will have a high probability of being accepted for publication. Among the topics to be included are organization and preparation of a scientific paper, how to cite the literature and prepare effective tables and illustrations, where and how to submit the manuscript, the review and publishing process, the electronic manuscript, how to deal with editors and the value of databases such as PubMed, Web of Knowledge and Web of Science (Timmermann, 2010).

Open Access Publishing

The key aim for dissemination strategies is to transmit useful and useable knowledge to appropriate target audiences, including research communities, practitioners, the public, policy makers and regulatory bodies. Each of these target audiences has its own particular needs.

The basic model of dissemination comes for the centre to the periphery, i.e. from the developed countries to the developing countries via journals. The open access model enables peer-to-peer sharing and will help to stopping poverty and dependency (Chan,L. 2009).

The basic philosophy of OA is that the publicly funded research emerging from universities and research institutions should be freely available to researchers working to benefit the public, rather than subject to fees imposed by publishers. OA refers primarily to material distributed in electronic form on the Internet (e-prints).

The open access (OA) model of publishing has been suggested as a solution for mitigating some of the restrictions faced by scientists in low-income countries, and has made significant progress in improving free access to research.

However, as it emerges into the mainstream, the OA model must also face questions concerning its implications for the global distribution of intellectual property, widespread integration, and financial viability.

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How Should A Young Researcher Write and Publish A Good Research Paper?

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Publishing research results and methods is a key activity for any active researcher. It may be particularly important for the young and inexperienced, since it is a way to obtain useful quality control and general guidance at no cost. However, research publishing is often not easy for the young researcher.

This paper lists briefly some important considerations regarding where a paper should be published and how it should be written, in the hope that these considerations will be helpful for the young researcher. However, it should be recognised that there are many different research fields and journals which in some respects makes it difficult to give detailed advice, valid in all cases.

The reader should also be aware that numerous longer articles and books have been written about the present topics, and some young researchers may prefer to go to more complete discussions in the literature.

Introduction

Researchers write papers for several reasons, and any author should consider these carefully:

- To inform other researchers, as well as research users about their results
- To receive constructive criticism from experts in the field, journal referees or other readers
- To join relevant informal research networks world-wide
- To document their successful research efforts in order to secure future research funding and promotion

For young researchers the last purpose often seems to dominate and this may lead to an urge to publish as many papers as possible, often with overlapping content, as fast as possible. However, in the long term, publishing "lightweight" papers fast and in large numbers may be less efficient than producing fewer, but more solid papers in better journals, although this may take more time.

Especially, young researchers without strong mentors may benefit considerably from the comments of referees provided by good journals. Obtaining constructive criticism is a key for such researchers to improve, and they should actively seek guidance whenever possible, instead of hiding their weaknesses.

Before the young researcher starts writing a paper it is usually a good idea to have selected a suitable journal. The reason is not only that different journals require different formats, but also that the group of potential readers vary with the journal chosen, and it is of utmost importance that the paper is written in a way that suits the expected audience.

There are today several new opportunities (especially Internet-based and electronic) for publishing research, but the following considerations refer primarily to publishing in traditional, recognised journals. We shall in the following first discuss the selection of a journal, and later how the paper may best be written.

Selecting a proper journal for a good paper

We have already argued that it is highly important for researchers to get assistance with correction of their own mistakes and misconceptions early in the career. For young researchers in strong research environments, this is often primarily accomplished through discussions with more experienced colleagues (peers) or local mentors. However, especially for the many talented, young researchers without a strong, local research environment and without highly competent mentors, good journals may be of great importance in this respect.

Scientific guidance from publishing activities is usually best obtained by publishing in a quality journal with a strong (and hopefully also constructive, although this is not always the case) referee system. However, in practice those who need guidance the most often avoid publishing in such journals; the reason is that it may require much more time and effort than publishing in weak journals does; it seems easier to try to hide possible weaknesses. It is then overlooked that time spent on discussions with referees and editors may be highly educational for the inexperienced author.

Thus, publishing in journals that provide competent (and helpful) reviews, rather than producing a long publication list of papers in obscure journals is highly recommended. The author should demonstrate a constructive attitude, and should not try to hide questionable research methods and results from expert criticism. Instead the author should actively seek qualified and constructive criticism.

Another advantage connected with good journals is that they often reach many more readers than weaker journals. It is of great importance that the young researcher is able to reach a large number of potential partners in research communities anywhere in the world. At the moment, publication in English language journals tends to reach by far the largest number of relevant readers in the global research community.

Publishing complete papers in good journals is increasingly a good strategy, also when it comes to promotion, funding and other such concerns. Today, researchers are often being evaluated, not on the basis of the length of their publication list, but on the quality and impact of their most significant publications1. Citation counts are also becoming part of evaluations; it is not only important to be cited frequently, it is also increasingly important to publish in high impact (overall frequently cited) research journals, since the citation rates of the journals used are becoming an important criterion.

How should an author work with journals?

It is not always easy for young and inexperienced researchers to get their papers accepted in quality journals. Often an experienced mentor can be very helpful, and it is important that young researchers try to locate suitable mentors. However, good mentors may be hard to find, especially in developing countries. Also cooperation (especially co-publishing) with experienced researchers at home or elsewhere will often be very useful in this context, as long as an attempt is made to maximise learning from the cooperation. However, if such support is hard to find, good journal editors and referees offer an alternative source of guidance.

1 Increasingly evaluation committees ask applicants about information, not on their total amount of publications, but on their 5 or 10 most significant publications

When a paper has been submitted, the author will receive one or more reports from the journal referees. These will often be very useful and provide essential information to the author. However, in some cases the referee will have misunderstood part of the paper. In such cases the author should demonstrate some degree of humility and assume that the misunderstanding was caused by an unclear text, and an attempt to reformulate it should be made. In other cases the referee may make suggestions that the author does not find useful. Even then, it may be worthwhile for the author to accept part of the suggestions, but minimise the required changes. It is often much better to be diplomatic than stubborn in the negotiations with editors and referees!

Many journals still have (at least formally) a system of page charges. It means that the author is encouraged to pay a sum of money per manuscript page. In most fields only a very small fraction of the authors pay these amounts; instead they ask to have the charges waived. In most cases authors from developing countries are likely to obtain such waivers without any problems.

Do not forget the users of research!

Finally, an important point, especially in developing countries: potential real life applications of the research should not be forgotten. Instead an attempt should be made to reach local (national, even regional) users of research knowledge in the given field. This will often require additional publication in other kinds of journals, such as local (national) journals using the national language. Such papers will often have to summarise all recent research in the field; often such reviews are extremely useful for industry, and writing them is often a valuable educational activity for the author.

Writing a good paper

It is important for the author as well as for the reader that the paper is clear and reasonably easy to understand. This may be particulary important when the paper targets users of research knowledge, but it is also highly recommended for papers in proper research journals; this will be the target of the following discussion. Some authors try to impress their readers by using a complicated language, difficult words and long sentences, but this is not a constructive strategy, the purpose of the writing should be to give as many readers as possible a clear understanding of what has been done.

If an author is not (yet) sufficiently competent in the language to be used (often English), it is a good idea to seek help with the writing, if necessary even from a language-competent non-researcher. Studies show that a large part of the readers only read the abstract, the conclusion, the references, and look at the figures. Therefore, the author should make sure that these parts of the papers are of a particularly good quality and stimulate the interest for reading the rest of the paper. In a way the author has to sell the product!

A good paper should have a key message, typically in the form of conclusions based on research findings, methodology development, or even, for example, on uncertainties and the need for new studies of a specific issue. It is extremely inportant that ther author make sure that these key messag es are clear to all readers.

The author should concentrate on what is useful and interesting for the reader to read, less on what the author initially may have planned to say. It is not necessary to repeat excessively what has been publish before; instead it should be summarised and references should be provided to relevant and reliable sources.

When an author uses methods, results, etc. developed or obtained by other researchers, full credit should be given (maybe even praise). New authors should not try to ”reinvent” what has been done before. Giving full credit to others will make an author respected, trusted, and well liked in the research community within the field. It never pays off to try to ”steal” results or methods!

Typical components of a research paper

A research paper will typically have the following parts, although there may at times be reasons for using a different setup:

- A short abstract informing readers about what they can expect of the paper
- An introduction, in which the research activities and resulting messages are briefly described. Wider implications of the research may be touched upon and a summary of earlier work on the problem may be included. References should be given to anyone in the field who have contributed significantly

- A methodology section, in which the research methods are described, either briefly by giving reference to similar descriptions in the literature, or, if necessary, in more detail
- An experimental section (if applicable) in which experiments are described in detail. If they include much repetitive work (as, for example, natural product chemistry often does) this should be summarized in a clear and condensed form. Any non-trivial equipment and supplies used should be described; if the equipment is home constructed it should be described in detail (or reference to a description elewhere should be given. In the case of a commercial instrument it is sufficient to mention the manufacturer's name and the model. It may at times be relevant also to describe the supplies used, such as the quality of solvents, etc.
- A key section on the actual investigation (e.g. experiments) and the results, in which the latter typically are shown in the form of figures or tables. It is important that these are very clear and do not overlap too much – if necessary, the author should find ways to summarize. In the figures, it should not be forgotten to clearly specify units used. As a standard practice, the number of decimal points given should correspond to the actual reliability of the results
- A section on how the data obtained are used (often called the discussion) and the conclusions that are reached. Comments may be added, for example on planned, related future work or on the need for further investigations to be done by others, e.g. researchers with access to specific equipment or expertise that the author does not have
- An acknowledgement, in which credit is given to people who have assisted with the research project in different ways, but without being coauthors. Also donors, grant organizations, etc., that made the work possible should be given credit here. It may often be a clever strategy to make these latter acknowledgements carefully
- Finally, references which should be clear and precise, so that readers can locate them if they want to learn more.

Any author must keep in mind that each journal has its own rules and formats. It is important to understand these well before completing the final version of the paper.

Conclusions

For the young scientist publication of research activities is an important part of a learning process. It is important to try to obtain constructive criticism, and this is often best when papers are submitted to quality journals, although there are also many other good reasons to submit papers to good, international journals. Young researchers should not try to hide weaknesses in the research, but instead get it out in the open in order to improve research methods and strategies.

In the long term it will, for several reasons, be better to produce fewer and better papers in good journals than many weak papers in insignificant journals.

Research papers should be written for the sake of the readers, not for selfish reasons. The important key messages should be as clear as possible. When dealing with journals, young researchers should make sure that they understand the comments of reviewers and editors fully and they should be flexible and diplomatic rather than stubborn in their negotiations with them.

In spite of all kinds of good advice, the ability to write good research papers usually to a large extent comes through a learning-by-doing process. There will be defeats, but they should be considered as part of the learning process. Therefore, do not delay it: Get started writing papers now!

Better Science And Better Science Communication

Lila Castellanos-Serra, Project Leader, Department of Proteomics, Center for Genetic Engineering and Biotechnology, Havana.

Excellence in science depends on a number of things: the relevance of questions asked; the quality of experiments; and the quality of interpretation of the results. Over the past two decades, the volume and complexity of information produced in the biological and biomedical sciences has been rapidly increasing, along with the expansion of new technologies and especially in data generation. Genome sequencing, once a rare and expensive set of technologies, now exists on an industrial scale. Nevertheless, data validation – verifying data and more importantly, interpreting data – still takes place on a more human scale, which means that it takes place much more slowly. The consequence of this is that data validation is not able to keep up with the speed of data production. Journal editors are aware of this and are working to turn things around.

Two Examples of What is Being Done: EQUATOR and MIBBI

Two examples of what is being done are EQUATOR (http://www.equator-network.org, Web launch in June 2008) and MIBBI (http://mibbi.org, Web launch in August 2008).

EQUATOR is an acronym for Enhancing the Quality and Transparency of Health Research. According to EQUATOR: "Too often, good research evidence is undermined by poor quality reporting. The EQUATOR Network is an international initiative that seeks to improve reliability and value of medical research literature by promoting transparent and accurate reporting of research studies." Reporting guidelines "specify a minimum set of items required for a clear and transparent account of what was done and what was found in a research study, reflecting in particular issues that might introduce bias into the research". They reflect "consensus opinion of biomedical and medical experts, including research methodologists and journal editors and they do not substitute but complement basic writing principles, styles of publications, and instructions to authors".

While EQUATOR intends to increase quality and confidence of medical reports, a similar effort is being undertaken in biomedical and biological research through a project called MIBBI. MIBBI is an acronym for Minimum Information for Biological and Biomedical Investigation, first described in detail in *Nature Biotechnology* on August 2008 (Taylor, 2008). "To fully understand the context, methods, data and conclusions that pertain to an experiment, one must have access to a range of background information. However, the current diversity of experimental designs and analytical techniques complicates the discovery and evaluation of experimental data; furthermore, the increasing rate of production of those data compounds the problem. Community opinion increasingly favors that a regularized set of the available metadata ('data about the data') pertaining to an experiment be associated with the results, making explicit both the biological and methodological contexts. Such minimum information checklists promote transparency in experimental reporting, enhance accessibility to data and support effective quality assessment, increasing the general value of a body of work (and the competitiveness of the originators)".

How To Handle Terminology? The OBI Consortium

The mismatch between data production and data validation in biological research has been accompanied by a significant growth in new terminology and also by a tendency for different groups of researchers to ascribe different means to the same words and terms – depending on the field of study. Some kind of unifying terminology is needed, which is where the ONTOLOGY project (http://obi-ontology.org) comes in. This is an international effort to build an ontology to be used for annotation of biomedical investigations, lead by The Ontology for Biomedical Investigations (OBI) Consortium (http://purl.obolibrary.org/obo/obi).

As stated in the OBI portal: "OBI project is developing an integrated ontology for the description of biological and clinical investigations. This includes a set of 'universal' terms that are applicable across various biological and technological domains, and domain-specific terms relevant only to a given domain. This ontology will support the consistent annotation of biomedical investigations, regardless of the particular field of study. The ontology will represent the design of an investigation, the protocols and instrumentation used, the material used, the data generated and the type analysis performed on it".

New Challenges For Scientists And Editors In Developing Countries

These new requirements are translated into higher standards for article approval that can not be reached by simply "learning how to better write papers" or "developing writing skills". In fact, as a part of good practice in science publishing, better writing skills are but the last step on a long road to doing science according to rigorous standards.

Data transparency is only possible if a system for data collection and registry is established at the beginning of an experiment and complying with current international standards. This objective is difficult to attain in the context of developing countries. Scientists working in developing countries can not ignore how deeply these new concepts in publishing medicine and biology may affect their already scarce presence in international journals. And journal editors should consider these realities, if local journals are looking to increase their international visibility.

The scarce presence in mainstream journals of papers originated in developing countries has been recognized. This is a consequence of multiple causes, some are economic and social, among them is the lack of an innovative industry catalyzing national research and promoting endogenous science; as a consequence, scientists are not socially demanded and they are socially undervalued. Drain of clever minds from poor countries to developed countries reinforces the problem, making the return of highly prepared professionals rather an exception.

In developing countries, science is mainly an academic exercise done at local universities, under the leadership of supervisors that were themselves prepared in developed countries. In cases when, luckily, these former Ph. D. students return home, too often they import research agendas that, while being pertinent in the context of the developed world, do not face issues of local relevance. The effect is a sort of "brain drain without emigration". Concentration of scientific activity "in the north" should not be considered "a problem of the South", but a problem with global consequences as it risks reducing diversity of approaches, so sterilizing creativity of Science at large.

Biomedical Research Publishing Is Changing. Are Developing Countries Ready?

Science education in developing countries is mainly oriented to prepare what I would call "knowledge-consumers", when it should also be preparing "knowledge-producers". In manh of our countries, preparing professionals to be producers of knowledge requires important changes during at the undergraduate and graduate level. In particular, it requires an emphasis in developing people to be experimentalists, training them to be able to critically analyse published research. This in turn requires several interventions. It means giving students access to original scientific literature during their undergraduate studies; enabling them to be familiar with intellectual property protection by accessing patent databases as primary sources of information. At the same time, students need to be given space to discuss the many unresolved questions at the frontiers of science: understanding how what is "state of the art" today, might have come about through a creative hypothesis. In other words, presenting knowledge as an unfinished, ongoing process.

In my experience as both a journal editor and reviewer, causes for rejection of articles are several, and in most cases, are not only attributable to a lack of writing skills, or a lack of fluency in a foreign language. A poorly constructed hypothesis; or a shaky experimental design; or poor quality control cannot be addressed through good writing.

Starting on 2004, as a component of graduate studies we have developed a training program for graduate students in biomedical sciences working in research projects. The program is called: "Communicating biomedical, biological and medical information: from research design to research report". This is an interactive program conducted by a scientist working in the field, with experience (also) as an editor and reviewer.

The program is structured around five key issues:

- Principles of Research Methodology: to promote a critical analysis of student's own research project and published science
- Elements of Cognitive Psychology: to better understand the mechanisms underlying knowledge communication and perception
- Good Publication Practice: to become informed about new trends and requirements for article acceptance in mainstream journals
- Protection of Intellectual Property: to become familiar with knowledge protection by intellectual property systems, including patenting
- The Craft of Scientific Writing: where participants work on their own research reports.

This experience has been highly rewarding. It has opened up a permanent communication with former students, who at any time may request assistance for reviewing their articles and thesis. As a real life evaluation of its impact, participants receive their certificate only after they get a paper accepted in a recognized journal or they approve their M. Sc. or Ph. D. document.

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Peer Review Needs New Models

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Something that often amuses audiences when I say this is that religion, as much as science is cited as among the factors that led to the development of peer review. [1]

Peer review is of course the idea that when a scientist lays claim to a new fact, or a new discovery, then this needs to be verified, ideally by a third party. That verification could be to repeat the finding, or in the very least it is a check of a finding by peers, before that finding can be said to be certain.

What is peer review's connection to religion? We know that many of the earliest observatories were based inside places of worship. In the first few centuries after the birth of the great religions you'd find more observatories inside temples, mosques, and monasteries, than outside. And officials who worked in such places of worship also doubled up as astronomers.

Mosques for example had a permanent office of the resident astronomer – in Arabic, he would be called a *muwaqqit*, or a timekeeper. And it would be his job to compute astronomical tables by recording the motion of planets and stars. There was good reason for this because accurate tables were needed for working out times for prayers, or for calculating the birth of the new Moon, signaling the start of a new month.

Working in a mosque meant that *muwaqqits* also got to rub shoulders with imams and with other kinds of theologians, such as compilers of *Hadith*, which describes the many volumes of biographical records of the life of Prophet Muhammad. Some of these conversations between *muwaqqits* and the *Hadith*-men have also been recorded, and have come to us through the work of science historians such as Aydin Sayili from Turkey. [2]

It is fascinating to read some of the transcripts that Sayili has unearthed because they reveal things that are otherwise counter-intuitive. Today, you might expect a scientist to challenge a theologian – at least you would in one of the developed countries of Europe. But back then it was theologians who were challenging astronomers.

The *Hadith* men had a major complaint: they thought the astronomers did not pay enough attention to detail and to rigour; they regarded them to be just that bit flaky and they encouraged astronomers to prove that what they were recording was in fact accurate, trustworthy and verifiable. Astronomy was a relatively new field and astronomers tended to work alone, or in small groups. The *Hadith* men on the other hand were more confident of the accuracy of their historical work as they were organized in larger networks, and had devised quite elaborate systems of checking each others' work.

In Egypt, well known mosque-observatories included the mosque of Abu Jafar in Cairo. In the early 11th century its resident astronomer was a man called Ibn Yunus, and here he being is challenged by a theologian who says: "He has made his observations alone; how can one adhere to the opinion of one single person and abandon that of all others?" [3]

The theologians were concerned about the reliability of astronomical data and they wanted to be sure that what they were being told – in terms of when to pray, or when to start a new Month – was in fact correct. Although the phrase hadn't been invented at the time, the theologians were challenging the astronomers to submit their work to peer review.

The State Of Peer Review Today

Over time, and especially since the professionalization of science, peer review has become the gold standard for verification of research in the sciences and humanities. But it is my considered view that the gold on the standard is in need of a little polish.

Unusually for such a specialized field, peer review-related controversies have become big news internationally. Two controversies in particular have caught the attention of newspaper and magazine editors. There is of course the case of the leaked emails from scientists working at the University of East Anglia's Climatic Research Unit in the UK. This unit is one of the world's top labs for climate change science. Yet computer hackers managed to penetrate the university's computers and released several years worth of email correspondence between scientists working there.

The email trail seemed to suggest that the scientists were doing more than just science: they were looking to influence journals not to publish the work of other scientists; and, on the surface, they seem to have been reluctant to share their data with their critics. This incident has had extensive media coverage and was the subject of three separate inquiries in the UK. The scientists involved have been cleared of any wrong-doing but their often blasé approach to peer review did not put them in a good light.

Climate science is not the only field where peer review is under scrutiny.

In July 2009, 14 prominent stem-cell scientists across the world sent a letter to the editors of the leading peer-review journals [4]. The letter was released to the media in March 2010. And again, it indicates that all may not be as it seems.

What did this letter say?

It complained that journals were not publishing the best stem cell science. And it claimed that the best work was being held back—in effect that a kind of censorship was at work.

Prompted by these two examples my *Research Fortnight* colleagues decided to investigate further and assess the health of peer review today. We spoke to researchers in the UK mostly, by phone and by email asking them to describe their experiences as reviewers, of being reviewed and of working with research journals. More often than not the voice at the other end of the line is that of a frustrated scientist. What have they been telling us? [5]

The comments we have recorded include journals standing accused of "vindictive and personalised reviewing". One scientist told us that "reviewers are out to kill my paper". Another told us that editors were "playing a political game".

What we found can be summarized as follows:

- In the world of smaller and specialist journals, editors, scientists and reviewers are mostly all working academics and that reviewing is a spare-time activity
- Some journal editors are reluctant to publish work that might offend senior professors and star-academics
- Scientists who submit papers are sometimes concerned that reviewers are not always qualified to comment on papers that come before them
- Conventional peer review makes it difficult to publish truly ground-breaking work. When a field becomes mature, standards are set and it becomes harder to test the boundaries of what some scientists regard as reality, or truth.

We also discovered something else: few scientists agreed to speak to us on the record. Even fewer allowed us to use their names in any printed article – especially younger and mid-career researchers.

One scientist who did agree to speak on the record is Paul Fairchild, a stem cells researcher based at the Oxford Stem Cell Institute in the UK. He told us that the papers which are more likely to fall foul of peer review are those that claim to make the biggest breakthroughs. This is partly understandable: no journal wants to publish something that could make it look silly if proved wrong. But at the same time, Fairchild told us that reviewers find it hard to accept new work that challenges their own thinking.

As evidence for this claim he described his own story. In the early 1990s, he tried publishing research which questioned known thinking about autoimmune diseases. The paper was submitted – and rejected – by no fewer than six journals, before it was published in 1993 [6]. His work was solid. We know this because it is now regarded as mainstream opinion and his paper remains highly cited today, 18 years after being rejected so many times. Fairchild is convinced that he suffered this many rejections because his work challenged existing thinking – and that as a young researcher, he ruffled lot of more senior feathers.

A second example of challenges to the peer review system is much more recent. And it comes from the Large Hadron Collider at CERN, the particle physics lab on the border of France and Swizterland. The LHC is the world's most powerful particle collider and will remain so for at least the next 20 years. Some 10,000 scientists are working at CERN and the papers that are beginning to emerge from its collaborations typically have several hundred author names. But how is this a challenge to peer review?

CERN is attracting the best scientists. But if that is so (and it is), then where will those scientists come from who can properly and independently verify its discoveries? In an ideal world there would be a second group of 10,000 working on a parallel LHC. But science fiction aside, are there enough scientists qualified enough outside of the LHC to be able to verify its findings?

Even CERN's own management recognizes that it is practically impossible to properly peer review what it is doing – and claims that its internal peer review processes are probably more robust than anything a journal can offer [7]. If that is true then it is my contention that journals that publish in these fields are in effect simply acting as a vehicle for posting announcements from large and well-funded research groups. They are not providing scrutiny.

That's not because they don't want to. Its because they are unable to.

Peer Review Tomorrow

No one that we spoke to said that peer review should stop, or that it should be be replaced. Scientists are intensely proud of the tradition into which they work and the ideal that every finding and every discovery needs to be verified independently. But they do believe that change is needed to the way in which peer review is currently conducted, and they believe there is much room for improvement.

- Scientists want journals to publish the content of peer- review reports, but anonymised so that the identity of the reviewer can remain confidential.
- They want more journals to publish responses to reviews and other, associated editorial correspondence. This could be added as 'supplementary information.
- Publishing the paper trail that accompanies a piece of scientific research would be a powerful example of transparency in the scientific process. It would allow readers to judge what a paper had to go through to be published, and whether that was reasonable. And it would help to hold journal editors to account.

Scientists want journals to prevent reviewers from seeing the names of the scientists whose work they are reviewing.

These scientists are not anti-establishment. They recognize the important of journals. They know that within scholarly journal publishing there is often a fine line between publishing work that might seem ground breaking to some, but nonsensical to others. And they know that this poses a challenge for journal editors who do not want to take risks with the reputations of their publications.

Many centuries ago when science was in its infancy, the more established theologians challenged scientists not to play fast and loose with facts, and they urged them to devise systems to check each other's work. Peer review as it has evolved today is one such system, but those who work inside that system believe it could be better. Journals and journal editors need to respond constructively to their concerns. Not doing so risks damaging not just the reputations of journals, but it risks damaging the integrity of science as a whole.

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Why Smaller Journals Should Merge

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Progress in a research field is usually strongly dependent on open communication and cooperation between active researchers in the field. In this connection communication through research journals is a key activity, and this situation has not been changed by recent new modes of publication.

Unfortunately, the wish to facilitate publication in journals has often - especially in developing countries - led to creation of an excess of research journals relative to the capacity of potential authors and the number of potential readers. The result is a market of weak journals with too few good authors and reviewers and much too few readers.

One way of improving this situation in a given research field is to merge several weak journals into a strong one. This has been successfully done many years ago for numerous science fields in the Nordic countries. More recently, countries like Brazil have managed similar successes.

Introduction

Throughout the 20th century research journals have played a very important role in the development of individual research fields and for communication between their researchers. Historically, this role may have been primarily academic, but with the advance of the knowledge society, as well as the increasing competition for research funding, it has broadened considerably to at least three major roles:

- The traditional, academic one: To facilitate communication between researchers, providing the individual researcher with both quality control and access to cooperative partners. This purpose is often best served by subject specific journals with an international profile (for example using English language as a standard)

- the practical one: To inform the users of research based knowledge - from industry staff to high school teachers - about developments in specific fields, either through short papers or more extensive reviews; the latter are often particularly in demand by industry. These needs are best served by national journals in which both industry and university researchers may contribute as authors. The potential impact of such journals in developing countries should not be underestimated
- The more "selfish", but necessary one: To document the author's successful research efforts

There is rarely a shortage of research journals in developing countries, only a shortage of good journals. Nevertheless, statements like: "I have not published much, since we cannot afford to run a research journal" are often heard in developing countries. It may be exactly this feeling that has often led to creation of too many journals. However, this is based on a misunderstanding of the true purposes of scientific publication: to make communication with all other researchers in the field possible. If most other researchers in the field do not have access to the journal, it will have little value.

The discussion in the following is partly based on a presentation made at a conference in Bagamoyo, Tanzania, in 2002 (Thulstrup, 2002).

A multitude of journals in many countries

A count in the mid-1990s showed that Indonesia alone was the home of about 500 different research journals (Koswara, 1998). In this connection it may be mentioned that at the time, Indonesian researchers published less than 100 papers annually in international, mainstream scientific journals. Among the many Indonesian research journals:

- Most were local, typically produced by a single university or even department, recruiting most of its authors from the same university/department
- Publication times were frequently very long (sometimes years)
- At times very different research areas were mixed in the same journal, making it hard to sell
- the number of readers was often quite limited, usually mainly local readers who would know about the research anyway, and

- The quality control process (reviewers) for submitted papers was often lacking or unsatisfactory

A more recent (late 1990s), informal estimate of the situation in Brazil (a research powerhouse among developing countries) indicated a total number of research journals well over 1000, many of them with the same problems as the Indonesian journals. However, it must be added that there have been and are ongoing significant improvements in both countries; especially the Brazilian efforts have been very impressive.

In both countries the total costs, both in money and "free" (not paid by the journal) editor time, hardware, postage, etc. of producing all these journals are very high, although it is rarely added up. But the outcome of these substantial investments is often questionable, partly because of a very limited journal circulation and frequent poor quality control. In fact, a pessimist might say that many of the journals have helped hide research from relevant, constructive and critical readers. These would include international researchers in the specific field, who never got a chance to know that the paper had been published, as well as potential users, such as industry, including local industry.

Merging small, inefficient journals

A similar situation exists in many other developing countries. Fortunately, simple, regional solutions may be possible, in particular in the form of mergers of a larger number of such "inefficient" journals within related fields into a small number of national or (preferably) regional, usually English language, academic research journals, one for each subject. In addition to such international journals, it may be useful to ensure that some reasonably subject specific local language journals exist, targeting local (or regional) users of research based knowledge.

Such reorganizations (mergers) may produce substantial benefits within research communication and at the same time save much money, as it more recently has been done in Brazil. One of many benefits would be that researchers in a field get a better chance to find out about the activities of other researchers with the same interests. Such knowledge is often lacking in developing countries, both at the regional and national levels.

In practice, mergers can only be successful if proper incentives are introduced for the present publishers (e.g. departments, universities, scientific societies, etc.) and, in particular, for the editors. It is also necessary to establish a sufficient trust between the editors involved in the mergers within each single research subject. Fortunately, trust is actually not uncommon among researchers in the same field.

Successful mergers, like many other endeavors, clearly require that a constructive "social intelligence" replace "individual intelligence" both in the general research communities, and especially among editors and publishers. The importance of small journal mergers has been amply demonstrated in industrialized countries (as well as in Brazil) and has frequently taking place during the last decades, even among strong research journals with long distinguished histories, especially in Europe. The following example from the relatively small Nordic countries may be particularly relevant for developing countries:

The successful mergers of science journals in the Nordic countries

Large-scale, regional mergers of scientific research journals were performed from the 1960s to the 1980s in Denmark, Finland, Norway and Sweden (the group of Nordic countries, of which Iceland, with a much smaller population, is also a member). Although these countries only have a total population of little more than 20 million, they have made important international contributions within scientific research; one of several reasons for this is that successful mergers of scientific research journals in the region have taken place a couple of decades ago. These mergers transformed a large number of small, Nordic local or national journals, often in local languages, into a limited number of fairly specialized, strong, international (English language) research journals. Many of the new, merged journals were soon able to attract international quality authors and they have received good citation ratings. Editorial boards and selection of referees were generally made fully international.

Most of the small journals were at the time of the mergers owned by national scientific societies for the specific fields, or even by university departments. This kind of ownership often continued after the mergers, but several of the new journals have later been sold, for example to international, commercial publishing houses or larger, international science associations in return for scientific guaranties and money. Some Nordic science societies have actually become rich this way! These sales were possible because a substantial scientific prestige of the journals was combined with a reasonably solid economy (i.e. financial independence).

How can journal mergers be performed in practice?

Restructuring of scientific research journals in Scandinavia was not always easy. At first, it gave rise to much criticism. Many did not like to give up or even change their pet publishing project. However, the critical voices stopped when the value of some of the new journals had been demonstrated. The mergers were also facilitated through a mix of incentives. Most importantly, the original owners, local or national societies, university departments, etc. found the new opportunity for improved scientific excellence a strong incentive for accepting the merger.

In addition, the national research councils in the four countries formed the Nordic Publishing Board (NOP), that used state funds from the four countries to provide further incentives for the mergers and other forms of internationalization (Westerlund, 1988). NOP formed committees for humanities, social sciences, and natural sciences, but only the latter, NOP-N, tried to develop new journals over a wide range. In particular, NOP-N offered research council (state) funds in support of:

- Improved management and editing of the new journals
- Technical upgrading
- Training of editorial staff, including cadres of "future editors"[1]
- International sales and academic promotion campaigns
- Support for editorial cooperation between different journals, and
- Comparative studies that revealed strengths and weaknesses for each individual journal, especially with respect to financial management.

The latter activity turned out to be extremely useful. By comparing a wide range of key data for a large number of journals (e.g. printing costs, publication times, etc.) it was possible to identify best practices for all

1 This is also given particularly high priority in Brazil, where young, "future editors" can obtain a formal diploma by taking part in course activities

aspects of the editorial and publishing work, and to provide individual editors with this information.

NOP-N has also in other ways tried to facilitate a strengthening of the efficiency of the journals. For example, in order to reduce costs and further "professionalize" the journals, seven newly merged, but still small, biological journals were given a common office for technical editing (located in Lund, Sweden), led by a professional managing editor. This helped the scientific editors, placed elsewhere in the Nordic countries avoid a massive amount of bureaucratic tasks and time-consuming correspondence with printers, shipping companies, etc. At the same time, the managing technical editor – both because of his/her experience and because of the volume of business - could work out much better deals with printers and other suppliers (Enckell, 1988). In a relatively short time the joint office became a widely recognized success.

Nevertheless, it was at times difficult to ensure economic independence of smaller journals without external support. Such support has been provided by NOP-N to selected journals for limited periods of time, but NOP-N has consistently required that it remained a key priority of all journals to become financially independent.[2] Although many editors complained about this pressure, they were given tools to improve the financial situation of their journal and they have generally been very pleased with the end result, including the financial independence.

How can the successful strategies be transformed to developing countries?

NOP-N and its support for individual journals have now largely been phased out. The mission is accomplished. Most scientific publishing in Scandinavia has become international, scientifically strong, and financially independent. The new journals attract leading scientists, both from the Nordic countries and elsewhere, as authors, which their weaker predecessors had never accomplished. A few journals have returned to national funding sources, but on the whole the NOP initiatives, especially those of NOP-N,

2 Unfortunately the simplest solution, to increase subscription rates after a journal had become a success, has often not been a realistic option, since most research libraries struggle to be able to afford even the most necessary journal subscriptions.

have been a major success. The question is to what extent these experiences can be transformed to developing countries?

As a first step in the strengthening of scientific publishing in a country or region, each individual end-product journal must identify its future roles. It must decide to become either an international research journal, facilitating communication between researchers from many countries, or a communication channel between those who create knowledge and those who use it.[3] Based on the present function of each journal before the merger and on the goals for the future, decisions on the needed changes in organization should be made. In most cases, earlier policies of the journal must be adjusted considerably to satisfy the new roles for the journal.

Conclusions

The positive outcomes of regional cooperation among the Nordic countries within scientific publishing through mergers of small research journals into stronger, more international ones, makes it worthwhile to consider this possibility for developing countries. Actually, the Nordic model has already served as a useful model in some developing countries, including Brazil.

In many ways the model seems well suited for regional cooperation within publishing between, for example, smaller African countries. However, in spite of the fact that efficiency is likely to be improved, successful policy changes will also require outside support in Africa, as it did in the Nordic countries. It is in particular essential that a range of incentives can be offered to those responsible for the journals. In Africa such support is most likely be found from donors or development banks, although it is remarkable that most of these (except a few, for example Sida-SAREC in Sweden) tend to overlook scientific journals as a potential driving force in the upgrading of research and its impact on development. Also international organizations, in particular INASP (International Network for the Availability of Scientific Publications), might possibly be interested.

A final word on the essential role of editors: In connection with the proposed policy changes it must be kept in mind that the competence and motivation of the editors involved are determining factors for success, not only for reforms, but also in general. Editors may help make mediocre

3 There might actually at times also be a need for a forum for young and less established researchers to gain experience as authors in their field.

authors successful or they may cause talented authors to fail. Therefore not only training of editors, but also provision of incentives for good performance are keys to success.

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Open Access: The Next Revolution in Scholarly Publishing

Ramy Karam Aziz[1] *and Peter Binfield*[2]

The advancement of science largely relies on the timely sharing and propagation of experimental data, results, and analyses between scientists. However, the current situation within the publishing enterprise suffers from several problems, including the overemphasis (for individuals) on high publication volume and citations, the cumbersome process of submitting papers, the obstacles against free access to published articles, and the misuse of existing metrics intended to measure performance. Being aware of these problems, several players have attempted to challenge the status quo by adopting new or revolutionary publication models. Most prominent among these attempts in recent years is the emergence and growth of the Open Access movement. Here, we focus on the experience of the Public Library of Science (PLoS), now the largest not-for-profit Open Access publisher, and report on some of its innovative projects, which attempt to overcome existing pre- and post-publication problems.

The current paradigm in scholarly communication: publish or perish

Communicating and publishing the results of scientific research is at the core of the scientific enterprise. Since the publication of the first journal in 1665 (Philosophical Transactions of the Royal Society of London, Mabe, 2009), scientists have been actively writing and publishing research and

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review articles. During the past four centuries, the medium for scholarly publishing has largely been printed journals to which individuals, libraries, and institutions subscribe.

The primary goal of scholarly publishing is (supposed to be) the advancement of science through sharing data and findings that fill gaps in knowledge, and allowing peers to evaluate these findings, reproduce them, and build upon them. Nevertheless, this ideal goal is not always evident to the scientific community. An entire culture has been created in which scholarly papers have become the currency of research productivity, and the act of publication has become an end in and of itself. Not only are scientists evaluated and promoted on the basis of the number of publishable units they produce, but in most countries and institutions the flow of money directed to research, and consequently the survival of scientists, largely depends on scientific productivity, which is frequently measured by publication volume.

In other terms, the cliché expression "Publish or Perish" has been coined and has, consciously and subconsciously, infiltrated scientific circles to the extent that for many, maximizing published scientific output has become more important than solving problems or contributing to knowledge, and the number of publications has become more appreciated than their content.

Because of the proliferation of journals and the importance of measuring productivity in an increasingly competitive scientific environment, multiple methods and metrics have been developed to measure scientific productivity beyond the simple practice of counting publishable units, since those could widely range in size, scope, and impact.

Perhaps the most popular of all metrics are those based on citations, i.e., methods that evaluate an article by how many times it has been referred to (positively or negatively) in another publication. A few variants of citation-based metrics are popular among scientists, in particular the Impact Factor (currently measured and propagated by Thomson Scientific), the Eigenfactor (Bergstrom et al, 2008), PageRank (Page et al, 1999), and Hirsch index (H-index) (Hirsch, 2005).

With the exception of the H-index, these metrics are mostly used to evaluate journals rather than individual articles, and have led to a hierarchical system that ranks journals according to their alleged impact, reputation, or prestige. Articles commonly 'inherit' the prestige of the journal in which they are published, i.e., an article benefits or suffers from the reputation of its journal. In other terms, articles are prejudged before they are even read; even more, a scientist's decision to read an article may be exclusively based on the reputation of the journal that has approved that article and brought it to light.

What is wrong with the current publishing environment?

As indicated above, the current situation in scientific communities, notably in academia, is based on a paradigm where science is communicated in publishable units, 'packaged' in journals with a limited page budget (primarily printed although mostly available electronically), in an environment where scientists are often evaluated by the number of articles they publish, with weight placed on the reputation of the journals that have agreed to publish these articles (usually after some form of pre-publication peer review).

The current system, as has become obvious to many, is not achieving the original goals of scholarly communication, is not working properly, and is not compatible with state-of-the art technologies available to scholars and students today. Even though many scientists accept, adapt to, benefit from, or even manipulate the status quo, authors and editors alike express their dismay with the current methods of peer review (Rothwell and Martyn, 2000; Smith, 2006; Young *et al*, 2008) or bibliometerics (e.g.,Hirsch, 2007; Jackson, 2010; Rossner *et al*, 2007; The PLoS Medicine Editors, 2006).

Typical problems with the current publishing environment are listed below.

- The publication volume has become overwhelming: one million authors publish more than 1.5 million publications/year in over 24,000 scholarly journals, read by 10-15 million readers at about 10,000 institutions (Mabe, 2009; Ware and Mabe, 2009)
- Scholars use at least four different search engines (PubMed, URL: http://ncbi.nih.gov/Pubmed; Science Direct, URL: http://www.sciencedirect.com; Google Scholar, URL: http://scholar.google.com; and ISI Web of Knowledge or Web of Science, URL: http://isiknowledge.com) and yet cannot guarantee to find an article they are looking for
- Even when a scholar or a student finds an article, most likely he or she will not be able to read beyond the abstract without someone (often their institution if they are fortunate enough to be affiliated with a wealthy one) paying for the privilege (80% of peer-reviewed articles are not freely available according

to http://www.doaj.org). Many readers get partial, or sometimes erroneous, information from abstracts. Being unable to access articles can sometimes be a genuine health issue, for example, when a patient's family needs to make an informed decision regarding the patient's health. And finally, given that in several countries, research is already funded by taxpayers' money, it is surprising that those who funded the research (the taxpayers) are not granted access to the results of their investment

- Although the scientific content of articles is contributed, reviewed, and often edited by volunteer scientists, the revenue goes to the publishers, and many publishers keep full or partial copyrights, which often means that scientists are unable to access the final work that they have spent hours to review, and that authors may not be able to freely distribute their work, even though distribution of their work is the ultimate goal behind all these efforts
- The process of submitting, resubmitting, and revising scientific articles has become too cumbersome and slow such that by the time an article is published, it can sometimes be quite out of date
- There is an implicit level of 'filtering' that is imposed by the publication process itself. In many instances, editorial staff (who are often non-practicing scientists) filter the submitted articles based on journal interest and significance, which results in biases. High-quality but 'unattractive' research may not find its way to publication. Negative results of well-performed experiments may never be published, costing taxpayers money and other scientists time to conduct experiments already known not to work. Finally, research that is anti-dogma or too innovative to be acceptable may never find its way to the scientific community because editors may not send it for peer review, or if they do, a small number of anonymous peer reviewers may hamper the publication
- A culture has been created that judges articles and authors by the impact or prestige of the journals in which they are published. This can be likened to rating movies by the companies that produce them, or to valuing athletes simply because they play for a successful team. Among all ranking systems, Thomson Reuters' Impact Factor has prevailed and has been widely used to evaluate individual articles, an application that even the inventor of this value opposes (Garfield, 1996, 1998).

Seeking solutions: The Open Access movement and the Public Library of Science

Many of the aforementioned anomalies and problems in the scholarly practices and culture drove a group of scientists with an interest in the public sharing of data to found the Public Library of Science (PLoS)—a publisher of open access scholarly materials. The group, led by three pioneers, Patrick O. Brown, Michael B. Eisen, and Harold Varmus, the Nobel Laureate and former head of the United States National Institutes of Health (NIH), initially ran an online petition calling on academics to rethink the way they interact with publishers and, soon after, created a publishing company (PLoS) in 2003 to help accelerate this change.

The remainder of this article focuses on PLoS's efforts towards streamlining scientific publishing, but it does so merely as a case study of what has been achieved in this one organization. There are, of course, many publishers and many committed advocates of Open Access outside of PLoS who are actively contributing to the revolution referenced in the title of this work. As one example of the scale of this movement, although PLoS is the largest not-for-profit publisher of open access journals (by volume of articles published annually), it only publishes seven journals while there are now over 5,500 open access journals in existence, as listed in the Directory for Open Access Journals (URL: http://www.doaj.org).

PLoS was launched with the following core principles (from: http://www.plos.org/about/principles.php):

1. Commitment to open access
2. Excellence in content, presentation, transparency, and editorial performance
3. Scientific integrity
4. Breadth (expansion of scope beyond areas of 'high impact' or 'wide interest')
5. Cooperation
6. Financial fairness
7. Community engagement
8. Internationalism
9. Science as a public resource

PLoS launched with the intention of gaining the trust of the scientific community and attracting first-tier scientists to publish in an Open Access venue. The strategy for this 'launch phase' was to establish competitive, highly selective journals that would publish high quality research while remaining committed to full open access publication models, and its result was the launch of the two journals, *PLoS Biology* and *PLoS Medicine*. The goal of this phase was to prove that an open access environment is suitable and competent for publishing high quality science.

The second phase of PLoS publications was to launch a series of discipline-specific community journals (i.e, ones whose editorial model would resemble the bulk of the 24,000 journals in existence today). The intention with these journals was to demonstrate that a 'typical' journal, using editorial processes driven by academics (as opposed to professional editors), can be run under an Open Access model but still be high quality and self-sustaining. The journals involved in this phase were *PLoS Genetics*, *PLoS Computational Biology*, *PLoS Pathogens*, and *PLoS Neglected Tropical Diseases*, and all four of them are now vibrant, successful titles in their own right (PLoS, 2010).

However, pre-publication barriers to publication and the ingrained system of journal filtering which effectively judges an article as 'important' or 'unimportant' before publication were among the main challenges that PLoS had set out to solve, and so in 2006 PLoS moved to launch a new journal which would attempt to tackle these issues. The resulting journal was *PLoS ONE*, which launched with the scope to publish in all scientific disciplines, using a rapid and inclusive model. Upon submission, articles would be evaluated solely on their scientific merits and not on any subjective measure of 'impact.' Individual Academic Editors would be responsible for the peer review and acceptance of individual articles, and, once accepted, articles would be placed online as rapidly as possible with tools that would facilitate post publication evaluation (at the article level).

As such, the most innovative feature of *PLoS ONE* (for which it won an industry award for Innovation in 2009, http://tinyurl.com/PONEaward) has been to separate pre-publication peer review (which examines the scientific robustness, integrity, and technical standards of a manuscript) from post-publication evaluation of that article (which can be more subjective, but which is best evaluated only once the community has digested the article). Clearly, what *PLoS ONE* is doing has struck a chord in the community, as in 2010 it became the largest journal in the world, publishing approximately 7,500 papers.

It is worth mentioning that the PLoS journals use an 'author pays' publication fee model, just one of the business models that are possible for an Open Access publication. As such, authors publishing in *PLoS ONE*, for example, are asked to pay a fee of $1,350 when their articles are accepted for publication. The ability to pay should *never* be an impediment to the ability to publish, and so PLoS provides full waivers for anyone who is unable to pay.

While there will always be debate as to what is the fairest business model for scholarly publication, it is a fact that the costs incurred in publishing and maintaining articles has to be covered in some way. However, as a not-for-profit, PLoS does not exist to make the kinds of profits that other publishers may aim for. In addition, with the fee being incurred only at publication, taxpayers are not charged for the article more than one time (and then only at the point of creation, not consumption).

Moreover, in an effort to re-invent the way in which scholarly articles are evaluated (and to move away from the current reliance on journal based metrics), PLoS has recently adopted multidimensional 'article-level metrics' for all articles published in their journals (URL: http://article-level-metrics.plos.org). Specifically, PLoS attempts to measure the following activities for any given article, and to present these data in the context of the article itself:

- Citations
- Web usage
- Expert Ratings
- Social bookmarking
- Community rating
- Media/blog coverage
- Commenting activity

It is the intent that by providing this suite of metrics, a reader of the article will be able to form an opinion of the 'value' of that article (specific to their own interests). Readers will no longer have to rely on the single filter of 'selection by journal X' when deciding how 'impactful' an article is; rather, they will now be able to use the metrics provided to make a more intelligent determination for themselves (although it is acknowledged that any metric is merely an indicator; the best way to evaluate an article is to read it!)

Finally, PLoS has not stopped innovating. In recent months they have launched two new products, which further experiment with the publication model (*PLoS Currents* and *PLoS Hubs*).

PLoS Currents has been created to be an extremely rapid primary publication mechanism for those researchers who wish to have their content online in days instead of months. Articles are submitted to the Current (for example, *PLoS Currents: Influenza*, URL: http://knol.google.com/k/plos-currents-influenza#) and are reviewed by a board of experts who are able to make a rapid publication decision. Once accepted, the article goes online immediately (currently on the Google knol platform), and so time from submission to publication can be accelerated to as little as 24 hours. Published articles are indexed in PubMed, and the platform allows versioning for researchers to update their articles in near 'real time'. There are currently three *PLoS Currents* (Influenza, Huntington Disease, and Evidence on Genomic Tests) with plans to add more in the future.

PLoS Hubs has been created to show the benefits of publishing in an open access format, via the post-publication aggregation and enhancement of articles published in any open access venue. Expert moderators select open access content suitable for inclusion, and that content is then 'ingested' into the Hub (via PubMed Central) allowing the platform to do more with each article than would be possible by simply 'linking' to external sources (for example, tagging, semantic enrichment, user interactions, etc). One pilot Hub has been created (the PLoS Hub for Biodiversity, URL: http://hubs.plos.org/web/biodiversity), and more will be created in the future.

As mentioned in the core principles, PLoS is also committed to internationalism, and in fact, the *PLoS ONE* model is a good example of this in practice. Currently, more than 50% of PLoS ONE articles come from countries outside USA or UK, unlike several other journals such as *Nature*, *Science*, *PNAS*, and *PLoS Biology*, in which > 60% of the articles come from these two countries. In addition, the *PLoS ONE* editorial board has over 1,300 practicing scientists from academic and industrial institutions, and these come from more than 50 countries, with only 50% residing in the USA or UK.

Conclusion: a paradigm shift

In conclusion, the scientific community around the world is now realizing that the current system for scholarly publishing cannot continue in the same way that it has done for the past four centuries, in a pre-Internet world. The technology is now available and the environment is sufficiently conducive to allow scholars to invent novel publication models that are not restricted by numbers of pages or other print-specific problems. Under such models, articles are not static or unchangeable once printed; they are not hidden or restricted to the elite but available to all; they are not pre-selected based on subjective criteria or prejudged by outdated journal-level metrics; and their review by peers is a never-ending process, through discussions and debates that start the moment the article is published.

PLoS and other revolutionary publishers and scientists will keep working to come up with the best models to guarantee that the original goal of sharing science be achieved, and that the old paradigm "publish or perish" be changed forever to "do good science or perish."

Post scriptum: declaration of scholarly rights

All human beings are born equal and are therefore entitled to the following rights whether they can or cannot afford journal-subscription or article-processing fees.

Everyone has the right to:

- Access scientific knowledge freely and promptly
- Perform scientific research and publish its results, regardless of his/her affiliation or lack thereof
- Reuse scientific data to benefit humanity, Earth, and the universe.

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