A Presentation of the Self-Publishing Model (SPM) as the Advent of a New Era of Scientific Communication

Author: Nour Ouda, Claus Jacob

Endorsed by: Claus Jacob

Edited by: Ahmad Yaman Abdin and Muhammad Jawad Nasim

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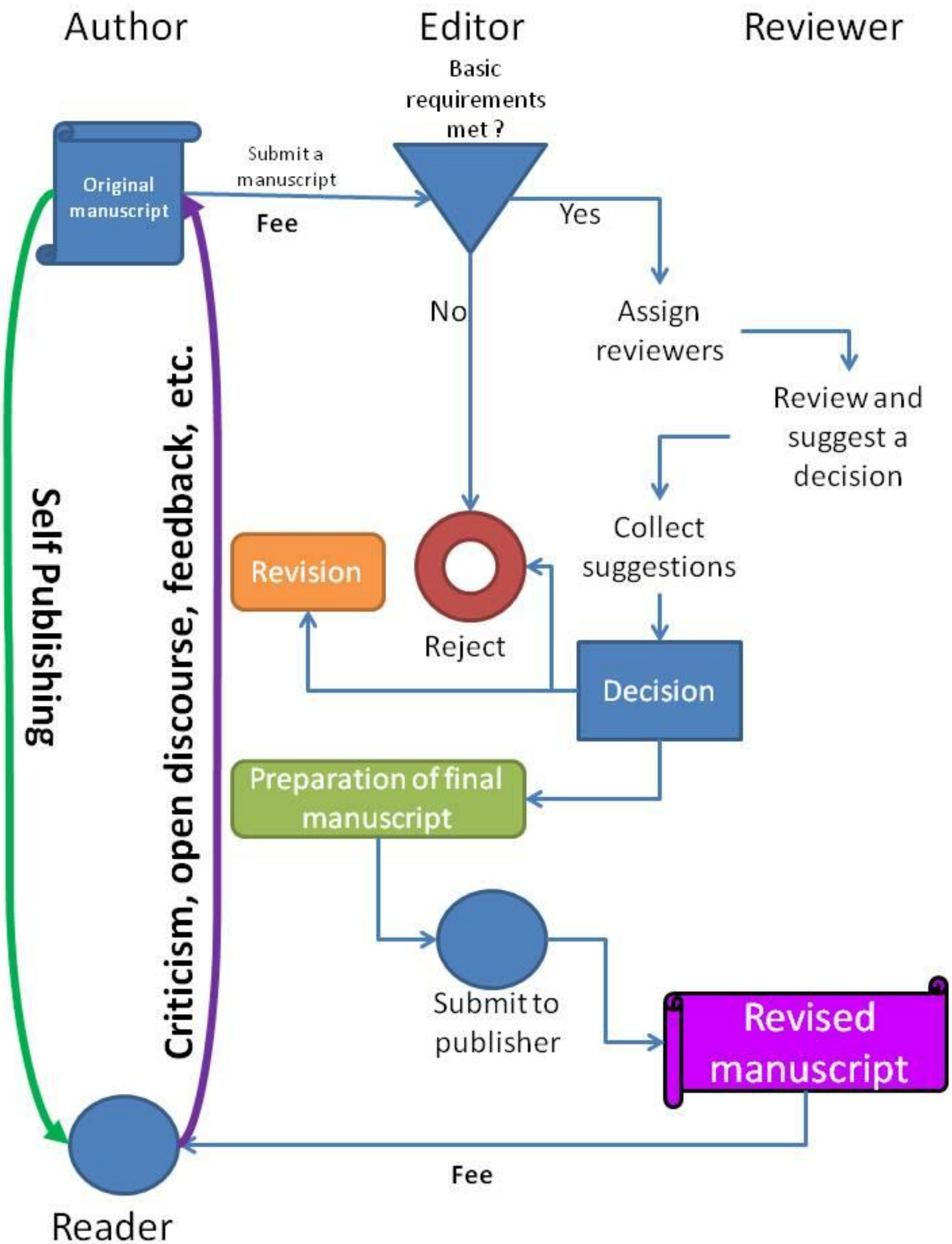
Abstract

Traditional scientific dissemination via journals is problematic. It restricts the free exchange of knowledge due to financial restraints and, because of a subjective reviewing process, often impinges on authors' originality. Eventually, important pieces of research are lost, whilst others are skewed in order to please anonymous referees. The Self-Publishing Movement (SPM) considers the free and open access to scientific knowledge as a right for all. Under the auspices of the SPM disseminating and acquiring knowledge is free of charge. The originality and creativity of authors' work and ideas are preserved by avoiding the influence of referees. The standard linguistic and scientific quality of the work can be maintained by peer editors and endorsers before the dissemination. The overall quality and significance of the scientific endeavor is evaluated by the entire readership, interactively, through endorsements, objections and feedback on a free, public platform. The SPM follows the idea that science is a continuous, interactive social process free for all to participate - and that this process is possible today thanks to modern IT. The SPM pitches an open debate and endorsements of manuscripts against refereeing, and their subsequent reads, citations, use and usefulness against rigid and de facto unrelated impact factors.



Author
Editor
Reviewer
Basic requirements met ?
Original manuscript
Submit a manuscript
Fee
Yes
No
Assign reviewers
Review and suggest a decision
Collect suggestions
Revision
Reject
Decision
Preparation of final manuscript
Submit to publisher
Revised manuscript
Self Publishing
Criticism, open discourse, feedback, etc.
Fee
Reader

1. Introduction

"Plato is my friend, Aristotle is my friend, but my greatest friend is truth," as Isaac Newton (1642-1726) has been quoted[1], clearly emphasizing that scientists are in a constant endeavor to uncover the truth about the universe in every aspect of scientific activity, *i.e*. the context of discovery, the context of justification and the context of dissemination.

History has focused on the context of discovery, which refers to the process by which a theory arrives. By the 20th Century, the attention shifted towards the context of justification, which involves validating the theory and searching for proofs (as falsification). Nowadays, the focus has shifted once again to the context of dissemination, which is becoming an important and integral part of scientific activity. Dissemination refers to the process of publishing approved theories, which contributes to the growth of science, development of knowledge and pursuit of truth.

In this thesis, I will consider the significance of publishing for scientists as well as the gradual changes in the publication system since the initiation of open access movement. I will discuss the issue of credibility, scrutiny as well as financial intentions associated with the dissemination of literature.

This thesis will also address the significance of scientific truth and the scientific activity utilized to render it attainable for scientists. I will probe deeper to define the scientific inquiry, considering the inductive-deductive patterns. I will then proceed to define falsifiability, which stems from the logical asymmetry between verification and falsification. Moreover, this study will discuss the different contexts of scientific activity, *i.e*. the context of discovery and the context of justification.

In the subsequent chapter, I will move from the invention and appraisal of theories to their dissemination. This section will consider the development of scientific communication. In effect, history reveals that each stage of development was strongly affected by social and technological advances. Thus, in the epoch of increasing technological advances, effective implementation of new technology is becoming a challenge.

Theoretically, scientific truth is a major intention for dissemination of new scientific discoveries. This raises the question if scientific truths are influenced by dramatic changes in scientific publishing tools, "especially" in the open access era. Furthermore, I will discuss the onset of open access publishing and the transition from printed journals to electronic journals, which represents a huge step towards rapid communication. Two decades after its first appearance in the late 1990s, the debut of "open access" has opened a door to a new era of publication. It is an era in which knowledge is shared on a wider scale through the straightforward accessibility of scientific literature.

Chapter 4 will highlight the scientific publishing practices, which have been affected decisively by many factors. Firstly, the number of open access journals has surged dramatically over the last decade. Secondly, the number of scientists is increasing who are under pressure to produce publications, and hence, are faced with the choice between "publish or perish." Thirdly, the mainstays upon which the modern scientific publishing is based are shaken.

These changes in the publishing environment have raised important questions: Are the scientific truths going to be influenced? How can we maintain scientific authenticity in the context of an increasing pressure to produce publications?

These questions have fueled debates between proponents and opponents of open access publication. Some supporters argue that, in open access publishing, there is a mutually beneficial relationship between authors and readers. Motives of authors to publish in open access journals have stemmed from their desire to advance knowledge. Altruism, however, has not been the only reason, career building is a reason as well[2]. In effect, increasing visibility definitely means increasing citations, which can enhance an author's career.

"*OA is not a sacrifice for authors who write for impact rather than money. It increases a work's visibility, retrievability, audience, usage, and citations, which all convert to career building*."[3] (Peter Suber, Open Access, p.16)

On the other hand, there is a fierce criticism on open access publishing practices. Some argue that, the peer review system is losing its credibility. Besides, digitalization of literature has increased the burden on reviewers, *i.e*. there are no limits for pages published per article and no print costs as well, at least not for the journal: *PLoS ONE*, which has published more than

105,000 papers since 2006[4]. In addition to that, some open access journals publish almost everything "methodologically sound," regardless of scientific significance.

Manipulation of impact factor values another issue which also needs attention. A journal's prestige is affected highly by the citation rates of the published articles, which are traditionally calculated by Thomson Reuters, although some fake Impact Factor (IF) claims have recently emerged[5]. Unfortunately, impact factor is now trickery augmented in and by several ways[6].

Chapter 5 will address the ethical issues regarding the open access-publishing model. How could scientists in Third World countries afford the article processing charges (APCs)? Is it more ethical to charge readers or authors?

Developing nations have benefited highly from the removal of barriers by open access publishing. Scientific results are flowing more than before to less well financed researchers. In these countries, researchers can access final manuscripts for free, but at the same time, it is hard for them to publish in open access journals[7].

In the proceeding chapter, I will develop my hypothesis and support it with reasons and historical evidences. I will introduce an alternative Self-publishing Model (SPM), which is cost-neutral, more rapid, more effective, less biased and in the end more democratic with its own "esteem factors" for manuscripts, authors and websites.

2. The role of dissemination in the scientific activity

"Truth in science can be defined as the working hypothesis best suited to open the way to the next better one," as Konrad Lorenz (1903-1989) has been quoted[8], obviously asserting that theories are constantly changing, new theories which explain new observations could replace old theories leading to an increase in knowledge expanding, thus closer approach to the scientific truth. Is scientific truth, however, approachable? If yes, could it be inevitable and maintained? In order to answer these fundamental questions, we should discuss the process of scientific inquiry *per se* and how to reach a specific theory.

This section addresses the emergence and the development of contexts of scientific activity, *i.e.* "The context of discovery and justification" by which scientific inquiry is processed and achieved. These two terms are often referred to Hans Reichenbach (1891-1953). In the early years of 20th Century, a sharp distinction between the two contexts has been created[9]. Recently, the interest has shifted to the context of dissemination and its significance for scientific activity.

2.1 The context of discovery

Philosophical reflection on scientific discovery has been intricate in meaning. In its "narrowest" concept, it could refer to the product of a successful scientific inquiry, or in its "widest" concept, it could refer to the process of a successful scientific attempt. In the course of the 1930s, however, the term "discovery" has been mainly referred to its narrowest concept, *i.e*. it is the activity which leads to a new ideas or hypotheses, which explain specific data. Thus, it refers to the purported Eureka Moment. It is a psychological, subjective and non-rational process, which cannot be subjected to a normative analysis[10]. Friedrich Kekulé (1829-1896), for instance, a German chemist, elucidated the hexagonal structure of benzene. It has been claimed that, Kekulé arrived at this hypothesis after dreaming of a snake that was trying to bite its own tail[11].

2.1.1 Scientific reasoning

According to Stanford Encyclopedia of Philosophy (SEP): "*In the early 20th century, the view that discovery is or at least crucially involves a non-analyzable creative act of a gifted genius was widespread but not unanimously accepted. Alternative conceptions of discovery emphasize that discovery is an extended process, i.e. that the discovery process includes the reasoning processes through which a new insight is articulated and further developed*."[12]

Inductive-deductive patterns of scientific inquiry go back to Aristotle (384-322 BC)[13]. In inductive reasoning which is the generalization from observation, premises do not entail the conclusion, which means the conclusion is probably true. On the contrary, deductive reasoning moves from true premises to a definitely true conclusion. In effect, deductive reasoning is a much safer process than inductive reasoning, because if we know that our premises are right from the beginning, we will guarantee the achievement of a true conclusion. If we reason inductively, however, we could obtain wrong conclusions. Nevertheless, it is the method that modern science is using. Scientists obtain their general conclusion from limited data, for example; Isaac Newton's principal of universal gravitation, which states that bodies exert a gravitational attraction on every other body. Obviously, it is impossible for Newton to examine all bodies in the universe, however, he saw that the principle held true for the planets and the sun and various sorts moving near the earth's surface, hence, he concluded inductively that his principle held true for all bodies[14].

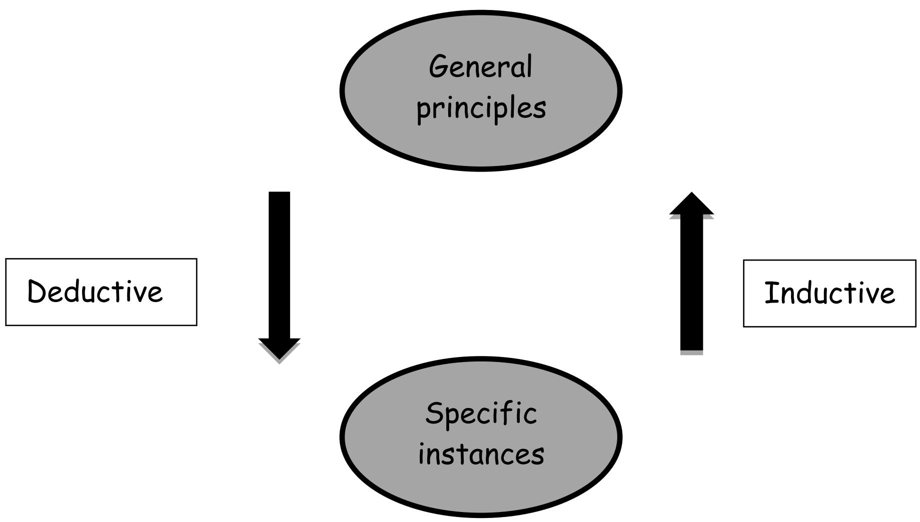


Figure 1. Inductive-deductive reasoning as proposed originally by Aristotle.

2.2 The context of justification

On the contrary, justification is -in part- a logical process of testing the hypothesis using scientific methods. "*Once the investigator has thought up the hypothesis, by whatever means, method comes into play in the activity of assembling evidence and accepting only those ideas that are well supported by the evidence*."[15] (Barker and Kitcher 2014, p.15).

Philosophers of science who advocate the "context distinction" argued that philosophy of science is a normative endeavor and it is concerned entirely with the context of justification, which could be subjected to normative analysis[16]. Logical positivists, for instance, a group of scientists and philosophers who met in Vienna in the 1920s and early 1930s under the leadership of Moritz Schlick (1882-1936), strongly advocated the contexts distinction and argued that philosophy of science is concerned with studying the context of justification[17].

"*The early years of the 20th century witnessed exciting scientific advances, particularly in physics, which impressed the positivists tremendously. One of their aims was to make philosophy itself more 'scientific', in the hope that this would allow similar advances to be made in philosophy*."[18] (Okasha 2002, p. 79)

2.2.1 Verification, Falsification and Corroboration

Karl Popper (1902-1994), an influential 20th Century philosopher of science, strongly repudiated induction activity claiming that scientists only need to use deductive inferences, thus he substituted induction activity with falsifiability, a demarcating criterion that distinguishes science from pseudo-science[19,20]. Accordingly, in Poppers' opinion, anthropology, phrenology, astronomy and psychoanalysis, even Freud's psychoanalytic theory, are not sciences. Many questions, however, were raised concerning Popper's theory of falsifiability indicating that there is a problem; What if we continue finding negative evidences on theories? What if an alternative theory couldn't be found? Is it plausible to give up on a whole theory because of one negative experiment? Imre Lakatos (1922-1974), a Hungarian-born philosopher of mathematics and science, who delivered many immense contributions to the philosophy of science, saw that Popper's theory is so restrictive since it precludes important theories due to negative observations. According to Popper, any theory which deserves to be scientific should be empirically falsifiable. Lakatos proposed a radical modification to Popper's demarcation between science and pseudo-science, called "Methodology of Scientific Research Programmes" or MSRP[21]. Lakatos did not exclude Popper's falsifiability totally from his new approach, however, he diminished its importance. That is, instead of focusing on one falsifiable theory, which ought to be rejected as soon as it is refuted, he replaced it with a sequence of theories as a belt surrounding a hard inner core which is characterized to be irrefutable and non-falsified, at least for the time being. Thus, testing will be directed only on the auxiliary hypothesis and one negative test result will not refute the entire research programmes, on the other hand, auxiliary hypothesis could be changed[22].

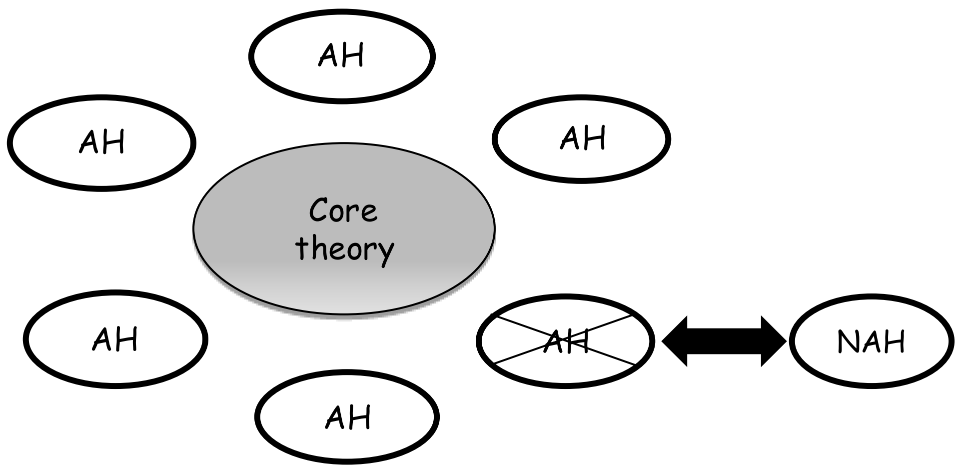


Figure 2. Lakatos research programmes. AH: Auxiliary hypothesis NAH: New auxiliary hypothesis.

Popper's theory of the demarcation criterion stems from his conception of the logical asymmetry between verification and falsification, as he stated in his book, "The Logic of Scientific Discovery":

"*My proposal is based upon an asymmetry between verifiability and falsifiability; an asymmetry which results from the logical form of universal statements. For these are never derivable from singular statements, but can be contradicted by singular statements*."[23] (Popper1968, p.19)

Hence, we conclude that it is logically impossible to conclusively verify a general statement as to falsify a singular statement from a numerous number of experiments while one experiment can verify a singular statement and falsify a general one as in Table 1.

Table 1. Asymmetry of Verification and Falsification.

	General statement	Singular statement
Verification	Infinite confirming experiments	One confirming experiment
Falsification	One counter experiment	Infinite counter experiments

According to Popper, theories can never be logically verified. Thus, he holds that, theories can receive corroboration. That is, if a theory passes a rigors test, it does not indicate that it is true or it will withstand the next tests. Consequently, a corroborated theory will be temporarily retained until it is at last falsified[24].

2.3 The context of dissemination

Eventually, after the hypothesis has been generated and subsequently justified, what is the next step? What if the phases of scientific activity stop there? Knowledge will not improve and it will ultimately reach a plateau because new results are not being *shared among scientists*. Hence, emerges the important question: If a tree falls in a forest and no one is around to hear it, does it make a sound? George Berkeley (1685-1753)[25]. In other words, are scientific discoveries that are not published still discoveries or not?

This strongly suggests that, to some extent at least, dissemination of discovery is as important as the discovery *per se*. Therefore, publication is essential for scientists, it is proof of the originality of their findings, a cachet in their scientific career and more importantly, by publication they render knowledge available to the scientific community, thus, their discoveries become effective. We conclude that attention should not be confined to the context of discovery and the context of justification, the context of dissemination should receive some attention as well.

In the next chapter, I will probe deeper in the coinage “The context of dissemination” and discuss its importance in the scientific field. Moreover, I will take glance on how scientific communication is shaped and has developed from the beginning and the changes, which it has passed through until it has reached a stage where it is best reflected by the unfortunate catch-phrase “publish or perish.”

3. The History of Scientific Communication

This thesis is concerned with highlighting the important role of technological advancement in knowledge transfer among scientists starting from the invention of the printing press by Johannes Gutenberg (1398-1468), in the mid of 15th Century. In order to understand changes in scientific communication, I will take a glance on its origin, discussing several achievements in its timeline, and emphasizing both the significance and the impact of digitalization.

3.1 The "Gutenberg revolution" and the scientific revolution

History reveals that the development of publishing was coinciding with a highly increased rate of scientific progress. It was just a perfect timing for the Gutenberg revolution to occur in the 15th Century predating the scientific revolution by two centuries. It is worth mentioning that the role of printing in the 15th Century was different from its role in the 17th Century. That is, it did not serve as a new knowledge exchanger rather it served in unification and gathering of existing knowledge. The significant role of printing in scientific communication brightened up in the scientific revolution era in the 17th Century. This is the very era of the emergence of modern sciences, emanation of great advances and initiation of a more professionalized scientific practice. The scientific revolution soon became an intellectual revolution when scientists began to transcend the conceptual boundaries between translating and combining the ancient knowledge. They also started to observe, investigate, and to discover new science[26]. Loet Leydesdorff (*b.*1948) has described the role of scientific communication with respect to scientific truth: "*scientific communications are expected to search for truth, while the truth is no longer given as in (religious) belief systems*."[27] (Leydesdorff, 2003)

In the course of the 17th Century there was an intense and competitive endeavor to find a fast and spacious way for scientific communication to cope with the increasing rate of scientific discoveries during the scientific revolution and onwards. Scientists were in a constant explicit tendency to find a method of communication with their fellows all over the world in order to share their new research results and to become instantaneously aware of new scientific discoveries. As the information scientist John Mackenzie Owen stated in his well-known book, the "Scientific Article in the Age of Digitization":

"*It has been common practice since the 17th century to think about science as an 'open' communicative system based on the widest possible diffusion of ideas and research findings, allowing for their unrestricted scrutiny, criticism and debate. This implies some mechanism that ensures the proliferation and exchange of ideas, and the universal availability of research outcomes irrespective of time and place. Such a mechanism has to be seen as an organized system for scientific communication that performs specific functions (e.g. distribution, access, preservation), and that also operates as a social system in that whoever is excluded from the communicative system cannot act as a member of the scientific community*."[28] (Owen 2007, p.31)

3.2 Letters and traveling as a mode of communication

Despite the significant role of printing in communication among scientists, it was a slow process. As John Owen stated in his book "Scientific Article in the Age of Digitization": "*Since it required a considerable amount of time to create a significant body of data in printed form, it is understandable that the print 'revolution' in the domain of science was a relatively slow process*." [29](Owen 2007, p.33)

Therefore, a quicker means of communication were required to cope with the increasing rate of scientific development. Interestingly, letters, traveling and face-to-face meetings played an essential role in accelerating the scientific communication among scientists all over the world[30].

3.3 The establishment of scientific societies:

Scientific discoveries, investigation and communication have become institutionalized after the foundation of the scientific societies such as Deutsche Akademie der Naturforscher Leopoldina in 1652, which was founded by four physicians, namely Johann Laurentius Bausch (1605-1665), Johann Michael Fehr (1610-1688), Georg Balthasar Metzger (1632-1687) and Georg Balthasar Wohlfarth (1607-1674) [31]. The Royal Society in London was established in November 1660 by Christopher Wren (1632-1723), Robert Boyle (1627-1691) and John Wilkins (1614-1672) and chartered by Charles II in 1662 as the Royal Society for the Improvement of Natural Knowledge. The Académie des Sciences in Paris came just a few years later, as a group of scholars gathering fortnightly in the king's library in the rue Vivienne, and it was formally founded by the politician Jean-Baptiste Colbert (1619-1683) in 1666. This was the first step for the beginning of an important movement that changed the way how scientists communicate with each other. Since then, this movement has grown dramatically. Many national institutions were formed that brought together the scientists of the enlightenment, as described in Table 2[32].

Table 2. Timeline of some national scientific societies

Date	Institution
1635	Académie française
1652	Deutsche Akademie der Naturforscher Leopoldina
1660	Royal Society of London
1666	Académie des sciences in Paris
1683	Accademia dei Dissonanti di Modena
1725	St. Petersburg Academy of Sciences
1739	Royal Swedish Academy
1783	Royal Society of Edinburgh
1785	Royal Irish Academy
1808	Koninklijk Instituut van Wetenschappen, Letterkunde en Schoone Kunsten in Amsterdam

In this era, science was in a massive need for institutions, which gather scientists from different fields and places who are interested in different fields of science. As John Owen defined the Royal Society:

"*A new type of institution that would bring together people both from within the university and outside, from various fields of science, and with a consciously expansive, outward-looking approach to the organization of scientific activity, as exemplified in endeavors ranging from novel forms of publication to scientific expeditions in the modern sense*."[33] (Owen 2005, p.35)

Unquestionably, scientific societies have performed many significant roles in the improvement of science; scientific knowledge became more open than before by allowing sharing of new ideas and discoveries, acceleration of the dissemination of knowledge by the usage of printing and periodical publication and by eventually archiving the new observations and findings.

3.4 The establishment of scientific journals

There were many achievements in the early years of the Royal Society, like Robert Hooke's (1635-1703) book "Micrographia" and the first issue of *Philosophical Transactions,* which began life in March 1665[34]. It was in fact initiated and financed by the Society's first secretary, Henry Oldenburg (1619-1677). This development is regarded as an important step towards formal scientific communication. The contents of the journal in its early years were mainly book reviews and new findings and observations from natural philosophers. In 1752, the Society took over the financial responsibility for the journal. Since then, the contents became more closely related to the contents of the Society's meetings[35].

Two months before the inauguration of *Philosophical Transactions,* in January 1665, the first issue of the *Journal des sçavans* (later renamed *Journal des savants*) had been published. It was a private enterprise of Denis de Sallo (1626-1669), and consisted of reports on new scientific discoveries and meetings as well as reviews of newly published books. Just a few similar projects were published by both scientific societies and private enterprises by the late of 17th Century. Over the course of the 18th Century, however, there was a marked increase in the number and periodicity of scientific journals with over 422 titles appearing in the period of 1750-1790[36].

The 19th Century has witnessed a remarkable increase in scientific publishing both in terms of the number of published articles and journal titles[37]. Furthermore, it was the period of the emergence of numerous specialist disciplinary journals. The *Philosophical Transactions,* for instance, became divided into two series 'A' and 'B' in 1887, for the physical and biological sciences, respectively[38]. Various prominent scientific journals were established in the last decades of the 19th Century and are still being published today. *Nature,* for example, which was established in 1869 in London by the scientist Norman Locker (1836-1920)[39] and its rival *Science* which was founded in 1880 by the New York journalist John Michels in cooperation with Thomas A. Edison (1847-1931)[40].

Studying the history of some "elite" journals reveals that they have and often still occupy an eminent place inside the scientific community. Moreover, they were the forum where scientists share, debate and object or advocate scientific discoveries. "Can journals influence science?" this question is the title for a "News and views" editorial written by John Maddox (1925-2009), the editor of *Nature* for 22 years from 1966–1973 and 1980–1995[41]. He emphasizes the significant role journals play in science when he stated:

"*Which holds that the scientific literature is and should be a passive means of communication-a mirror held up to the face of research in which people other than its authors can discover what is happening in laboratories the world over. That is, of course, an idealization which is far from the truth*."[42] (Baldwin 2015, p.228)

3.5 The digitalization of scientific journals

It is unquestionable that new technologies can drastically influence communication practices, which consequently influence the progression of science. The final decades of the 20th Century have witnessed an upheaval on the scientific communication level, "the digitalization of the scientific journals", *i.e*. the evolution from ink journals to digital texts. This tremendous innovation constituted a prominent event in the context of scientific publishing. It has been suggested that digitalization of publication can be called "paradigm shift" in the traditional sense of the famous word Thomas Kuhn (1922-1966) coined[43]. It is worth mentioning that the phenomena of electronic journals have begun in the late 1980s.

3.5.1 The electronic-only journals

Historically, electronic journals or "e-journals" have passed through several stages. The initial stage was electronic-only journals, *i.e*. with the absence of printed versions, such as *New horizons in adult education,* which was established in 1987 by Michael Ehringhaus and Bird Stasz of Syracuse University. Another peer reviewed electronic-only journal is *The Online Journal of Current Clinical Trial,* which was launched in September 1991, and has been described as the first peer reviewed electronic journal in medicine[44]. It was a result of cooperation between the American Association for the Advancement of Science (AAAS) and the Online Computer Library Center (OCLC)[45].

Electronic mailing lists in the 1980s, undoubtedly, have served science effectively by accelerating communication among scientists. Scientists used to send their new results before publication to their colleagues. This was somehow problematic, however, as the increasing number of preprints was creating an uncontrollable number of mailing list posts. The foundation of xxx.lanl.gov, the Los Alamos preprint server in August 1991 by the physicist Paul Ginsparg (*b*.1955) has tackled this problem by allowing physicists to upload their papers in a non-peer reviewed fashion[46].

3.5.2 The online-journals

The second stage started around 1997 when existing printed journals started to publish an electronic parallel counterpart, the "online-journals." The printed and the digital format are almost in all cases identical. Differences, however, can be formed in the improved functionality level, *i.e*. email alerts and search function[47], and in speeding up access to the journal.

The growth of electronic journals has changed the way scientists communicate with each other and the way they comprehend literature in their field. This was definitely a progression, which facilitates scientists' interaction with science. As Melinda Baldwin stated in "*Making Nature"*:

"*The ability to search for articles by topics and keywords and access them online has changed the way most scientists interact with the literature in their field. It is far more common for scientists to read a handful of individual articles from different journals than to browse through a full issue of a single journal*."[48] (Baldwin 2015, p. 234)

3.5.3 The open access movement

The third stage is the establishment of the PubMed Central around 2000 by the US National Institute of Health (NIH). It is an open access repository, where researchers could post papers resulting from government-funded research[49]. As Melinda Baldwin described this development:

"*Some open-access pressure comes from government whose taxpayers fund research through organizations such as the US National Science Foundation or the UK Medical Research Council; if taxpayers funded the work, many argue, they should be able to read the resulting research.*"[50] (Baldwin 2015, p.236)

The open access movement, afterwards, developed from using repositories of already published papers to publishing original papers. The establishment of Public Library of Science (PLoS) in 2000 by three scientists, Patrick Brown (*b*.1954), Michael Eisen (*b*.1967) and Harold Varmus (*b*.1939), was the first step of this development[51]. *PLoS Biology* was the first open access journal in 2003. After a year, they established *PLoS Medicine*. *PLoS Computational Biology, PLoS Genetics, and PLoS Pathogens* followed this in 2005. *PLoS ONE*, however, which was established in 2006, is the organization's most original and significant publication[52]. A statement printed in an "open letter" addressed to the scientific community in 2001 clarified the intentions of the PLoS establishment:

"*We support the establishment of an online public library that would provide the full contents of the published record of research and scholarly discourse in medicine and the life sciences in a freely accessible, fully searchable, interlinked form. Establishment of this public library would vastly increase the accessibility and utility of the scientific literature, enhance scientific productivity, and catalyze integration of the disparate communities of knowledge and ideas in biomedical sciences*."[53]

Thenceforth, the open access publishing movement started to grow steadily producing a dramatic influence on scientific publishing[54]. According to the Directory of Open Access Journals (DOAJ), the four-year period from 2009 to 2013 has witnessed a sharp increase in the number of open access journals. In 2009, the number was 5,000 journals and then went up to reach 8,847 journals in 2013 with an ever-growing tendency[55].

Publishers of subscription journals felt that their business was extremely threatened by the emergence of the new publishing model. Thus rather than fighting it, they decided to adapt and compete. They invented the hybrid journals, where they use to turn the published article open access after collecting extra fees. This situation is defined as "double dipping"; gaining money from both readers and authors[56]. For example, in the *Proceedings of the National Academy of Science* (PNAS), if authors pay $1350, their papers can be open accessed while still being published in the prestigious journal, which itself charges a significant subscription fee[57].

Unsurprisingly, the open access movement has acquired the support of scientists. Steven Harnad (*b*.1945) a cognitive scientist, for example, publishes most of his research as open access.

According to Melinda Baldwin, in 2001 he stated that[58] "*Online journals and archives had the potential to "free the literature" and enable scientists to share their work with the entire research community, not just those scientists whose institutions subscribe to a particular journal*."[59] (Baldwin 2015, p.237)

3.6 The economics behind the open access movement

So far, this chapter has been a mere historical description of scientific communication. This section will address the academic publishing business and look at the impacts of the open access movement from an economical standpoint.

Academic publishing is a very profitable business, generating $9 billion in revenue annually, according to Outsell, Inc. a marketing firm focused on the scientific publishing industry. Elsevier, for instance, had a revenue around $3 billion in 2012. Thus, we can conclude that publishers of subscription journals generate billions of dollars from subscription fees[60].

Open access publishing has shifted the equation from "pay-read," which is the equation that traditional journals are based on, to "pay-publish." The open access business model is funded by article-processing charges (APCs). For example, *PLoS ONE* charges $1,320 APC, whereas *PeerJ* offers to publish an unlimited number of papers per author for a one-time fee of $299[61]. Hence, we can conclude that 'readers' are the main target for subscription- based journals, while open access journals aim towards authors.

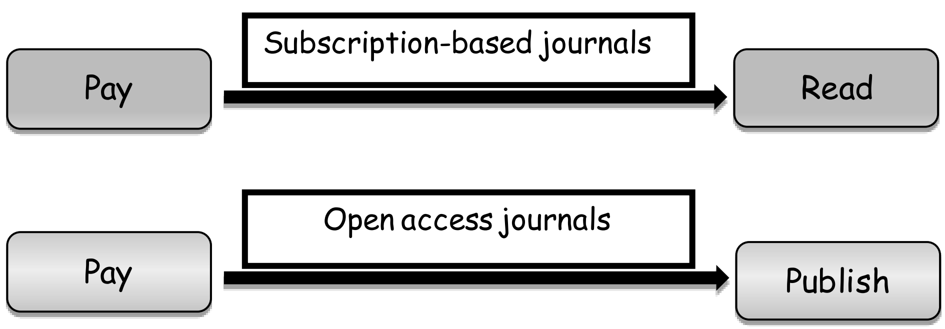


Figure 3. Changes in the equation after the invention of OA.

A key problem of subscription-based journals is to cover topics which will attract a sufficient number of readers. This is well documented for the journal *Academy*, founded in 1869 as *Nature*, a meanwhile leading journal. Charles Appleton (1841-1879), the editor of *Academy*, desired to attract more readers by adding coverage of the recent work in literature and philosophy. The first issue was published under the title *The Academy: A Monthly Record of Literature, Learning, Science and Art.* In 1873, however, the number of readers was not as expected and the journal was not profitable. Thus, the editor decided to change the content of the journal by decreasing the scientific content in favor of more philosophy and literature[62].

Open access journals, like any business, aspire to increase their income using techniques in soliciting authors. One of the techniques applied frequently is marketing. The *International Journal of Sciences: Basic and Applied Research* (IJSBAR), for instance, offers rapid decision starting from the date of submission, which takes approximately 21 days[63]. Another example is the *Planta Medica Journal*, a sister journal of the traditional "*Planta Medica*," which has been launched as an open access journal in 2014. It proposes a new way of marketing by inventing an unprecedented slogan "pay what you want" in the beginning of 2016, and for one year[64]. Furthermore, this journal annually rewards the most promising, innovative paper as judged by the journals' editors and based on the scientific quality and the interest that the paper has received from within the scientific community.

Table 3. Timeline of important events in scientific communication**.**

Date	Events
Around 1440	The invention of printing press by Johannes Gutenberg
1478	The first book was printed at Oxford University
1660	The foundation of the Royal Society in London
1665	The first issue of a scientific journal was launched "*Journal des savants*"
1665	The first issue of the scientific journal related to the Royal Society secretary "*Philosophical Transactions*" was launched
1666	The foundation of the *Académie des Sciences* in Paris
19th century	The emergence of numerous specialist disciplinary journals
1987	The first e-only journals emerge
1997	Electronic versions of printed journals
2000	Open access journals

Obviously, scientific journals have succeeded to become an important means of publication and communication among scientists. Unsurprisingly, modern technology has tipped the scales and changed the perspective of the scientific community towards scientific communication.

We can conclude that focusing on the profits in some journals has converted the context of dissemination into a socio-economic activity. To go beyond a mere historical description of prominent events, I will define in the following chapter the most important practices that form the infrastructure of the scientific publishing and the changes that they have passed through.

4. Pillars of publishing practices

When the infrastructure is shaken, everything collapses. In this section, I will shed light on two important practices that form the infrastructure of the scientific publishing domain, *i.e*. the peer review system and the impact factor of scientific journals. I will discuss their history, importance, and criticism. I will evaluate if this infrastructure is shaken or still safe for the decades to come. Afterwards, I will argue for an alternative approach to dissemination that may protect scientific publishing from corruption, cronyism and eventually collapse.

Undoubtedly, scientific publishing is part and parcel of the scientific process *per se*, which serves as a quality control guardian and knowledge disseminator[65], thus, it can significantly influence the progression of science. This can only occur if, however, the academic publishing process is achieved to the fullest. There is no denying that there have been many endeavors to evaluate and therefore, upgrade scientific papers. One method of evaluation is pre-publication scrutinizing of scientific papers by peer reviewers who have the adequate expertise in the specific field. Another "seal of quality" results from calculating the impact factor of scientific journals that are listed in the *Journal Citation Reports* (JCR) by Thomson Reuters[66].

4.1 The peer review system between the past and the present

Peer review, which constitutes a pivotal mechanism of the scientific publishing process and the quality assurance of modern scientific literature, has passed through several changes according to the development of scientific communication from traditional scientific journals to online publishing. In order to understand these changes we should go back to the commencement of this system.

4.1.1 The history of the peer review process

Many people may assume that the peer review process with all its formalized and marshaled procedure was implanted at the same time as the establishment of the first scientific journals, such as The *Journal des Sçavans* in Paris and *Philosophical Transactions* in London in 1665. These assumptions are incorrect and stem from a misinterpretation of the editorial practices[67].

Surprisingly, a serious pursue of the history of scientific journals in general and especially *Philosophical Transactions* discloses that a lot of peer review proceedings as we recognize today happened at that time but in a different way. At that time, it was mainly the *editors decision* what to publish in the periodical and what not. Sometimes, however, editors sought for help in order to test the quality and the suitability of manuscripts and to judge whether it will be or will not be an adequate material for the scientific journal. This approach was the case for about one century until the middle of the 18th Century (1752) when the *Philosophical Transactions* editorial came under the accountability of the Royal Society. Henceforth the submission and evaluation process became less opaque, more organized and, most importantly, less biased by the creation of the *committee of papers*[68].

It is worth noticing that William Whewell (1794-1866), a Cambridge professor and philosopher of science, proposed the practice of peer review in 1831 to the Royal Society of London. To join every article with a report before publishing, he thought this could increase publicity of science, and since then it became a crucial part of the publishing system of the Royal Society[69]. Thenceforth, other learned societies, such as the Royal Society of Edinburgh and the Linnean Society of London started to implement a similar process. The presence of the committee along with an extensive report strategy has served as a potent control mechanism in order to protect scientific literature from fraud. In contrast, it slowed down the dissemination and sharing process of new research findings. Ultimately, most of the non-affiliated journals incorporated this refereeing process in the 20th Century[70].

For the prestigious journal *Nature*, for instance, the external refereeing was not mandatory until the editor David Davis (b.1939) took over the editorship position in 1973[71]. One of his major goals, as he stated, was "getting the refereeing system beyond reproach."[72] His predecessors Lionel Brimble (1904-1965) and Arthur Gale (1895-1978) had absolutely no problem publishing submitted papers from scientists they trusted without peer review. Their successor Sir John Maddox (1925-2009) followed that manner in reviewing as well.[73]

Publishing without refereeing may be considered scourge in the modern publishing era, yet there have been many magnificent manuscripts and scientific milestones had not been submitted to the peer review process and few people showed denunciation. In 1953, for instance, James Waston (*b*.1928) and Francis Crick (1916-2004) submitted a paper to *Nature* describing the DNA structure, during the Brimble and Gale period of editorship. Interestingly, this paper was published without going through the peer review process. Another example is the "periodicity" paper by David Raup (1933-2015), a member of the National Academy of Science (NAS). The paper was published in the venerable *Proceedings of the National Academy of Sciences* (PNAS), without being refereed[74].

This indicates that a scientific journal could obtain and maintain a significant standing in the scientific community and be with a respected reputation even when editors usually eschewed the peer review process.

Table 4 summarizes the progression of academic review and how it has evolved over the last 300 years[75].

Table 4. Timeline of the peer review system.

1665	The *Philosophical Transactions* created by Henry Oldenburg didn't use the referee system
1699	France's Royal Academy of Science founded by Louis XIV
1752	The establishment of the *Committee of Papers* to vote on what to publish
1831	The proposal from a Cambridge professor William Whewell to the Royal Society of London to commission public reports on manuscripts
1833	The reports have become private and anonymous
1973	External refereeing becomes mandatory in *Nature*
1991	The invention of xxx.lanl.gov Later relocated to the web at arXiv.org
2006	*PLoS ONE* an open access journal that focus on technical soundness of papers, leaves the assessment of their impact to readers
2007	Open peer review system by *EMBO Journal*, the *Frontiers* series and *BMJ Open*

4.1.2 The bright side of publishing "anything"

The quality, singularity and the scientific importance of a submitted manuscript, as the history shows, have been highly important in the editorial process. A throwback to the history reveals that dissemination of knowledge has become more controlled and formalized. For instance, manuscripts that lack novelty and scientific prominence are rejected immediately. In short, they proved that properly accomplished science deserves proper dissemination. Obviously, the platform has been slumped gradually and standards for publishing have been changed.

Nowadays, the peer reviewers of some journals do review, mostly for soundness and no longer for novelty or significance. In fact, they are throwing the onus on the reader's side to decide whether the scientific articles that have been published have a significant impact on the scientific literature or not. "*The journal's peer review process focuses on the technical soundness of papers leaving the assessment of their impact and importance to the scientific community*," a statement found on the *FEBS open bio* web page. Interestingly, *PLOS ONE, Peerj* and *Biology Open* are open access peer reviewed journals which are following the same policy.

There are, of course, also examples where many journals have accepted manuscripts for publication without screening either evaluation, which results in a potential negative impact on the scientific community. During the late 1960s, for instance, the polywater subject triggered a controversy among the scientific community. In fact, the Soviet scientist Nikolai Fedyakin claimed to have discovered a new form of water with a higher density, a very low freezing point, and a very high boiling point. Not surprisingly, it grabbed the attention of the press. *Science*, for example, published an article about polywater's unique characteristics on the 27th of June 1969[76]. As early as 1970, however, concerns arose among the scientific community. Scientists started to investigate and scrutinize this new form of water. Finally, in 1973, it turned out that polywater was just normal water contaminated with impurities from laboratory equipment[77].

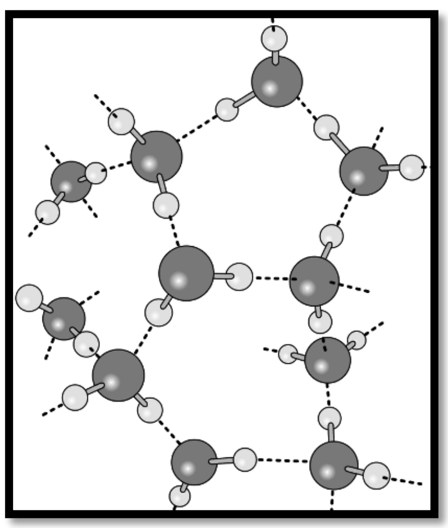


Figure 4. A representation of polywater at the molecular level.

On the other hand, stern peer review is well known for the danger of mistakenly rejecting rather than accepting. Indeed many Nobel Prize papers were rejected when submitted the first time in scientific journals. *Nature* rejected Hans Krebs's paper that describes the citric acid cycle in 1937, however, its author won the Nobel Prize in 1953. As a matter of fact, *Nature* had even warned the biochemist about the delay in publishing that might occur in case he decides to wait and not send it to another periodical[78].

Svante Arrehnius (1859-1927), a Nobel Prize laureate, had a similar anecdote but within a different scenario. In 1884 his professors at Uppsala University, Per Theodor Cleve and Tobias Thalén, underestimated and fiercely criticized his doctoral dissertation, which consisted of 150 pages on electrolytic conductivity. Nonetheless, he earned the Nobel Prize in chemistry for his dissertation in 1903[79].

An editorial was published in *Nature,* in 2003, admitting the obliquity of judgments and underestimation of some Nobel Prize papers. They formed the unarguable *faux pas* in the journal's history[80]. For instance, Pavel Cherenkov's (1904-1990) paper, "visible radiation produced by electrons moving in a medium with velocities exceeding that of light" was rejected by *Nature* in June 1937, however, accepted by *Physical Review*[81].

Apparently, the scientific community is not always in coherence with peer reviewers with regard to many papers that earned the Nobel Prize despite rejection by peer reviewers. Many people argued that, in spite of the great benefits from applying a scrutinizing peer review, there are disadvantages that trigger the controversy about these practices. Unfortunately, it is hard to find an invincible system devoid of any errors. This confronts us with an important question:

Is peer review the only system to keep science safe from roguery and preserve the reputation of the scientific literature from pathological science?

4.1.3 The peer review system between proponents and opponents

The peer review process is being recently highly criticized for its disability of maintaining the integrity of research. According to Richard Smith, a former editor-in-chief of the *British Medical Journal*, "Peer review is a sacred cow that is ready to be slain" and in his opinion, it should be swept away. This is what he stated in the Royal Society's conference on the 20thof April 2015, which discussed the future of scholarly scientific communication[82]. Apparently, Dr. Smith strongly opposed the practice of peer review, accusing it of being time wasting, expensive and based on faith, not evidence. Moreover, he admitted that the real peer reviewer is the scientific community. In light of this, John Ioannidis most cited paper in 2005, which was published in *PloS Medicine* "why most published research findings are false" shows that flawed research is most likely to be published by elite journals, as novel research is what they are explicitly looking for[83]. Possibly, their ultimate goal is to attract more subscribers and to grab the readers' attention.

Dr. Aileen Fyfe, a reader in modern British history at the University of St Andrews, opposed Dr. Smith's description of peer review as "sacred cow." She countered: "*Peer review is often thought of as ancient and unchanging, but it is neither – and it shouldn't be treated as a sacred cow*." Moreover, she accentuated the critical role that the peer review is playing recently as a prevailing practice in scientific communication[84].

4.2 Metrics of impact and value

4.2.1 The impact factor: a metric between influence and prestige

The reputation of the scientific journal has been the indicator of a trustable and worthy science. It has been the measurement of author's scientific eligibility. It is calculated using a variety of metrics; the most famous one is the impact factor, which is an indicator of journal citedness. The idea was firstly mentioned in *Science* magazine in 1955, mentioning the citation index history[85]. "Citation Analysis as a tool in journal evaluation," was also published in *Science* in 1972 and eventually grasped editors' attention[86].

Unfortunately, people misinterpreted the main reason for its invention, as was expected from its inventor, "*I expected it to be used constructively while recognizing that in the wrong hands it might be abused*," stated Eugene Garfield[87]. Recently, the impact factor has been mistakenly interpreted as a metric to measure researchers' quality and excellence. Moreover, authors are not any more acknowledged by their good papers. The visibility of their papers will increase if they are published in a high-ranking journal and their career will be affected by this. Clearly, editors are using several ways to manipulate the impact factor, such as pressuring authors to cite papers from the same journal, or increasing the number of review articles, thus, the journal's impact factor will be inflated[88]. In addition to the editorial trickeries, some journals apply misleading metrics which can augment the "correct" impact factor[89]. The *World Journal of Pharmacy and Pharmaceutical Sciences* (WJPPS), for instance, uses the Science Journal Impact Factor (SJIF) as its own impact factor. In 2015, this journal has an SJIM of 6.64 which is considered very high especially if one "compares" it with the "official" IF from Thomson Reuter[90]. The OMICS Publishing Group is a publisher of open access journals which publishes around 700 journals. Theses journals use an "individual" method in calculating the impact factor, *i.e.* the impact factor for 2015 is calculated by dividing the average number of citations *during* 2015 by the number of articles published in 2013 and 2014[91], whereas the official calculation of the impact factor from Thomson Reuter for the previous case is different. It should be calculated by taking the number of citations in 2013 and 2014 from articles that were published in 2013 and 2014 dividing by the total number of articles published in that same journal in 2013 and 2014[92].

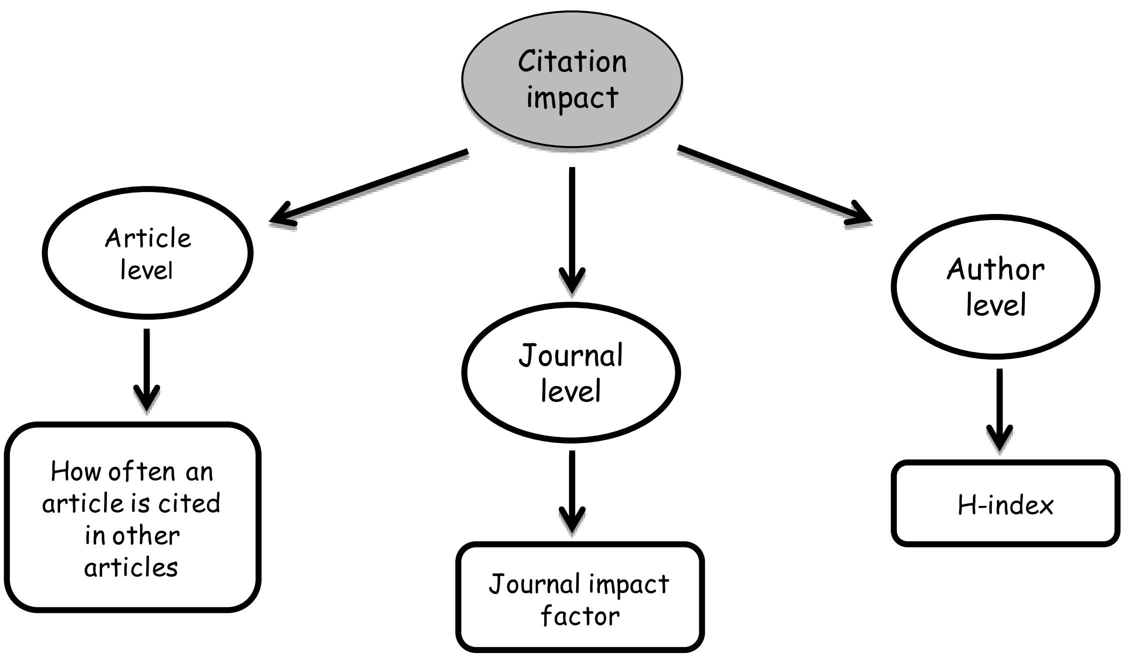


Figure 5. Levels of citation impact.

4.2.2 Scopus Journal Metrics

Scopus® is a fairly respectable bibliographic database comprising abstracts and citations of peer-reviewed literature: scientific journals, books and conference proceedings. It is owned by Elsevier and characterized by its profundity of coverage with the full database reaching back to 1966[93]. Scopus® has created its own evolving basket of various metrics at different levels, *i.e.* journal, article and author levels. On the 8th of December 2016, Scopus has launched CiteScore™ metrics[94], a family consisting of eight metrics as comprehensive indicators at the journal impact level. CiteScore ™ metrics are: CiteScore, CiteScore Tracker, CiteScore Percentile, CiteScore Quartiles, CiteScore Rank, Citation Count, Document Count and Percentage Cited.

CiteScore itself, which is the first metric of the CiteScore™ metrics mentioned above, is distinguished by being a robust metric, which its method of calculating the citations differs from Thomson Reuter's method, *i.e.* CiteScore metric has a *three-year* citation window as a compromise between the two years and the five years. Besides, both the numerator and the denominator include all document types indexed by Scopus, *i.e*. articles, editorials, letters, etc. Consequently, manipulation will be more difficult[95].

4.2.3 Altmetrics: non-traditional filter

The expansion of academic literature and the increasing number of manuscripts has prompted scholars to rely on metrics to select the most relevant and trustworthy manuscripts from the others. Undoubtedly, there have been many attempts to improve alternative metrics for assessing the impact and value of academic research, with focus mainly on the authors and/or articles. For example, altmetrics represents a "non-traditional metrics" invented as an alternative to more traditional citation impact metrics, such as impact factor and H-index. The term altmetrics was proposed in 2010 as a generalization of article level metrics. Altmetrics depends on online scholarly tools in its filtration method. They are different from journal impact factor, which does not reflect the impact of the article itself. Moreover, it is different from citation metrics which reflects only cited and *peer reviewed work*[96]. CiteScore ™ and Altmetrics categories metrics are summarized in Tables 5 and 6[97], respectively.

Table 5. CiteScore metrics.

1.	CiteScore
2.	CiteScore Tracker
3.	CiteScore Percentile
4.	CiteScore Quartiles
5.	CiteScore Rank
6.	Citation Count
7.	Document Count
8.	Percentage Cited

Table 6. Categories of Altmetrics.

Viewed	HTML views and PDF downloads
Saved	Storing and referencing of articles in online tools such as Mendeley
Discussed	Twitter, Wikipedia, science blogs
Cited	The formal citation of an article in other articles
Recommended	The formal endorsement of a paper, e.g. F1000Prime

4.2.4 Peer review metrics

"*Several metrics have been developed to appraise and quantify the work of authors, articles and journals. Unfortunately, no attention has been given to peer-reviewers and their work. No metrics and no rewards exist to recognize and reward their performance. Peer review is a crucial phase in the process of publication for journals and publishers.*"[98] This sentence can be found on a website called Reviewercredits (*https://reviewercredits.com/intro.php*), which has been co-founded by two friends who are professors at the University of Milan-Bicocca, Italy. What is interesting, though, the rewards that the website aims to provide to appreciate reviewers are: the "academic" reward and the "tangible" reward, as defined by Table 7 below:

Table 7. Peer-reviewers' rewards.

The "Academic" reward	The activity of the reviewer is reflected by the reviewer index, which is calculated by accumulated points, that is for each review performed the reviewer will receive one point. This is an indicator of the industrious work of the reviewers
The "tangible" rewards	Reviewers can earn credits and the vision is to convert those credits to "tangible" rewards such as discounts on publishing fees, free subscription to journals or real cash.

It is reasonable to assume that the creation of such a website reflects the presence of profound problems in the refereeing system, which has been somewhat “hidden” in the past, with detrimental effects on the authors as well as reviewers themselves.

4.3 Ethics in the publishing domain

4.3.1 The nonprofit organization COPE

Similar to the other contexts of scientific activity, dissemination of knowledge is based on trust and honesty. Thus, the presence of organizations that protect publication ethics is significant to reassure the existence of trustworthy journals. The Committee on Publication Ethics (COPE) is a forum for editors and publishers of peer reviewed journals to discuss all aspects of publication ethics. A small group of medical journal editors in the UK established COPE in 1997. They have been concerned about misconduct in publication. Today COPE has 10.000 members worldwide from all academic fields. This nonprofit organization promotes integrity in scholarly publishing. It provides editors and publishers with advice if and when they face certain problems, as well as criteria to help authors in assessing journals[99].

4.3.2 Beall list

Jeffery Beall is an academic librarian and a researcher at the University of Colorado in Denver who has coined the term “predatory publishing.” After noticing the increasing number of spam emails sent to him prompting him to publish in certain journals or joining editorial boards. Beall became fascinated by the grammatical mistakes in most of the emails. Therefore, in 2010 he created a *Beall’s list of potential, possible, or probable predatory scholarly open access publishers*. In 2012, he invented his own criteria in evaluating publishers. According to Beall, 2012 was the year when predatory journals exploded.[100] Curiously, the Beall list was taken offline on the 15thof January 2017. A spokeswoman for the University of Colorado declared that it was Beall’s “personal decision.”[101]

To sum up, flaws of both methods (peer review system and impact factor) are well documented. According to Dr. Richard Price, the founder and the CEO of Academia.edu[102]: “*It is worth* *mentioning that any credibility metric in any domain is going to be gamed the journal publishing system is subject to this as much as anything else*." These flaws alongside with the scientific results that are constrained unless researchers pay, non-surprisingly, have forced academics to search for alternatives. Moreover, the next chapter will discuss many ethical questions concerned with scientists in the developing countries. Is it ethical to sell a scientific discovery? Should knowledge be oriented and/or directed to certain people? How can scientists in the developing nations participate in the progress and progression of science if they are unable to pay?

5. Open access and developing countries

The issue we have studied so far, the open access movement and its impact in some ways, on scientific communication, clearly shows that open access has gained extravagant publicity. It has returned the process of scientific publishing to its origin: disseminating knowledge worldwide. This has occurred by the removal of barriers, such as the price barrier, which are hindering scientists from accessing recently published research. The presence of such barriers can affect science negatively, especially in developing nations. Firstly, researchers cannot be updated with the newest research findings. Secondly, entrepreneurs cannot innovate. Thirdly, doctors will be less qualified due to the obstacles they are facing to access the latest medical research. Finally, the "brain drain" syndrome, which is a consequence of the migration of academics and researchers from developing countries to more developed countries due to the lack of adequate funded institutions and libraries, will continue to increase[103].

According to The Berlin Declaration on Open Access to Knowledge in the Sciences and Humanities, "*the mission of disseminating knowledge is only half complete if the information is not made widely and readily available to society*."[104] (Berlin Declaration, 2003)

Advocates of the open access movement have strongly argued that all scientists all over the world should freely access publicly funded research. Unsurprisingly, researchers from developing countries are the most beneficiaries from this movement, due to the lack of financial resources which support academic institutions and afford subscription fees. Most libraries in sub-Saharan Africa have not subscribed to any journal for years. The Indian Institute of Science, Bangalore, has the best-funded research library in India, yet its annual library budget is just $2.2 million[105].

Many voluntary ventures have been formed with the same vision of disseminating knowledge equally to all people all over the world. EIFL (electronic information for libraries), for instance, is a non-profit organization that works with libraries to enable access to knowledge in developing and transition economy countries in Africa, Asia Pacific, Europe and Latin America. Those kinds of organizations have enabled billions of people in the developing countries to reap the benefits of the digital technology by assisting them to overcome obstacles, such as the high subscription costs of scholarly journals[106].

It is widely acknowledged that the flow of knowledge and the increasing availability of new scientific results achieved by the open access model have led scientists in the developing countries to become more effective members in their respective scientific fields. Open access has widened the scope of the scientific community by encouraging the contribution of new and diverse minds[107]. The purpose of the invention of open access has clearly been defined in the Budapest Open Access Initiative conference that was launched by the open society institute in 2002:[108] [109]

"*An old tradition and a new technology have converged to make possible an unprecedented public good. The old tradition is the willingness of scientists and scholars to publish the fruits of their research in scholarly journals without payment, for the sake of inquiry and knowledge. The new technology is the internet. The public good they make possible is the world-wide electronic distribution of the peer-reviewed journal literature and completely free and unrestricted access to it by all scientists, scholars, teachers, students, and other curious minds*."

It is so obvious that it hardly needs arguing for, that the open access movement has offered remarkable benefits to researchers in the whole world and especially to those in the developing countries where most of the institutions are professionally impoverished. Open access has provided equality in accessing knowledge irrespectively of where they live. Unsurprisingly, there is a lack of awareness and misunderstanding of the presence of such initiative. Educating academics and librarians in developing nations about the presence and importance of open access and convincing institutes and libraries to adopt open access could tackle this problem easily.

Yet there are still other ethical questions which have arisen from the open access movement. Hence, there are serious ethical issues concerning the situation of authors in developing nations. Are they going to be capable of affording the APCs of the open access journals? How can they participate in knowledge progression while their papers are constrained behind publishing barriers? Those and similar ethical questions have rendered the open access movement a topic of major debate among scientists all over the world. Decreasing the APCs for authors in developing countries could solve this problem, but who will compensate for that?

This "asymmetry" between being able to access articles for free but being unable now to pay the publishing fees may even increase injustice. In the era of "publish or perish," is it not legitimate for an author to pay her or his way to publications in expensive, high Impact Factor (IF) journals? Thus, nothing has been gained and some issues may even have taken a turn to the worse. Ideally, both authoring and accessing science need to be free which is impossible as long as editors, journals, websites, etc. have to be involved.

In the end, publishing is not for free and someone has to pay. If this is not the readers, government or a sponsor, then it must be the author.

6. Hypothesis: Self-publishing model (SPM)

Eventually remains the question how to maintain quality in the sense of ensuring the validity of the published data, and how to tackle ethical problems related to such kinds of publication, for instance, false publications, manufactured data, paying for science, etc. By pushing the open access concept to the limit, scientists would simply publish their data on their own devices, for instance, on an internet platform of their choice such as their society, university, institution or even personal website. The last choice, however, could require some caution. Creators of such individual websites could easily fake science and papers and individual websites would not be homogeneous. In contrast, platforms such as ResearchGate® enable their members to upload their papers (which have been published already in journals), they allow anyone to communicate with other members and to follow their activities. Thus, a ResearchGate®-like system could tackle this problem, yet would differ from ResearchGate in one crucial aspect: authors could upload their *unrefereed* papers.

Such a free exchange would reflect any civilian society, whereby the scientific community would depend on free and rapid exchange of information. Nowadays we do not need to wait for some news portal to publish information; instead, various news channels are open to everybody. Just like a variety of scientific news channels would be available to the scientific community, leaving it to that very community to decide about relevance and to safeguard validity.

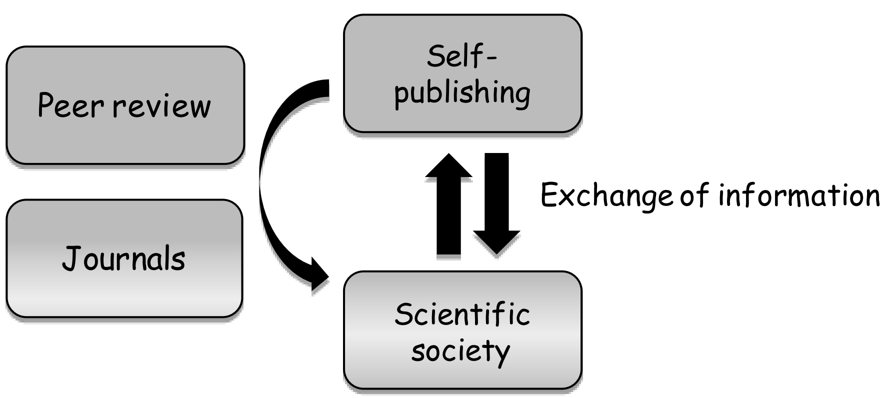


Figure 6. Hypothesis of future publishing without the need of journals, reviewers, editors and fees.

6.1 The Fear of accepting reality and coping with technology advances

Plausibly, people are used to traditional modes of publishing and are still afraid of trusting non-reviewed articles even though the evidence condemning such peer review practices is increasing dramatically. Ultimately, embracing SPM with a pinch of caution is supported by several advantages as summarized in Table 8.

Table 8. Advantages of the Self-Publishing Model (SPM).

SPM advantages
Higher speed of knowledge transfer
It is not prone to bias by reviewers (More democratic, the whole community can referee)
Manuscripts are original (Authors will not modulate their manuscripts in order to satisfy editors' demands)
It is openly accessed worldwide
There will be no fees required to either read or publish
It can be investigated by authors and read worldwide regardless of financial resources, standing and regulation
There will be no fear of stealing ideas from peer reviewers (since they are active competitors from the same field)
It resembles traditional publishing by University Press, such as Oxford University Press (OUP)

With the presence of the World Wide Web and its facilitations, publishing freely on the net could herald a new era of the scientific communication, but also the throwback of the origin of knowledge dissemination before the emergence of scientific journals, so the history could be repeated but in a more universal way[110]. Still, history of scientific dissemination should encourage this approach: non-reviewed articles. Manuscripts of Hippocrates exist now unchanged in the medical school on the island of Cos. Greece[111], Nicolaus Copernicus' important book describing the new conception of the universe, heliocentric theory was not peer reviewed, Isaac Newton's *Principia Mthematica*, which was published in 1687, and Albert Einstein's Relativity paper, which was published in *Annalen der Physik*, also passed without being refereed[112]. Still, the crucial questions that may stem from these historical episodes are:

- Does this kind of publishing lead to a "total chaos" in the scientific community and more anarchy or will it be a solution for most problems related to traditional publishing especially financial ones?
- Which alternative strategies could be applied in order to ensure the veracity of scientific literature that is being published without refereeing?

Even though "publishing freely on the net" may represent a preferred approach, of course, there will be cautions, and the quality of what is being published on the net should be maintained, since web search engines do not discriminate between subscription-based articles or open access articles from self-published articles, regardless of quality. As we saw in Chapter 4, the easiness of gaming in impact factor alongside with its assessment of primarily the value of the journal, not individual articles, has led to the invention of another metrics, which are related to authors and articles themselves. In my opinion, those metrics can also be applied as an indicators of impact in the SPM, such as the article download counts of full-text. Those "esteem factors" could be divided to three categories; papers rating, authors rating and website rating.

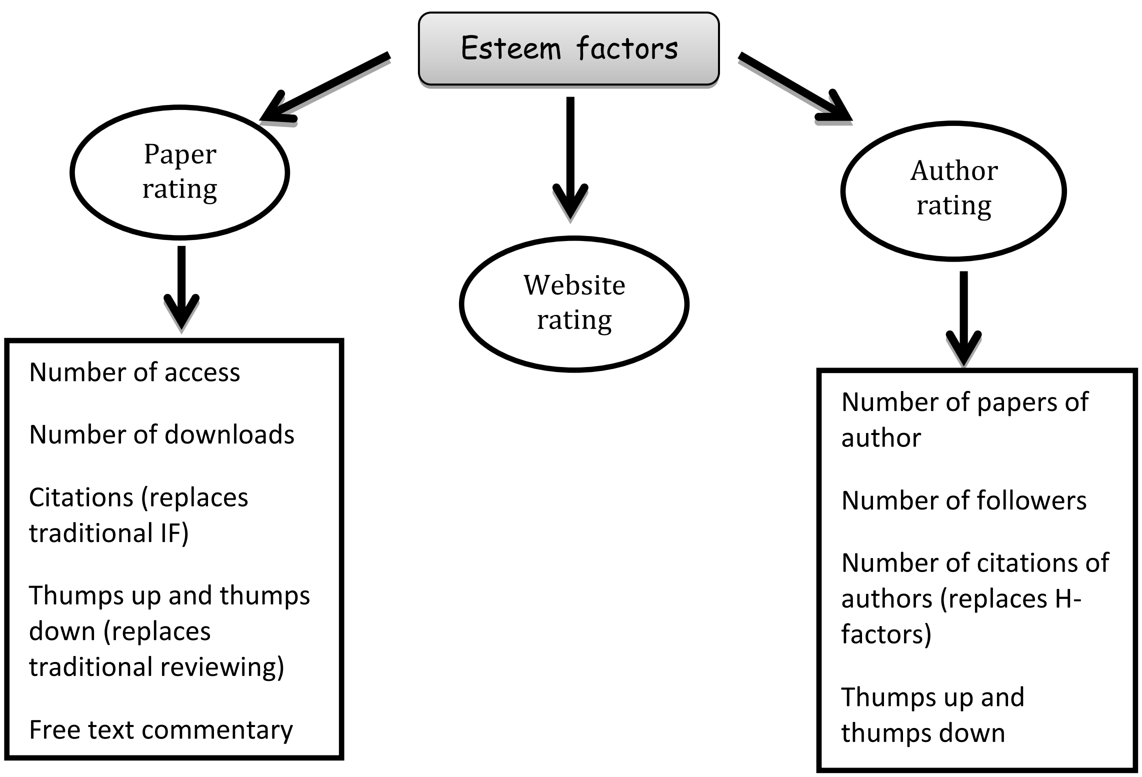


Figure 7. Esteem factors categories.

Social networking sites for scientists and researchers such as Academia.edu, Mendeley and ResearchGate® exist already and may be of use in order to provide such esteem factors. In other words, although people are used to traditional publishing and scared to move a step forward into the unknown, there are many safeguards which can be put in place, and considering the massive benefit of such an approach. Scientists should prepare themselves for a new and innovative form of rapid world-wide dissemination without the need of the "middleman."

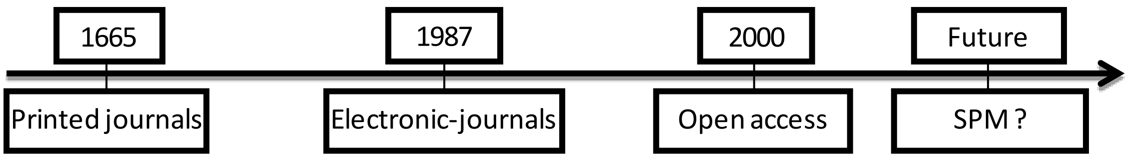


Figure 8. Timeline of scientific communication.

7. Conclusions

History reveals that scientists usually focus only on two contexts, the context of discovery and the context of justification. Recent developments in the field of publishing indicate, however, that another context should be considered with the same importance in the scientific activity. This is the context of dissemination. This idea stems from the following questions: What happens to a discovery after it has been justified? Is a discovery considered a discovery if it is kept private and not disseminated?

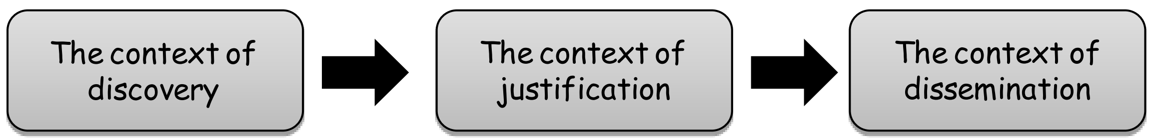


Figure 9. Different contexts of the scientific activity.

The rapid pace of modern science creates a need for a new mode of communication. In the historical description of scientific communication (Chapter 3), I have shown that the evolution of scientific communication has generally been slow. There was a time- lag between each stage, beginning from the Gutenberg revolution in the 15^{th} Century to the foundation of scientific societies in the 17^{th} Century and the invention of scientific journals as a formal way of scientific communication.

As illustrated in the previous chapters, the technological impact on the process of dissemination of knowledge is enormous and there is a direct and firm link between technological inventions on the one side and scientific communication on the other. The digitalization of scientific journals, for instance, has revolutionized scientific communication, a process which is reflected by the open access movement in our generation.

Indeed, the advent of the open access movement has pushed scientific communication into a new direction. It enables all scientists to participate in knowledge construction by the ease of access to new scientific findings without being hindered by a "pay wall," and open access movement has increased visibility of scientific research dramatically.

A central feature of modern dissemination is money, *i.e.* the question "who pays?" Table 9 describes the differences on the financial level among the more traditional subscription-based journals, alternative open access journals and double dipping journals.

Table 9. Differences on the financial level among different kinds of journals

	Open access journals	***Subscription based journals***	***Double-dipping journals***
Researchers	All researchers can access freely without subscription fees 	Researchers in institutions that can afford to pay the subscription charges or in Universities where libraries have subscribed to these journals 	They could benefit if authors are able to pay APC*, thus their articles will be open access, or if their institutions or Universities' libraries have subscribed to these journals 
Authors	Authors pay APC* from their own money or from funded institutions 	Authors can publish without paying 	Authors still have the choice to publish without paying 

APC*: Article Processing Charge

As illustrated in the table above, thumps are up and down in different places due to financial reasons. Noticeably, journals that depend on subscription fees as a source of income have attracted lesser numbers of *readers*, whilst the opposite is true for most open access journals. Article Processing Charges (APCs), however, have formed an obstacle for many *authors* whom Universities or institutions do not support in their research. In short, open access has removed the fee for reading but has shifted the financial burden to the authors as a fee for writing (APCs). Thus, not much has been gained, as money is still involved. In some ways, it also has to be, as long as open access is a private "enterprise" and incurs costs, for instance, for the handling and reviewing process. That is, one has to pay many people in the journal office, even if it is located *de facto* in China or in India. Moreover, hybrid journals, which are also called "double dipping" journals since they have two sources of income, *i.e.* subscription fees and Article Processing

Charges, have benefited researchers if their institutes have not subscribed to subscription-based journals. Authors, however, still have the option to render their manuscripts open access by paying fees.

In Chapter 4, two significant yet controversial practices of scientific publishing have been defined. The first one is the peer review practice, which still is the cornerstone of scientific communication and a synonym for quality. The second one is the impact factor, which is a measure reflecting the importance of a journal and, supposedly, the manuscripts published there. These two metrics are recently facing increased criticism and occupy a large place in researchers' debates. The impact factor, for instance, is prone to fraudulence and the peer review practice is also losing its credibility. Those developments alongside with the inherent problems of scientists in developing countries to publish in open access journals or access subscription based journals are harbingers of the massive need to find an alternative way of publishing suitable for the 21st Century.

The coming together of the above-mentioned criticism and the technological advances has stimulated me to develop my hypothesis of a Self-Publishing Model (SPM) which may be seen as the beginning of a new era of scientific communication. It appears to be more adequate to disseminate modern science reliably, rapidly and without unnecessary bias, yet with the free and democratic scrutiny of the entire scientific community wherever it may located.

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