Peer Review in Scientific Publications: Benefits, Critiques, & A Survival Guide

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Abstract

WHAT IS PEER REVIEW AND WHAT IS ITS PURPOSE?

Peer Review is defined as "a process of subjecting an author's scholarly work, research or ideas to the scrutiny of others who are experts in the same field" (1). Peer review is intended to serve two primary purposes. Firstly, it acts as a filter to ensure that only high quality research is published, especially in reputable journals, by determining the validity, significance and originality of the study. Secondly, peer review is intended to improve the quality of manuscripts that are deemed suitable for publication. Peer reviewers provide suggestions to authors on how to improve the quality of their manuscripts, and also identify any errors that need correcting before publication.

HISTORY OF PEER REVIEW

The concept of peer review was developed long before the scholarly journal. In fact, the peer review process is thought to have been used as a method of evaluating written work since ancient Greece (2). The peer review process was first described by a physician named Ishaq bin Ali al-Rahwi of Syria, who lived from 854-931 CE, in his book *Ethics of the Physician* (2). There, he stated that physicians must take notes describing the state of their patients' medical conditions upon each visit. Following treatment, the notes were scrutinized by a local medical council to determine whether the physician had met the required standards of medical care. If the medical council deemed that the appropriate standards were not met, the physician in question could receive a lawsuit from the maltreated patient (2).

The invention of the printing press in 1453 allowed written documents to be distributed to the general public (3). At this time, it became more important to regulate the quality of the written material that became publicly available, and editing by peers increased in prevalence. In 1620, Francis Bacon wrote the work *Novum Organum*, where he described what eventually became known as the first universal method for generating and assessing new science (3). His work was instrumental in shaping the Scientific Method (3). In 1665, the French *Journal des sçavans* and the English *Philosophical Transactions of the Royal Society* were the first scientific journals to systematically publish research results (4). *Philosophical Transactions of the Royal Society* is thought to be the first journal to formalize the peer review process in 1665 (5), however, it is important to note that peer review was initially introduced to help editors decide which manuscripts to publish in their journals, and at that time it did not serve to ensure the validity of the research (6). It did not take long for the peer review process to evolve, and shortly thereafter papers were distributed to reviewers with the intent of authenticating the integrity of the research study before publication. The Royal Society of Edinburgh adhered to the following peer review process, published in their *Medical Essays and Observations* in 1731: *"Memoirs sent by correspondence are distributed according to the subject matter to those members who are most*

versed in these matters. The report of their identity is not known to the author." (7). The Royal Society of London adopted this review procedure in 1752 and developed the "Committee on Papers" to review manuscripts before they were published in *Philosophical Transactions* (6).

Peer review in the systematized and institutionalized form has developed immensely since the Second World War, at least partly due to the large increase in scientific research during this period (7). It is now used not only to ensure that a scientific manuscript is experimentally and ethically sound, but also to determine which papers sufficiently meet the journal's standards of quality and originality before publication. Peer review is now standard practice by most credible scientific journals, and is an essential part of determining the credibility and quality of work submitted.

IMPACT OF THE PEER REVIEW PROCESS

Peer review has become the foundation of the scholarly publication system because it effectively subjects an author's work to the scrutiny of other experts in the field. Thus, it encourages authors to strive to produce high quality research that will advance the field. Peer review also supports and maintains integrity and authenticity in the advancement of science. A scientific hypothesis or statement is generally not accepted by the academic community unless it has been published in a peer-reviewed journal (8). The Institute for Scientific Information (*ISI*) only considers journals that are peer-reviewed as candidates to receive Impact Factors. Peer review is a well-established process which has been a formal part of scientific communication for over 300 years.

OVERVIEW OF THE PEER REVIEW PROCESS

The peer review process begins when a scientist completes a research study and writes a manuscript that describes the purpose, experimental design, results, and conclusions of the study. The scientist then submits this paper to a suitable journal that specializes in a relevant research field, a step referred to as pre-submission. The editors of the journal will review the paper to ensure that the subject matter is in line with that of the journal, and that it fits with the editorial platform. Very few papers pass this initial evaluation. If the journal editors feel the paper sufficiently meets these requirements and is written by a credible source, they will send the paper to accomplished researchers in the field for a formal peer review. Peer reviewers are also known as referees (this process is summarized in Figure 1). The role of the editor is to select the most appropriate manuscripts for the journal, and to implement and monitor the peer review process. Editors must ensure that peer reviews are conducted fairly, and in an effective and timely manner. They must also ensure that there are no conflicts of interest involved in the peer review process.

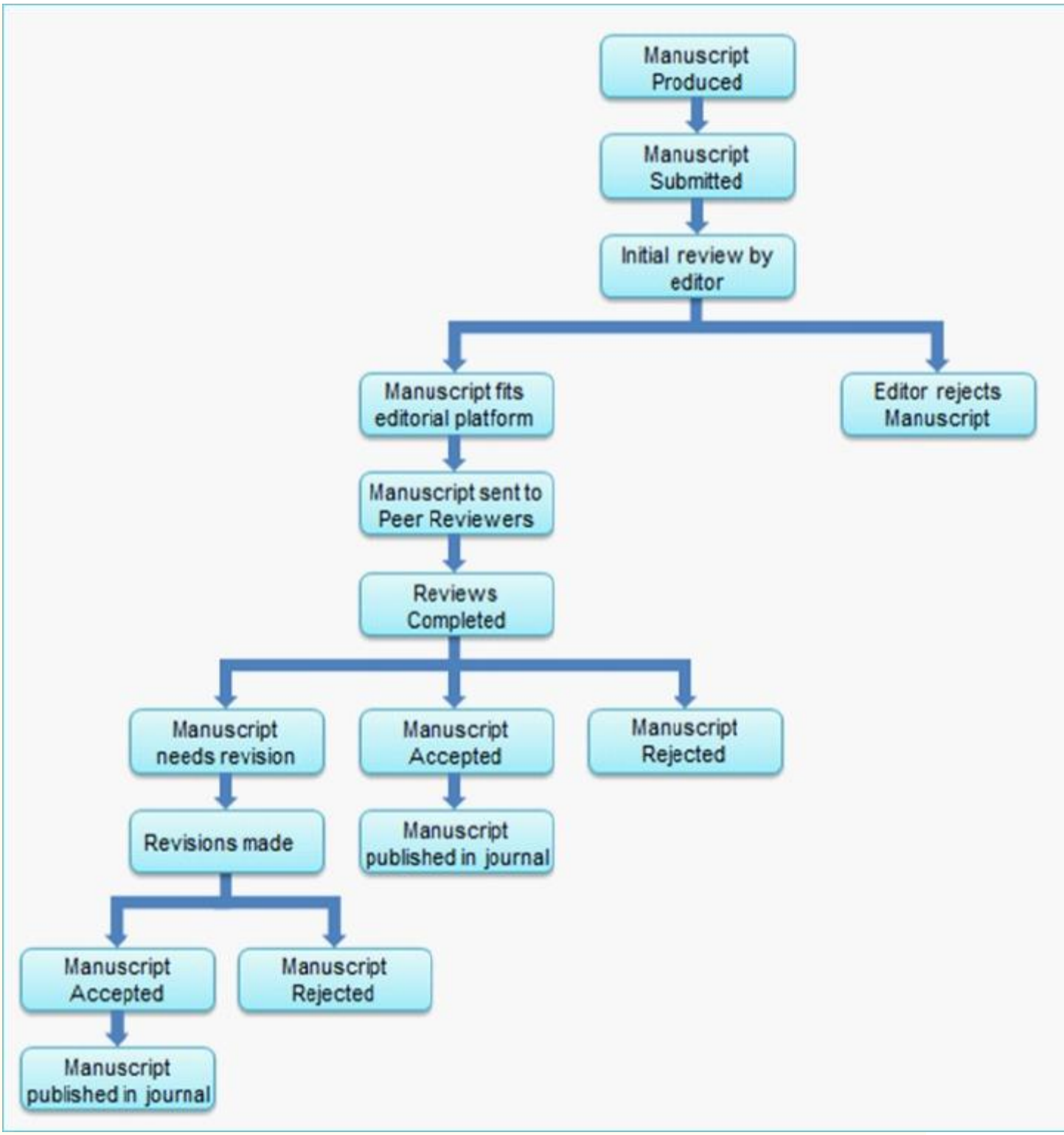

Figure 1

Overview of the review process

When a reviewer is provided with a paper, he or she reads it carefully and scrutinizes it to evaluate the validity of the science, the quality of the experimental design, and the appropriateness of the methods used. The reviewer also assesses the significance of the research, and judges whether the work will contribute to advancement in the field by evaluating the importance of the findings, and determining the originality of the research. Additionally, reviewers identify any scientific errors and references that are missing or incorrect. Peer reviewers give recommendations to the editor regarding whether the paper should be accepted, rejected, or improved before publication in the journal. The editor will mediate author-referee discussion in order to clarify the priority of certain referee requests, suggest areas that can be strengthened, and overrule reviewer recommendations that are beyond the study's scope (9). If the paper is accepted, as per suggestion by the peer reviewer, the paper goes into the production stage, where it is tweaked and formatted by the editors, and finally published in the scientific journal. An overview of the review process is presented in Figure 1.

WHO CONDUCTS REVIEWS?

Peer reviews are conducted by scientific experts with specialized knowledge on the content of the manuscript, as well as by scientists with a more general knowledge base. Peer reviewers can be anyone who has competence and expertise in the subject areas that the journal covers. Reviewers can range from young and up-and-coming researchers to old masters in the field. Often, the young reviewers are the most responsive and deliver the best quality reviews, though this is not always the case. On average, a reviewer will conduct approximately eight reviews per year, according to a study on peer review by the Publishing Research Consortium (PRC) (7). Journals will often have a pool of reviewers with diverse backgrounds to allow for many different perspectives. They will also keep a rather large reviewer bank, so that reviewers do not get burnt out, overwhelmed or time constrained from reviewing multiple articles simultaneously.

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THE EVALUATION CRITERIA FOR PEER REVIEW OF SCIENTIFIC PAPERS

As previously mentioned, when a reviewer receives a scientific manuscript, he/she will first determine if the subject matter is well suited for the content of the journal. The reviewer will then consider whether the research question is important and original, a process which may be aided by a literature scan of review articles.

Scientific papers submitted for peer review usually follow a specific structure that begins with the title, followed by the abstract, introduction, methodology, results, discussion, conclusions, and references. The title must be descriptive and include the concept and organism investigated, and potentially the variable manipulated and the systems used in the study. The peer reviewer evaluates if the title is descriptive enough, and ensures that it is clear and concise. A study by the National Association of Realtors (NAR) published by the Oxford University Press in 2006 indicated that the title of a manuscript plays a significant role in determining reader interest, as 72% of respondents said they could *usually* judge whether an article will be of interest to them based on the title and the author, while 13% of respondents claimed to *always* be able to do so (14).

The abstract is a summary of the paper, which briefly mentions the background or purpose, methods, key results, and major conclusions of the study. The peer reviewer assesses whether the abstract is sufficiently informative and if the content of the abstract is consistent with the rest of the paper. The NAR study indicated that 40% of respondents could determine whether an article would be of interest to them based on the abstract alone 60-80% of the time, while 32% could judge an article based on the abstract 80-100% of the time (14). This demonstrates that the abstract alone is often used to assess the value of an article.

The introduction of a scientific paper presents the research question in the context of what is already known about the topic, in order to identify why the question being studied is of interest to the scientific community, and what gap in knowledge the study aims to fill (15). The introduction identifies the study's purpose and scope, briefly describes the general methods of investigation, and outlines the hypothesis and predictions (15). The peer reviewer determines whether the introduction provides sufficient background information on the research topic, and ensures that the research question and hypothesis are clearly identifiable.

The methods section describes the experimental procedures, and explains why each experiment was conducted. The methods section also includes the equipment and reagents used in the investigation. The methods section should be detailed enough that it can be used it to repeat the experiment (15). Methods are written in the past tense and in the active voice. The peer reviewer assesses whether the appropriate methods were used to answer the research question, and if they were written with sufficient detail. If information is missing from the methods section, it is the peer reviewer's job to identify what details need to be added.

The results section is where the outcomes of the experiment and trends in the data are explained without judgement, bias or interpretation (15). This section can include statistical tests performed on the data, as well as figures and tables in addition to the text. The peer reviewer ensures that the results are described with sufficient detail, and determines their credibility. Reviewers also confirm that the text is consistent with the information presented in tables and figures, and that all figures and tables included are important and relevant (15). The peer reviewer will also make sure that table and figure captions are appropriate both contextually and in length, and that tables and figures present the data accurately.

The discussion section is where the data is analyzed. Here, the results are interpreted and related to past studies (15). The discussion describes the meaning and significance of the results in terms of the research question and hypothesis, and states whether the hypothesis was supported or rejected. This section may also provide possible explanations for unusual results and suggestions for future research (15). The discussion should end with a conclusions section that summarizes the major findings of the investigation. The peer reviewer determines whether the discussion is clear and focused, and whether the conclusions are an appropriate interpretation of the results. Reviewers also ensure that the discussion addresses the limitations of the study, any anomalies in the results, the relationship of the study to previous research, and the theoretical implications and practical applications of the study.

The references are found at the end of the paper, and list all of the information sources cited in the text to describe the background, methods, and/or interpret results. Depending on the citation method used, the references are listed in alphabetical order according to author last name, or numbered according to the order in which they appear in the paper. The peer reviewer ensures

that references are used appropriately, cited accurately, formatted correctly, and that none are missing.

Finally, the peer reviewer determines whether the paper is clearly written and if the content seems logical. After thoroughly reading through the entire manuscript, they determine whether it meets the journal's standards for publication,

and whether it falls within the top 25% of papers in its field (16) to determine priority for publication. An overview of what a peer reviewer looks for when evaluating a manuscript, in order of importance, is presented in Figure 2.

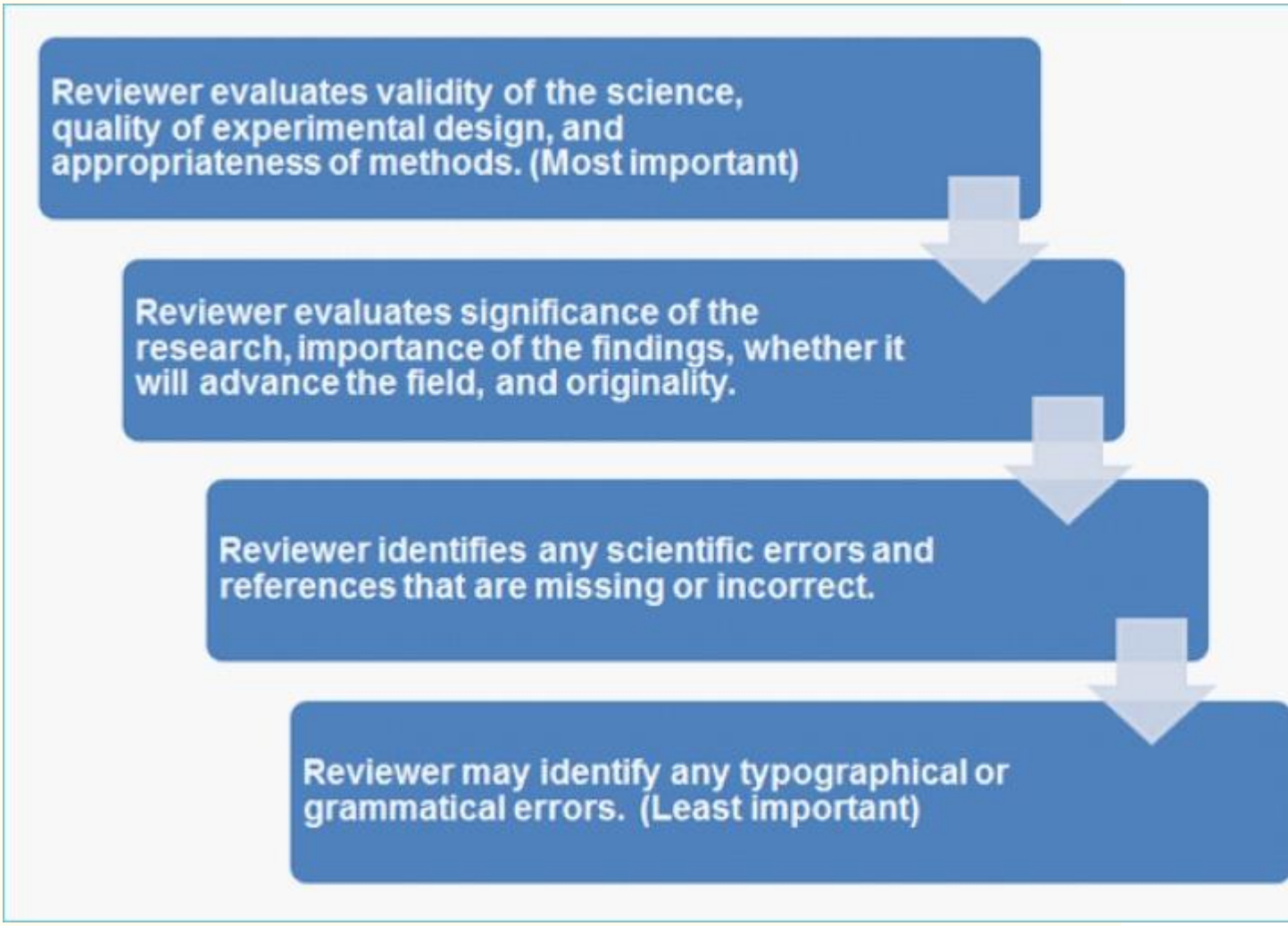

Figure 2

How a peer review evaluates a manuscript

To increase the chance of success in the peer review process, the author must ensure that the paper fully complies with the journal guidelines before submission. The author must also be

open to criticism and suggested revisions, and learn from mistakes made in previous submissions.

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CRITICISM OF PEER REVIEW

A major criticism of peer review is that there is little evidence that the process actually works, that it is actually an effective screen for good quality scientific work, and that it actually improves the quality of scientific literature. As a 2002 study published in the *Journal of the American Medical Association* concluded, *'Editorial peer review, although widely used, is largely untested and its effects are uncertain'* (25). Critics also argue that peer review is not effective at detecting errors. Highlighting this point, an experiment by Godlee *et al.* published in the *British Medical Journal* (BMJ) inserted eight deliberate errors into a paper that was nearly ready for publication, and then sent the paper to 420 potential reviewers (7). Of the 420 reviewers that received the paper, 221 (53%) responded, the average number of errors spotted by reviewers was two, no reviewer spotted more than five errors, and 35 reviewers (16%) did not spot any.

Another criticism of peer review is that the process is not conducted thoroughly by scientific conferences with the goal of obtaining large numbers of submitted papers. Such conferences often accept any paper sent in, regardless of its credibility or the prevalence of errors, because the more papers they accept, the more money they can make from author registration fees (26). This misconduct was exposed in 2014 by three MIT graduate students by the names of Jeremy Stribling, Dan Aguayo and Maxwell Krohn, who developed a simple computer program called SCIgen that generates nonsense papers and presents them as scientific papers (26). Subsequently, a nonsense SCIgen paper submitted to a conference was promptly accepted. *Nature* recently reported that French researcher Cyril Labbé discovered that sixteen SCIgen nonsense papers had been used by the German academic publisher Springer (26). Over 100 nonsense papers generated by SCIgen were published by the US Institute of Electrical and Electronic Engineers (IEEE) (26). Both organisations have been working to remove the papers. Labbé developed a program to detect SCIgen papers and has made it freely available to ensure publishers and conference organizers do not accept nonsense work in the future. It is available at this link: http://scigendetect.on.imag.fr/main.php (26).

Additionally, peer review is often criticized for being unable to accurately detect plagiarism. However, many believe that detecting plagiarism cannot practically be included as a component of peer review. As explained by Alice Tuff, development manager at Sense About Science, *'The vast majority of authors and reviewers think peer review should detect plagiarism (81%) but only a minority (38%) think it is capable. The academic time involved in detecting plagiarism through peer review would cause the system to grind to a halt'* (27). Publishing house Elsevier began developing electronic plagiarism tools with the help of journal editors in 2009 to help improve this issue (27).

It has also been argued that peer review has lowered research quality by limiting creativity amongst researchers. Proponents of this view claim that peer review has repressed scientists from pursuing innovative research ideas and bold research questions that have the potential to make

major advances and paradigm shifts in the field, as they believe that this work will likely be rejected by their peers upon review (28). Indeed, in some cases peer review may result in rejection of innovative research, as some studies may not seem particularly strong initially, yet may be capable of yielding very interesting and useful developments when examined under different circumstances, or in the light of new information (28). Scientists that do not believe in peer review argue that the process stifles the development of ingenious ideas, and thus the release of fresh knowledge and new developments into the scientific community.

Another issue that peer review is criticized for, is that there are a limited number of people that are competent to conduct peer review compared to the vast number of papers that need reviewing. An enormous number of papers published (1.3 million papers in 23,750 journals in 2006), but the number of competent peer reviewers available could not have reviewed them all (29). Thus, people who lack the required expertise to analyze the quality of a research paper are conducting reviews, and weak papers are being accepted as a result. It is now possible to publish any paper in an obscure journal that claims to be peer-reviewed, though the paper or journal itself could be substandard (29). On a similar note, the US National Library of Medicine indexes 39 journals that specialize in alternative medicine, and though they all identify themselves as "peer-reviewed", they rarely publish any high quality research (29). This highlights the fact that peer review of more controversial or specialized work is typically performed by people who are interested and hold similar views or opinions as the author, which can cause bias in their review. For instance, a paper on homeopathy is likely to be reviewed by fellow practicing homeopaths, and thus is likely to be accepted as credible, though other scientists may find the paper to be nonsense (29). In some cases, papers are initially published, but their credibility is challenged at a later date and they are subsequently retracted. Retraction Watch is a website dedicated to revealing papers that have been retracted after publishing, potentially due to improper peer review (30).

Additionally, despite its many positive outcomes, peer review is also criticized for being a delay to the dissemination of new knowledge into the scientific community, and as an unpaid-activity that takes scientists' time away from activities that they would otherwise prioritize, such as research and teaching, for which they are paid (31). As described by Eva Amsen, Outreach Director for F1000Research, peer review was originally developed as a means of helping editors choose which papers to publish when journals had to limit the number of papers they could print in one issue (32). However, nowadays most journals are available online, either exclusively or in addition to print, and many journals have very limited printing runs (32). Since there are no longer page limits to journals, any good work can and should be published. Consequently, being selective for the purpose of saving space in a journal is no longer a valid excuse that peer reviewers can use to reject a paper (32). However, some reviewers have used this excuse when they have personal ulterior motives, such as getting their own research published first.

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CONCLUDING REMARKS

Peer review has become fundamental in assisting editors in selecting credible, high quality, novel and interesting research papers to publish in scientific journals and to ensure the correction of any errors or issues present in submitted papers. Though the peer review process still has some flaws and deficiencies, a more suitable screening method for scientific papers has not yet been

proposed or developed. Researchers have begun and must continue to look for means of addressing the current issues with peer review to ensure that it is a full-proof system that ensures only quality research papers are released into the scientific community.

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