

Preprints as medium for communicating new ideas, hypotheses, data, analysis and beyond

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Abstract

Preprints emerged as a medium for exchanging ideas and new research data in the physics and mathematics community through the *arXiv* preprint server, and the phenomenon has since spread to biology and chemistry, with the promulgation of a variety of preprint servers such as *PeerJ Preprints* and *bioRxiv*. Partly as a response to the slow publication process where it could take months or even years to publish a manuscript, which leads to latency in the distribution of ideas and data useful to other researchers, preprints have also been conferred with the status of citability, and thus, a source of recognition for the work of the authors. Specifically, preprints could be used as an indication of the first publication of an idea. From my experience with publication of preprints on *PeerJ Preprints* and *figshare*, I see preprints as a publication format that liberates citizen scientists and afford an opportunity for common people with an interest in science to participate in the scientific dialogue. Beyond exchange of ideas and data, as well as laying an indication to the novelty of a work, preprints also allow the publication of hypotheses and research ideas of benefit to other researchers. For example, I share, using preprints, my research ideas on other areas of science which I lack the resources to partake. Additionally, commentary and perspective manuscripts could also be published, which democratizes the sharing of scientific ideas and enriches the scientific dialogue, as well as prevents the published literature from being monopolized by limited number of school of thoughts. Datasets could also be shared with others as preprints, and being citable, provides a platform for gaining credit, as well as a means for data comparison and reuse by others. In addition, presentations and posters, which are typically not published, could also be published as preprints; thereby, providing authors with a forum to communicate their preliminary findings expeditiously. Finally, with individual journals placing implicit restrictions on the style of communication and what should be described (for example, disallowing the publication of hypotheses papers), preprints afford authors' freedom to express their ideas in a format they think would best showcase their work in an understandable manner. Hence, preprint is an alternative scientific arena that works in complement to the published literature in enabling a wider and richer discussion of ideas, hypotheses, commentary and critique amongst scientists. With lower barriers to entry and the willingness to communicate as the only constraints, preprints may be identifiable as a revolution in scientific communication, aided by the low cost model of Web publication, which in adding to the diversity of ideas made known to scientists, non-scientists and policy makers, help anchor science firmly in any intellectual discussion of importance to society.

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Publication in a science journal is a long duration work of labour, starting from the submission of the manuscript to multiple rounds of peer review and rewrite, that could take months and even years. Hence, there is a significant time lag between the completion of a manuscript and its final publication in a journal for dissemination of ideas and concepts. This hampers the timely discussion of new ideas and concepts, which fertilize research in the same or allied fields. Additionally, the acceptance rate of journals is tight; thus, significant number of good manuscripts that report well designed experiments could not be published, for example, due to the relatively small scale of experiment study or presence of negative data. This represents a significant loss to science, which meant that there is substantial wastage of effort at rediscovering known truths as well as pursuing paths known to be false leads. Time wasted should have been more fruitfully used to advance science.

Hence, there is a movement towards more rapid publication of research manuscripts through streamlining the peer review process, as well as via the promulgation of a new type of research publication: preprints. Specifically, preprints came into its own through the efforts of the physics, mathematics and economics communities in attempting to bring to the scientific community new ideas and experiment data for discussion prior to formal publication in a journal.¹ Through early publication as preprints, it was hoped that the new publication format could help engender discussion of the manuscript and provide useful feedback to the authors to aid in refinement of logic of paper as well as enhance its discussion of concepts. *arXiv*, the preprint service for the physics and mathematics community, attracts thousands of submissions per week, and is the most widely used preprint service to date.

Success of the concept of preprints have since spread to biology, and more recently, chemistry. However, apprehension of many journals' rule of denying publication to a manuscript that has previously been published as a preprint (known as prior publication) continue to plague the fields of chemistry and biology as authors refrain from publishing their draft manuscripts early for discussion with the community. While the situation has since ameliorated with many journals now recognizing the value of preprints in aiding the scientific dialogue, and allowing manuscripts published as preprints to be accepted for peer review, the take-up rate of biology (e.g., *PeerJ Preprints* and *bioRxiv*) and chemistry preprint servers remains considerably lower than that for the physics and mathematics communities.

Hence, at least in the physics and mathematics communities, preprints have been recognized as a medium for earning priority for one's research ideas and work, and more importantly, as a platform for discussing new data and ideas.² But, the concept of preprints has evolved in recent years to encompass a larger role in scientific communications. Specifically, at the community level, preprints have enlarged its scope to include the publication of posters and presentations at conferences for allowing authors to earn credit (through citations) for their work (e.g., *F1000Research*). This opens up a new trend in scientific publishing: continuous, incremental documentation of the progress of a piece of research, which while benefiting the authors as they get the chance to continuously refine their thinking on their work, also help science historians and general readers understand the deeper and finer points about idea

genesis. To this end, version control and the provision of abstract preprints³ significantly enabled the publication of successive iterations of the same broad idea illustrating progressive refinement in thinking on the subject matter.

Additionally, preprints also encompass reviews and perspective manuscripts,^{4 5} which in providing authors an avenue of scientific publication, would also enliven the scientific literature through the promulgation of more lines of thoughts that, in increasing the diversity of ideas articulated, also strengthen the scientific peer review process against group think and stratified discussion, such as that between members of an expert group, and an alternative forum held between novices of a field. A lowered barrier of entry to articulation of ideas, preprints enable the scientific publication process to be more inclusive of minority ideas that may sow the seeds of the next breakthrough in our understanding of the natural world. From an alternative perspective, by democratizing the publication process and lowering the barriers to entry to a first online publication able to be cited by others, preprints have provided authors from around the world with a free publication medium that allows them to articulate their ideas and share their newly obtained experiment data to others for comment, much faster than the established scientific publication process of journals.

Datasets⁶ have also been incorporated into preprints as more avenues are sought for the publication of original data, for example, in dedicated journals for data such as *Scientific Data*. Furthermore, reuse and citation policy of data has since been promulgated to the scientific community, making published data citable, independent from its associated journal or preprint publication. Specifically, many journals have requested for the inclusion of one's experiment data as supplementary files to a publication to help increase the ease of reproducing one's work. The same trend has also been taken up by preprints in the form of datasets. Additionally, even graphic figures have earned the classification of preprints.⁷

Expanding from the scope of datasets, preprints have also included manuscripts that described failed experiments or negative data, which would greatly reduce the time and effort of other researchers in the same field at following the same path or thinking in research. Certainly, publishing one's failed experiments and negative data as preprints should be seen as a service to the scientific community in helping others avoid the same mistakes, or to point out deep problems of a particular line of thinking or experiment methodology.

Besides widening the scope of publication from research manuscripts to reviews and perspectives, it is my understanding that preprints could also be expanded to commentary articles as well as post-publication peer review of published journal articles.^{8 9 4 10 11 12 13 14} Specifically, preprints is a forum for discussing new ideas in science, and the post-publication discussion of published literature is an important process for the authors of the published paper to gain additional understanding of their paper from an audience beyond the peer reviewers. Such exchanges of ideas would only increase the strength of the logical reasoning and the depth of thought, that runs through the scientific process and thinking in defining experiment series

for future investigations. Such post-publication peer review could be in the form of commentary or perspectives, depending on the scope within which the author wishes to discuss his ideas on a piece of published research.

In addition to post-publication peer review, preprints could also include hypothesis manuscripts that describes new ideas or experiment designs that emerges from serendipitous observations, which typically could not be published in a scientific journal.¹⁵ Thus, preprints afford authors an opportunity to share with others ideas that they have on a research area tangential to their own, but which they do not have the resources to investigate.^{16 17 18} Hence, such hypotheses preprints serve as anchors on which others can build on in ideas or experiment design, and may help bring about an experiment investigation on a topic. It is important to note that such hypotheses paper may not be grandiose in content, but rather, an incremental advance on a known topic, which nevertheless could help propel the field forward in thinking. These hypotheses manuscripts serve science by allowing a diversity of ideas to sprout from bottom-up, which when combined with available experiment or simulation methods as well as other ideas from tangential fields allied to the original one, help potentiate new progress in new and established fields of research.

Finally, while preprints traditionally cover research manuscripts, the advent of preprints also provide an avenue for a re-interpretation of what is a research paper. Specifically, depending on the journal's requirement as well as recommendations of the peer reviewers, specific style of writing an introduction or discussing the data is expected for particular journals. Coupled to the peer reviewers' own understanding of science and what constitutes a research manuscript, specific wording or ways of discussing science are not allowed in journal publications. More importantly, journals narrowly focus on discussing the facts and their implications, and disallow more speculative or hypothesis ideas to be included in the manuscript. But, the preprint forum allows authors more freedom to articulate their ideas and ways of discussing and presenting their science to their colleagues. Thus, possibility exists for preprints as an alternate incarnation of the same manuscript that discusses the same set of experiment data. Specifically, a preprint could allow the author to discuss his ideas on the experiment findings and data more broadly and in more graphics than a typical journal allows based on page constraints. For example, a preprint could be worked to include a graphics abstract, highlights section and the main manuscript, while a corresponding publication in a journal may not have space for a graphics abstract.¹⁵ Hence, a preprint could exist alongside a journal paper to complement each other in discussing a piece of scientific work; thereby, expanding the wealth of information available from a work and, more importantly, the methods in which it is displayed and communicated to the scientific community, which brings more value to the readers in understanding the content more deeply.

Collectively, preprints have evolved since its inception as a medium for expedited communication of new research findings that help negate two significant negatives of the formal journal publication process: time lag and a high rejection rate. Specifically, preprints afford a low barrier to publication to experiment data and ideas that previously could not be

published given the small scale nature of the work (e.g., only one or two main figures).¹⁹ Thus, even relatively non leading edge research by undergraduates could be published as preprints, which help provide the students with credit, and at a scientific level, provide more data for other researchers to verify the veracity of a phenomenon described by others. It is through the collective that science works to seek understanding of nature, and preprints provided one avenue for doing that.

Besides research manuscripts as preprints, the publication format has also expanded to include datasets, posters, presentations, commentary, reviews, and perspectives. Datasets provided readers with a source of experiment findings to help further research of a phenomenon, at the aggregate level, through a meta-analysis. On the other hand, ability to publish one's ideas as commentary and perspectives democratizes science and help push minority ideas to the surface for scrutiny by interested scientists, who will not be hamstrung by the possible group think of a field. This could only help move science forward expeditiously. But, more importantly, in providing a low-cost format of publication, preprints afford negative data and experiment findings an avenue to be discussed scientifically; specifically, in seeking new ideas on how to take the research forward (from the authors' perspectives), as well as serving as a source of intellectual content for enabling others not to take a path proven not to work. A source of publication for enabling scientists to help each other where the mistakes in experimentation or experiment design are made known, preprints would only help move the mechanics of scientific investigation forward.

While peer review remains largely behind the view of authors despite recent movement in making the process more transparent, post-publication peer review is gaining traction in the scientific discourse, and preprints offer a low cost, low barrier of entry medium to interested scientists for putting their ideas on a published article forward in discussing new findings, which could only help enrich the scientific dialogue. Finally, scientific publication focuses traditionally on the factual and leans away from the speculative, but preprints afford an opportunity to exercise freedom in articulating one's ideas as hypotheses, especially in the circumstances of lack of resources to focus on a tangential field. Thus, preprints complement traditional scientific publication in a bigger way in offering authors' the freedom to express their creativity in discussing their work, in text and graphics, to potential readers and colleagues to aid in better understanding their ideas and research thinking. This is a significant departure from the narrow confines on which many science journals define scientific publication: discussion of facts and their implications in a defined format, which forgot about tangential hypotheses and more speculative ideas useful for potentiating new thinking.

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Conflicts of interest

The author declares no conflicts of interest.

Author's contribution

The author thought about the role of preprints in augmenting the scientific literature by expediting the promulgation of ideas previously hidden in manuscripts awaiting the lengthy process of journal publication. Additionally, his experience in publishing preprints over the years educated him of the utility of preprints in sharing hypotheses and ideas he formulated,

but which typically could not grace the pages of a journal due to the requirement for publishing analysis of real experiment data. Finally, preprints offer a chance for presenting a research manuscript at a broader level, where preliminary ideas and hypothesis that could not be published under the peer review process could be presented. He wrote the manuscript to share his ideas on preprints with the scientific community.

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