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OPEN SCIENCE TRAINING AND EDUCATION: CHALLENGES AND DIFFICULTIES ON THE RESEARCHERS' SIDE AND IN PUBLIC ENGAGEMENT

Preprints and peer review: a lesson from physics

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Abstract

For decades, particle physicists have been using open access archives of preprints, i.e. research papers shared before the submission to peer reviewed journals. With the shift to digital archives, this model has proved to be attractive to other disciplines: but can it be exported? In particle physics, archives do not only represent the medium of choice for the circulation of scientific knowledge, but they are central places to build a sense of belonging and to define one's role within the community.

Keywords

Scholarly communication, Science communication: theory and models

Publishing papers in peer review journals is one of a researcher's main goals. But is it also the best way to disseminate research results, and to make sure that the reference scientific community and the general public have access to such contents? Archives of preprints, i.e. papers that have not gone through peer review yet, can provide a fast, easy, open access alternative speeding up communication, and making contents immediately accessible to anyone. Incidentally, they also overcome some distortions of the peer review system. Open access archives for the publication of preprints have been proliferating, and by now they are available in many sectors of research, although in different forms. Some are public, some are private, others are relatively low-tech, whereas some others have adopted technologies that are typical of the most recent social media. Created a few years ago, bioRXiv.org is establishing itself in the field of life sciences, whereas in the field of social sciences a commercial network such as academia.edu has been proving able to supersede institutional and public archives and has been attracting increasing volumes of preprints. However, disciplines in which researchers have been using for decades open archives as the main infrastructures to exchange their own papers — such as particle physics — provide a telling example showing that this instrument is connected to specific ways of doing science communication and organising the scientific community. In short, open access archives are closely connected to the existence of a "preprint culture" [Mele et al., 2006] developed and settled over the 20th century. Other disciplines either not having developed this culture or having institutional or social structures different from physics have been facing specific issues and may struggle to adopt archives as the central place in which knowledge is shared and debated. In addition, preprint archives in physics take on a role that is different from a mere instrument for a faster and more

effective communication. In such discipline, the open access achieved thanks to the publication of preprints does not provide a competitive advantage versus colleagues as is the case in many scientific fields, but it rather meets the need of showing you are part of a community. The use of the word "community" may be dangerous when talking about a few tens of thousands of researchers scattered across several regions of the world and with extremely varied cultural backgrounds, but it can translate the internal cohesion of the world of particle physicists, which anthropologist Sharon Traweek defined as a distributed tribe [Traweek, 1988].

At the beginning of their career, physicists are socialised into the use of archives not only as authors, but also as readers.[1] Only as they progress in their career, those researchers are able to reduce their commitment to contributing to the archives and following their daily flow of papers. Although part of the physicists' community tends to defend the role played by peer review as a guarantee of the final quality of a publication, the information exchange and the circulation of research projects do not take place on the journals subject to peer review. To cut a long story short, physicists do not read journals. In fact, nearly all the research papers are published on arXiv.org, an open-access archive that is also the place where researchers go to download the papers they actually read. Other archives have been built on the basis of arXiv and do nothing but adding a layer of additional information, such as the number of citations received by a paper, or the number of publications of an author. Physicists all over the world refer to arXiv simply as "the archive", as it represents the reference place they go to when they have to disseminate their research results. As soon as a paper is thought to be ready to be read by the community, its authors publish it on arXiv. Only at a later time, the same paper is submitted to a journal to go through peer review, a process that can last several months. When the paper is accepted and published by the journal, often the authors replace the file existing on arXiv with the most updated version when it has undergone amendments or improvements. Each sub-discipline has its own specific space on arXiv, for example HEP-TH for theoretical physicists and HEP-EX for experimental physicists. This archive was launched in 1991, and since then it has become the standard for the publication of research results not only in particle physics, but also in other sectors of physics, mathematics, computational biology and other disciplines. However, the birth of arXiv within particle physics was not by chance. For decades, long before the rise of digital media, physicists have used preprints as the medium of choice. Whereas epistolary communication has always been one of the pillars of modern science, since the end of World War II particle physics has institutionalised the practice of exchanging preprints by post, irrespective of the distribution of the same papers via science journals. The libraries of departments or laboratories used to keep an archive of preprints that used to be sent in by other schools or laboratories around the world. Preprints were then hung on a bulletin board where researchers could read the titles, the authors, and if they were interested in a paper, they could request a copy. Obviously this practice was costly, and the wealth of a department or laboratory used to influence the quantity of preprints it was able to send out, whereas its reputation influenced the quantity of incoming preprints. The advent of digital archives has made this practice faster and more global: now publishing a preprint in the archives is free of charge and any researcher can do it in a few minutes. Most of all, the digitalisation of archives

[1] This paper is based on the preliminary results of a research project conducted through interviews with particle physicists in Italy and California in 2015.

has made them one of the central places in which physicists now build and prove their being part of the community. Indeed, this fast publishing system and easy access are not only instrumental to the use of archives as a means to spread knowledge. In particle physics, archives apparently meet a demand for internal cohesion — which proves the sense of belonging — and internal competition.

At the beginning of their doctoral programme, students are trained on the functioning of the archive, and gradually learn to look at it on a daily basis, also through a smartphone app allowing you to browse through the list of the papers published day by day. Students and postdoctoral fellows, who play a fundamental transitional role in physics, must be ready to discuss who published what on that specific day, possibly at the department cafeteria during lunch break. Postdoctoral fellows are also very much interested in their role as authors. The number of papers published every day (a few dozens for each main sub-discipline) makes it impossible to read the content. Reading is limited to the titles, the authors, in a few cases the abstracts, and much more rarely an entire article. Checking the archive on a daily basis teaches you what the subjects of the moment are, and allows you to prove you belong to the particle physics community. However, appearing in the archive a certain number of times per year guarantees a visibility that reinforces your role within the community: the archive does not only inform about the content of a research project, but also about who is working on what and collaborating with whom. Theoretical postdoc researchers tend to believe there is a suitable number of papers to be published in the archive every year. Once they have obtained an academic position, physicists can stop looking for daily updates on what happens in the archive, but they still use arXiv and other databases to learn about what their colleagues do when they do not have personal contacts or, for example, to evaluate aspiring postdoc fellows or researchers in the screening steps before hiring someone new.

Whereas the majority of the preprints published on arXiv turn into papers published by peer reviewed journals, it is not completely clear how this transition is evaluated. In a relatively small and cohesive sector as particle physics is, the publication process concerns a very limited number of journals that, with very few exceptions, struggle to differentiate from one another in terms of prestige. In the experimental sector, in which research papers are signed in an alphabetical order by the hundreds of people who work on a large-size research collaboration (for example one of the particle detectors at CERN), irrespective of their actual contribution, single authors must find alternative strategies to communicate their direct contribution to a research project or what subjects they are personally working on. Whereas a fundamental role is played by face-to-face communication activities, for example internal seminars, conferences, or informal interactions, such researchers use the archive also to publish works that are not destined for peer review, but that state more clearly their position as authors. This so-called "grey literature" comprises reports, conference proceedings, or other products of research that in many disciplines are considered liminal, if not irrelevant. In experimental physics, the archive allows for their dissemination and supports their role in defining the authorship of physicists whose contribution is made invisible by the scale of the collaborations they belong to.

Such features, which I have only partially outlined, force us to wonder whether the model of preprint archives may dominate also in other scientific disciplines that have now been embracing this form of communication for a few years. The different disciplinary cultures, local and epistemic, as well as the different social and institutional forms taken on by other research sectors require at least an adjustment of the preprint archive model. Obviously, there is also an issue regarding institutional incentives. The agencies financing university, under the pressure of arbitrary quality charts such as the Shangai Ranking or the Times Higher Education, which are based on the works published in journals, push their researchers to publish papers in the most prestigious journals, which have a higher impact factor. The Research Excellence Framework in the U.K. and the Anvur agency evaluation systems in Italy are two examples among many. Until this situation continues to exist, the publication of preprints will be complementary to the publication in peer-review journals, at least as concerns evaluation outside a small circle of peers. However, whereas rankings apparently meet institutional goals that are quite distant from knowledge production, particle physics show that the communication of results to the reference scientific community as well as the evaluation of researchers and the cohesion of the community itself can be based on the sharing of knowledge outside the peer review system.

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