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International trends in scientific publication as a requirement for doctoral degrees

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ABSTRACT

Introduction: scientific publishing and doctoral training are two deeply interconnected academic institutions. Scientific article is defined as a structured, published written report that communicates original research results, constituting the primary means for the validation and socialization of knowledge.
Objective: to analyze international trends in scientific publishing as a requirement for doctoral degrees.
Development: historical analysis reveals four macro-sequential trends. Initially, there was a dissociation between the doctoral thesis (medieval in origin, reformulated in the 19th-century Humboldtian model) and formal communication channels (scientific journals that emerged in the 17th century). In the 19th century, the convergence of science professionalization elevated the article to academic currency. After World War II, the explosion of scientific production and the development of bibliometric tools (such as the Science Citation Index) led to the formalization and institutionalization of the requirement in university regulations. Finally, the digital age and globalization have led to a homogenization toward the Anglo-Saxon model based on metrics, generating a high-tension ecosystem ("publish or perish") between the accumulation of academic capital and comprehensive research training.
Conclusions: the study identifies an evolutionary trajectory from initial dissociation to mandatory symbiosis, characterized by progressive formalization, disciplinary expansion, and globalization of the requirement. This process has created an inherent tension between the logic of metered scientific productivity and the ideals of deep and risky doctoral training.

Keywords: Scientific and Technical Publications; Periodicals as Topic; Research; Bibliometrics; Journal Impact Factor.

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INTRODUCTION

Scientific production in the form of a scientific article is one of the best ways to disseminate research results. In this sense, Lam Díaz,[1] defines a scientific article as a written and published report that describes original research results.

Mari Mut, cited by Gutiérrez Escobar,[2] defines the scientific article as that text that shows for the first time the results of a scientific investigation, and, therefore, forms part of the primary literature of science.

According to Reyes,[3] a scientific article is the final result of rigorous research, which has followed all the appropriate steps and methods to arrive at a conclusion or determine a final result and describes: problem, objective, background, results, discussion, and conclusions. Furthermore, he states that it is considered important because it contributes to the updating, synthesis, and dissemination of new knowledge. He also points out the validity of this definition for all areas of science.

The author of this document agrees with these definitions, defining a scientific article as a written report, following a specific structure, published in a scientific medium, that clearly and precisely communicates the results of an investigative process.

Doctoral training and the scientific publishing system are two deeply interconnected academic institutions whose joint evolution has defined modern research culture.

Therefore, analyzing the historical background of scientific publication as a doctoral degree requirement is necessary to understand the profound changes in the dynamics of knowledge communication, validation, and evaluation. Understanding this trajectory requires examining the parallel development of scientific journals alongside science itself and how they have transformed the criteria for what constitutes a trained researcher. This is essential for understanding the logic underlying the structures of the current publishing system, its role as scientific capital, and the network of relationships among the actors in this ecosystem. For this reason, the present study aims to analyze international trends in scientific publication as a doctoral degree requirement.

DEVELOPMENT

The historical analysis that follows is organized around the key milestones that have shaped the relationship between doctoral degrees and scientific publication. Starting from the separate origins of both institutions, it identifies the trends that gradually led to their convergence, institutionalization, and globalization, culminating in the current ecosystem characterized by production and impact metrics.

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Beginnings of the academic degree "Doctor of Science" and the first channels of Scientific Communication

Origins of the Doctor of Science degree

The doctorate as the highest academic degree has its roots in medieval European universities, where it was initially awarded in disciplines such as theology, medicine, and law.[4] Founded in 1088, the University of Bologna is recognized as the first to award doctoral degrees, although modern concepts differ from the initial ones.[5] Initially, this degree reflected the authority and training for teaching, which differs from the current conception, concentrated on research training and in-depth knowledge.

The current conception began to take shape in 19th-century Germany, particularly at the University of Berlin, founded in 1810 due to the influence of the academic Wilhelm von Humboldt.[6] This model promoted academic freedom and research as a path to the construction of knowledge, requiring the development of a doctoral thesis that contributed, through original results, to knowledge, and defended before a committee of experts.[7] In this still incipient stage of the conception of the doctorate, the fundamental requirement was the thesis, without the need for publication in external peer-reviewed formats.

From the Germanic context, the concept of Philosophiæ Doctor became popular, especially by using the term Philosophiæ not to designate the discipline, but by alluding to its etymological meaning "love of wisdom" and by promoting the search for knowledge in the broad sense.[8]

This model spread throughout Europe and North America, being adopted by academic institutions such as Yale (1861) and later Harvard (1872),[9] however, with significant adaptations that later led to additional requirements, such as scientific publication.

Origins of scientific journals

Simultaneously, but initially disconnected from the degree-granting process, formal scientific communication was taking its first steps. Formal scientific communication did not begin with scientific journals, but with a more flexible and fluid structure, based on networks of correspondence between philosophers during the 17th and 18th centuries. These networks of correspondence were the means through which scientific debate was recounted, ideas were shared, findings were discussed, and consensus was forged.[10]

These were informal but effective systems that sometimes included "regulators"—individuals who acted as curators of information and thus guided the debate. This process largely laid the groundwork for the later institutionalization of scientific academies.

The turning point that oriented scientific publishing to the form it is currently known occurred with the appearance of the first scientific journals, such as the Journal des sçavans in France and the Philosophical Transactions of the Royal Society in England.

The first scientific journal emerged in Paris in 1665 under the title "Le Journal des sçavans", supported by Louis XIV's finance minister Jean-Baptiste Colbert. It expressed its desire to communicate advances in fields such as mathematics, astronomy, and anatomy, and to publish a catalog of the most relevant books published in Europe, not only by title but also by content.[11]

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Similarly, it was published this same year by the*Royal Society of London for Improving Natural Knowledge*the first magazine oriented towards experimental science, with the title*"Philosophical Transactions of the Royal Society of London"*; its editor was the German theologian and philosopher Henry Oldenburg.[10]

These journals did not emerge in a vacuum; they were a strategic innovation by editors who saw the potential to leverage and formalize existing correspondence networks. In doing so, they transformed informal communication into a public, archivable, and verifiable record of advances in science and technology. This was the initial step in converting knowledge into a social good, communicable and validated by an academic community, by establishing the core functions of a scientific journal: recording, disseminating, and archiving knowledge.

During this period, the groundwork was also laid for one of the oldest processes within the editorial management process itself: the peer review process.*peer review*, whose emergence has been attributed to Henry Oldenburg, in establishing a committee to read and discuss the letters and articles sent to*Philosophical Transactions of the Royal Society of London*and respond to the authors either in weekly meetings, through correspondence, or as replies in the journal itself.[12]

From this analysis emerges the first trend: the initial dissociation. In its origins, doctoral qualifications (based on the thesis) and formal scientific communication (through journals) were separate spheres.

Formalization of science and incipient convergence

During the 19th century, the scientific landscape underwent a period of transformation. During this time, science became increasingly professionalized, and consequently, so did the tools for its dissemination. The research article evolved from an experimental report or a letter to a distinctive and exclusive writing language for professional scientists.

This change was not merely stylistic, but laid the foundation for considering scientific articles as the main way to establish and support the credibility of a researcher, claim the first time a discovery is made, and climb the research career ladder in an academic system that was becoming bureaucratized and competitive.

At this stage, scientific publication ceased to be an act of scientific socialization and became a process of professional validation, establishing the central role of scientific publication within scientific capital.

Profound transformations occurred in science, which caused the transition from the thesis as the sole requirement to incorporating scientific publication as a formal requirement.

In the case of the experimental and biomedical sciences, the practice of publishing in scientific journals prior to the thesis defense emerged as an early practice, influenced by the culture of "laboratory research" and the changing nature of these fields. In contrast, in the Social Sciences and Humanities, the monograph retained its position as a consolidated research product, with a publication process less suited to doctoral timelines and more extensive.[13]

Increasing academic competitiveness and the need for objective indicators to evaluate research productivity of both professors and institutions created the conditions for scientific publication to become a degree requirement. Therefore, starting in the 1970s, many universities included guidelines to incentivize or mandate scientific publication.

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During this period, several journals emerged that have shaped the advancement of scientific publishing, the journal*Nature*and the magazine*Science*.

*Nature*The journal, whose first issue was published in 1869, was edited by the British astronomer Norman Lockyer, supported by a body of renowned scientists, including the biologist Thomas Henry Huxley, the botanist Joseph Dalton Hooker, the philosopher and biologist Herbert Spencer, and the physicist John Tyndall.[11]

The magazine*Science*It was first published in 1880 in New York by journalist John Michaels, with the support of Thomas Alva Edison and later Alexander Graham Bell. It became the leading journal for the dissemination of scientific knowledge. *American Association for the Advancement of Science*(AAAS).[11]

Thus emerges the second trend: convergence through professionalization. The professionalization of science in the 19th century elevated the status of the scientific article as an academic currency, creating fertile ground for its eventual link to doctoral training.

The Post-War Period and the Institutionalization of the Requirement
The period following World War II witnessed an unprecedented acceleration in scientific research, largely funded by governments. This surge in research created a gap—a lack of means to disseminate findings—which laid the foundation for a fertile market that was quickly exploited by commercial publishers.[14]

The rise of new journals and the information overload generated a new need: to categorize, manage, and explore the growing volume of literature. This became "necessary" to avoid overlapping studies and to prevent major discoveries from going unnoticed.

In this context, the following emerged:*Science Citation Index*(SCI), proposed by Eugene Garfield in 1955 and launched in 1964. Its objective was to identify the core of central or highly influential journals within fields. This act, while a solution to information overload, laid the foundation for the development of modern bibliometrics and the creation of metrics such as the Impact Factor.[14]

Not only was literature organized, but the hierarchy of magazines based on prestige was crystallized, marking the culture of*Publish or Perish.*In addition to this, The subscription-based business model, controlled by a growing group of publishers, led to price increases. This economic strain would later fuel the Open Access movement.

This evaluative paradigm became institutionalized due to a set of factors, including competition for academic positions, the allocation of research funds based on productivity indicators (including the volume of articles published), and the development of university rankings based on metrics of scientific publications.[15]

This scenario of publishing expansion and quantification of impact coincided with an equally profound transformation in doctoral training systems. During the second half of the 20th century, postgraduate education underwent an unprecedented process of massification, driven by societal demand for highly qualified personnel and by state policies that linked scientific development with economic growth. The number of doctoral programs multiplied, and the role of the doctoral candidate evolved from that of a small elite to a fundamental link in the chain of scientific production.

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In this context, universities faced the need to establish objective and standardized criteria for evaluating the quality of research training. Publication in indexed journals emerged as a key indicator, given that it offered a seemingly universal measure of productivity, visibility, and peer review. Consequently, educational institutions incorporated the requirement of having at least one published or accepted article as a condition for thesis defense.

Thus, the publication requirement for doctoral degrees ceased to be perceived as an external complement to training, becoming a structural component of it, reshaping expectations about the doctoral candidate, completion deadlines, and the relationship with thesis supervisors.

From this analysis, a third trend emerges: formalization and institutionalization. The postwar boom in scientific production and the development of bibliometric tools transformed publication into a quality indicator. This process led universities to explicitly incorporate the requirement into doctoral regulations, laying the groundwork for future compendium thesis models and establishing a structural relationship between research training and editorial validation.

Globalization, homogenization and formative tension

The development of the*world Wide Web*The 1990s constituted the most disruptive change in the more than 350-year history of scientific publishing. This led to digital scientific journals becoming a reality by the end of the decade, around 1997, and consequently, a new gap emerged: the need for editorial management platforms.[16]

A significant milestone was the appearance of*Open Journal Systems*(OJS), launched in 2001 by the Public Knowledge Project, democratized access to an editorial management platform capable of editing, distributing, and archiving a publication online. This platform reduced the technical and financial barriers to creating new publishing houses. This new publishing system—digital publishing—coexisted with print publishing, which gradually lost ground and is now almost nonexistent or complementary to digital publishing.[16]

Digitization not only transformed editorial workflows but also profoundly reshaped doctoral training. The availability of platforms such as Open Journal Systems, institutional repositories, and online bibliographic managers altered the competencies required of doctoral students, who now had to master not only substantive research but also skills in digital scientific communication, author identity management (ORCID, ResearchGate), and an understanding of alternative metrics. In parallel, universities began incorporating workshops on scientific writing, open access publishing, and strategies for navigating an increasingly competitive publishing ecosystem into their doctoral programs.

This has transformed the requirements for publication during doctoral training. The goal, as in the previous period, is not only to publish, but also to ensure that the results are made visible through high-impact scientific journals indexed in databases such as Scopus or the Web of Science.

While the emergence of OJS and other editorial management systems democratized scientific publishing, it also accelerated publishing times. Models such as continuous publication replaced the traditional structure of volumes and issues, reducing the time between acceptance and dissemination of knowledge.[17] For the doctoral student, this immediacy meant a narrower window of visibility, and also demanded synchronizing the rhythms of their research with the accelerated publishing cycles.

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In parallel, the open science movement—which promotes free access to publications, data, and evaluation processes[18]—introduced new training requirements. Initiatives such as the*Scientific Electronic Library Online*(SciELO), created in 1997 in Brazil, demonstrated that it was possible to build regional platforms for scientific visibility,[19] but the predominance of the business model based on article processing charges (APCs) shifted costs onto the authors,[20,21] creating a new barrier for doctoral students with limited funding. Similarly, emerging practices such as open peer review[22,23] began to demand from doctoral students not only skills as authors, but also as more critical and exposed evaluators.

This context of modernization and hyper-accessibility consolidated scientific publication not only as a degree requirement, but as a central component of academic capital, essential for the doctoral student's professional integration. The doctoral experience was profoundly affected: on the one hand, early integration into disciplinary debates was facilitated, and valuable credentials for the job market were generated; on the other hand, the pressure to publish in indexed journals with accelerated timelines sometimes incentivized the choice of low-risk topics, the fragmentation of results, or the use of predatory journals, to the detriment of innovative and risky approaches.[24]

Institutional responses to these tensions have been heterogeneous. Some universities delved deeper into models of metric productivity; others, on the other hand, implemented safeguards to protect holistic education: limits on the number of required publications, inclusion of non-publishable training components in the requirements, or the strengthening of monitoring committees that evaluate the coherence between productivity and research development.

From this stage emerges a fourth trend: the globalization of the scientific publication requirement for doctoral degrees, and the resulting tension within the scientific ecosystem. Digitalization and global rankings have progressively homogenized doctoral models toward the Anglo-Saxon standard, based on the accumulation of quantifiable academic capital through publications.

Final considerations

The evolution of scientific publication as a doctoral requirement reveals a trajectory of intertwined transformations, influenced by academic, political, and economic factors. Establishing scientific publication as a requirement for doctoral degrees is not merely a technical-pedagogical development, but rather the objective reflection of profound changes in the nature of research, its communication, and its evaluation in contemporary society.

Based on the previous data, a group of macro trends were identified:

1. From dissociation to symbiosis: from two separate institutions (thesis vs. journals) to a symbiotic relationship where the second validates the first.
2. Progressive formalization and institutionalization: the transition from an informal practice to explicit regulations, with indicators of quantity, quality and impact.
3. Disciplinary expansion and globalization: the extension of the requirement from doctoral degrees in the "hard" sciences to the Social Sciences and Humanities, driven by the homogenization of global evaluation criteria.
4. From publication as a requirement to the tension over productivity: the growing pressure to publish created an inherent conflict between the need to generate credentials for the market and the ideal of deep research training.

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CONCLUSIONS

Analysis of international trends shows that scientific publication as a doctoral requirement has evolved from a nonexistent or informal practice to a globalized institutional requirement. This process was driven by the formalization of science, the postwar surge in research output, and the subsequent classification of knowledge. As a result, a symbiotic model has been consolidated where publication validates the dissertation, systematically and systematically generating a relationship between the researcher's comprehensive training and the production of quantifiable academic capital.

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