





## Paradigms in the teaching of contemporary science: unconscious fetters?

### Paradigmas no ensino da ciência contemporânea: grilhões inconscientes?

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#### ABSTRACT

Advances in technology have changed many aspects of communication, and that includes the scientific milieu. The format of content presentation, dissemination, availability and speed of sharing are examples of the discrepancy between the old model of dissemination of scientific information and the current one. However, the way of teaching scientific research in higher education (which permeates from scientific initiation to doctorate) still cultivates retrograde ideas that make it difficult to actually learn about the needs to do and transmit science with quality. The purpose of this article is to question some of the mistakes in the teaching of research and scientific writing. After all, the repercussions of such aspects can present themselves as barriers to learning and/or keep authors away from the publication of their studies. So, if developing science and building a scientifically literate society is really a purpose, we need to review the way we teach research.

**Keywords:** education; scientific production indicators; scientific communication and dissemination

#### RESUMO

Avanços na tecnologia modificaram diversos aspectos da comunicação, e isso inclui o meio científico. O formato de apresentação do conteúdo, divulgação, disponibilidade e velocidade de compartilhamento são exemplos da discrepância entre o antigo modelo de disseminação das informações científicas e o atual. No entanto, a forma de ensinar a pesquisa científica no ensino superior (que permeia desde a iniciação científica até o doutorado) ainda cultiva ideias retrógradas que dificultam o real aprendizado sobre as necessidades para fazer e transmitir ciência com qualidade. O objetivo desse artigo é questionar alguns dos equívocos no ensino da pesquisa e da escrita científica. Afinal, as repercussões de tais aspectos podem se apresentar como barreiras para o aprendizado e/ou afasta os autores da publicação dos seus estudos. Portanto, se o desenvolvimento da ciência e a construção de uma sociedade cientificamente alfabetizada é realmente um propósito, precisamos rever a forma como ensinamos pesquisa.

**Palavras-chave:** educação; indicadores de produção científica; comunicação e divulgação científica

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## Introduction

Contemporary science still experiences a mismatch between teaching and the real demands of the scientific community, where a paradoxical cycle feeds back and impedes the real effectiveness of research teaching. Crucial points such as scientific communication went through intense changes influenced by technology, which allowed the advancement of science dissemination and changed the way of reporting research results aiming the reader's attention, however, research teaching still follows some anachronisms.

This document aims to present some of the mismatches between academic teaching on research and the requirements of journals and, finally, to propose measures that improve the teaching and learning process in research, making the scientific environment more attractive to academics and professionals.

### *The influence of technology*

Technological advances have allowed us to migrate from a system of knowledge exchange mediated by letters, to a model of real-time information sharing [1]. This change allowed for greater dissemination of scientific content, now available and easily accessible to non-specialized audiences. Added to this are the facilities for sharing data and conducting research, increasingly arousing the interest of new researchers, who started to contribute to the scientific literature.

To get an idea of the advance in the number of publications over time, when performing a quick search via PubMed in the National Library of Medicine of the United States, for the term "Health", we found approximately 4.9 million results since the year 1782, of which, at least 3.8 million have been published since the 2000s [2]. Although the numbers described do not specifically reflect the quality of scientific production [3] and they need careful evaluation, there is an increase in worldwide involvement with research.

Easy access to scientific literature through smartphones facilitates learning and problem solving [4]. However, the high number of publications available each day on the same topic can impair the proper filtering and selection of information, which requires substantial knowledge for the reader to evaluate scientific research [5], and strategies [6] loyalty by the periodicals.

Changes in the technology and information scenario directly influence the way magazines disseminate their content, such as availability on websites at the expense of print placement; development of applications to provide immediate access to journal issues and even the creation of podcasts with scientific debate. In addition, there was an increase in the speed of availability of works for reading through publication in aheads of print, as an alternative that allows for a balance between the peer review procedure and the rapid availability for the community [7].

It is also necessary to recognize that aspects, formerly linked to the dissemination of computer software, are now part of the construction of the brand (scienti-

fic magazine) and its product (scientific document). As an example, we can mention the user interface (UI) and user experience (UE), which basically represent the way the content is presented to the user (dimensions, colors, typography, elements such as tables, figures) and what is the experience lived by the user, even when in possession of the product (Is it enjoyable? Does he feel motivated to stay on the platform? Does it meet your expectations?) [8].

Another point made more flexible by the digital age is the possibility of adding a greater number of images to scientific articles. Initially, due to the costs involved in printing the article, the number of figures was limited and, currently, according to the study design, authors are encouraged to present figures that facilitate the understanding of the content or even the dissemination of their research in the social media [6,9]. In a context with a growing number of journals providing information with the same theme, aspects related to the quality of information and publishing may be part of the reader's choice criteria.

### **Research teaching: how are we currently?**

Master's and doctoral programs aim to turn students into researchers. For this, a period of 2 to 4 years is necessary for each of these stages and the presentation of a dissertation or thesis as a final product. However, it is not uncommon for professionals who participated in strictu sensu graduate courses often present as scientific production only the documents generated during the program. Judging by the purpose of the program, which is the training of independent scientists, the ideal would be the existence of periodic reassessments on the existence and quality of these scientific productions [10]. We understand that the excessive charge for publications does not necessarily imply quality work, however, the absence of future contributions represents a social burden.

The evaluations of graduate programs are made based on the quantity and level of scientific production, and in 2018 an update was proposed in the evaluation criteria capable of encompassing qualitative aspects involving participants and graduates of each program, however, not yet were implemented [11]. Therefore, considering the current metrics, little production and low scientific quality represent risks for institutions, which may lose the right to keep graduate programs in operation. Therefore, this is a joint responsibility, of the student and the institution. Furthermore, the growth of any field of activity depends on scientific production, which leads us to reflect on the amount of professional dedication dedicated exclusively to research and how the organization of our socio-political system makes this growth difficult.

Protect Time, as it is called, refers to the percentage of working hours financed so that professionals can dedicate themselves to production and learning about research, such as participation in scientific events [12]. Although the Brazilian reality deviates from the values of 70-80% of the workload of dedication to research,

we must adapt them to our context, striving to maintain their existence, even in the absence of external sponsorship. We know it is not easy, but this seems to be the way to strengthen professional qualification.

The research by Park *et al.* [13] shows us that among the barriers encountered by physical therapists in the application of scientific knowledge are the time for reading and the autonomy to change protocols. If we think of the intensive care physical therapist, for example, we will have many professionals working in different institutions with almost exclusively practical demands. In this situation, the Herculean effort to add 1 hour of study/day, even far from the ideal 70%, contemplates the equivalent of a graduate degree (365 hours) per year, with direct effects on evidence-based decision making and quality of care. Involvement with research will promote greater mastery of updated knowledge and will empower professionals, making them capable of discussing the best strategies with other professionals and managers of the health system. At this point, reading materials that support rationality for decision making is fundamental [14].

On the other hand, we have the contact of undergraduate students with scientific research, whether due to mandatory training or through participation in scientific initiation programs. The research conducted by Riggs *et al.* [15] draws our attention to the following point: Academics who reach the first scientific publication during their undergraduate course have a higher level of scientific production after graduation, even before the doctorate. Certainly, favoring the engagement of academics with scientific research will bring benefits to the profession, not only due to the increase in scientific production, but also due to the technical qualification and development of the capacity to use evidence to obtain the best results in clinical practice.

But, how to provide this experience to the student if, despite the title, the professor of subjects related to research is not always an active researcher? Studies have repeatedly pointed out the importance of teaching quality for learning and part of this requirement comes from the involvement with the area in which it is proposed to teach [16].

The failure to teach research may be even more profound. When we challenge higher education academics about their experience with research during their undergraduate course, they often report that the scientific process is taught in a boring and unnecessarily bureaucratic way, which reduces the interest of this group. For example, it is not known when it appeared, but the idea of many pages to justify the importance of a content is still present and is not restricted to the scientific environment. Society still shares the retrograde thinking responsible for giving greater value to long arguments vs objective answers; planning with numerous procedures (sometimes unnecessary) vs planning aimed at solving the problem; theses with greater thickness vs article with smaller number of pages [6]. We must ask ourselves: which option satisfactorily meets our demand? and the answer will guide the choice.

If we think about the number of activities performed by health professionals and the need to make quick and well-informed decisions, the text that is too long will probably not be part of their preferences. However, this is still one of the main requirements that we observe in the thesis and dissertation evaluation boards. We emphasize that there are no problems with the requirements for adding content to scientific texts so that they can better express a thought, but the search for page numbers as a rule is based on an empty and unnecessary argumentation. This type of requirement is present from basic education to postgraduate programs [6]. Regarding the latter, the paradox of the need for content is established when requesting the addition of pages to a thesis, when, at the end of the defense for the title, the author is obliged to shred all the content to adapt it to the norms of a journal, which, would normally not accept it with more than half the original content. At this point, another question arises: if we want to train researchers, why not teach them and demand them according to the metrics that really imply in the construction of good research?

Perhaps for this reason, so many masters and doctors do not follow up with their own research after acquiring their respective titles. Perhaps, this is one of the factors that influence the population's view of science as something complex and difficult to appropriate. If we think that this process can be facilitated without harming scientific integrity, then we find the answer to bringing professionals and academics closer to research production.

When thinking about the teaching of writing, some rules that should have been buried by time still exist and oppose the author's freedom of creation. One example is the need for impartiality and impersonality in writing [6]. In the first case, when defending a point of view, absolute impartiality will already be compromised [6]. As for impersonality, from the author's point of view, we believe that the argument must be transparent, bluntly or strategies to make up one's thoughts amidst the ocean of knowledge. Thus, the reader will also benefit from realizing which extrapolations are the author's thoughts, whether they are supported or not by the research findings.

The contradiction extends to the aversion to the use of personal pronouns in the first person singular or plural [6]. Such incongruity amounts to the imposition of using the 3rd person to report their own findings, but what is the meaning? These and other ideas are perpetrated in research teaching, and we realize that although scientific thinking has evolved and we defend skeptical thinking, we still carry and pass on beliefs. Let's look at the following example:

A research group, of which I am a part, found higher plasma renin values in women using combined oral contraceptives. According to the requirements of impersonality in the scientific text, we must report as follows:

- The study by Oliveira *et al.* [17] found elevated plasma renin values in women using combined oral contraceptives.

**The form of personal writing would be:**

- Our research group found elevated plasma renin values in women using combined oral contraceptives [17].

The second form of presentation does not change the meaning of the sentence and even allows credit to be given directly to the person who writes and to the group that carried out the research. This trend can be observed in the publications of the largest journals in the world [18], however, we still find this obstacle in undergraduate and graduate teaching.

## Scientific journals

To understand the dichotomy between teaching and the dissemination of science, it is necessary to be aware of the following point: research is still consumed after its publication. Before that, projects, course conclusion works, dissertations and theses have almost zero value from a scientific point of view, since they will be consumed after their publication in the form of articles.

When observing the publication norms of a scientific journal, we verified aspects such as the limitation of references, images (with a suggestion of the minimum number), tables and words. And, in the absence of limitation described in the submission rules for the number of words, they appear in the form of reviewers' comments for adequacy of the manuscript, and this is, again, related to the influences of the dispute process for the reader's attention. These basic points are recommended for the publication of scientific articles, for which the researcher's ability to synthesize and deepen the content is increasingly required.

## Is it time to change?

Establishing quality communication, as well as taking care of the procedures for the construction and execution of the scientific method, is an obligation of the researcher. The clarity, objectivity and even the aesthetics of the presentations have helped in the promotion of scientific articles, therefore, it is up to researchers to dedicate more time to learning the art of communication. As for educational institutions, behavior change is crucial for advances in research and we risk raising the point that not only the number of annual publications, but also the interest of professionals and academics in science will grow exponentially when we get rid of the unfounded bureaucracies in the teaching of contemporary research.

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