

Thematic Article

Thoughts on open science, or new trends in publishing the results of pedagogical research

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Recommended citation:

Benedek, A. (2026). Thoughts on open science, or new trends in publishing the results of pedagogical research. *Central European Journal of Educational Research*, 8(1), 6–12. <https://doi.org/10.37441/cej/2026/8/1/16993>

Abstract

The radical transformation of education over the past quarter-century, especially accelerated by COVID-19, has raised significant challenges and opportunities for both pedagogical theory and practice. This article examines how the landscape of publishing scientific research—particularly in education—has evolved in response to these changes. Reflecting on more than fifty years in educational research, I explore how digital transformation and Open Science now shape scientific communication and publishing. The introduction reviews the early impulses that shape the theoretical background. It explores new communication forms arising from infocommunication (Katz et al., 2021). Examples show a paradigm shift, demonstrating how scientific communication has adopted online practices. The article highlights conceptual frameworks, spatial and methodological changes in communication, and new ways of sharing research (Nyíri, 2007). It emphasizes the expansion of publication spaces. These changes show that pedagogy researchers must address new issues.

Keywords: open science; educational research; online communication; publication

Introduction

Methodologically, this essay adopts an educational science lens to analyze how interdisciplinary approaches can address the profound and current challenges in scientific communication. With a specific focus on how generations born in the latter half of the 20th century now engage with redefining and disseminating knowledge, I position the article to argue that evolving models of communication require new frameworks for pedagogical scholarship.

My scientific career has centered on the theory of education within the shifting context of technological and social progress. The dawn of the 21st century marked a turning point—personally and professionally—when digital transformation began to reshape not only how education is delivered but also how research is communicated. I argue that the principle of Open Science, advocating for transparency, reproducibility, and broad knowledge sharing, has only recently taken root in educational science. This shift, driven by the digital age, introduces both opportunities and challenges for building a more open, collaborative scientific community.

On the theoretical background - early impulses

When we analyze changes in pedagogical thinking, it is clear that both theory and practice in human development have undergone significant shifts, especially since the mid-20th century and, more recently, in the early 21st century. One major influence was Eco's essay "Opera Aperta" (1962). The author, who also wrote famous historical novels, influenced scientific thinking during the second half of the 20th century. The model of the open work is like a vast, open information system. This helped science and art move toward open access to results. Open Access, once just an idea, became reality and libraries led the way in this process.

The quick adoption of Information and Communication technologies has radically advanced openness, information access, and knowledge sharing. This transformation—visible in the rise of mobile phones and the uptake of networked communication—has helped make Open Science a reality, profoundly affecting how

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scientific research in education and other fields is published and disseminated. The article argues that this paradigm shift demands an active reassessment of research communication practices.

In the late 20th century, Umberto Eco's book "How to Write a Thesis?" (1977, originally in Italian) became an important guide for higher education students. Eco's book was practical but also reflected the spirit of its time. It came before the European 'Bologna Process,' which introduced a two-stage higher education system. Eco examined writing at a crucial time, but the book is now outdated in its technological advice. Later developments—such as mobile phones, supercomputers, and cloud services—transformed everything.

Paradigm shift in the scientific communication space – new publication practice

The process of scientific communication underwent an epochal change immediately after the millennium. Landmark initiatives such as the Budapest Open Access Initiative (2002), the Berlin Declaration (2003), and the Bethesda Statement (2003) were foundational in defining and advancing Open Science. These initiatives argue for unrestricted access to scientific knowledge and stress that libraries and publishers play a crucial role in this transition. My central argument is that such community-driven commitments have set the framework for current debates and practices in publishing educational research.

The documents illustrating the shift in communication strategy have provided important orientation for the modern understanding of Open Access, interpreting the processes of change initiated by the Internet world and drawing attention to the new contexts associated with the publication of scientific research results: A complete version of the work and all supplemental materials, including a copy of the permission, in an appropriate standard electronic format is deposited (and thus published) in at least one online repository using suitable technical standards. It is supported and maintained by an academic institution, scholarly society, government agency, or other well-established organization that seeks to enable open access, unrestricted distribution, interoperability, and long-term archiving (Berlin Declaration, 2003).

The documents referred to reflect the significant changes taking place in our present, which have radically transformed the practice of publishing the results of scientific research in an environment that carries Open Science and new electronic network possibilities. Responding directly to new trends in a progressive manner, in 2007 the Frontiers publishing house was established at the Swiss Federal Institute of Technology (EPFL) in Lausanne, Switzerland, on the initiative of neuroscientists Henry Markram and Kamila Markram, as a non-profit foundation to illustrate how the Open Science principle can be applied in practice. Consistently applying the requirements of Open Access, Frontiers, which has the most modern IT background, currently has 228 periodicals, and its archive contains 635 thousand scientific publications, which are used by about 3 million researchers.

Educational science research always offers a good opportunity for multidisciplinary analyses, but national online applications are less suitable for illustrating the effects of Open Science. Therefore, it is worth considering an analysis of international publication trends. During my investigation, I considered the English-speaking area relevant and selected three widely used online publication databases that allow comparison to illustrate the trends. The newest of these is the aforementioned Frontier. The online database of Springer, which organizes 2,900 periodicals and about 300,000 scientific books, and the online database of the Taylor & Francis publishing group, which organizes 4,709,000 peer-reviewed scientific works, have a significant history, and based on their data, we undertook a thematic analysis of the connections between educational research publications and the Open Science topic. These significant service providers in international scientific communication were among the first to switch to open-access services, so obtaining comparative data was feasible within the online information framework. The question was formulated as: in what order of magnitude and dynamics do the above topics appear in the examined period (2007-2025), especially in the last decade?

The literature on the topic was analyzed using the Systematic Quantitative Literature Review (SQLR) method (Pickering & Byrne, 2014). Although many new, electronically available professional studies and analyses have appeared on this topic in the past two decades, and the SQLR methodology has only been developed in recent years, this procedure allows the analysis of literature sources to be carried out in steps that allow the delimitation of the topic, the dynamics and reference value of the appearance, and the selection of relevant sources. In advance, the topic was designated, the research topic was defined, relevant keywords were generated, and reference publications were selected in accordance with the basic steps of the SQLR methodology. The study's analysis confirmed the assumption that the number of new publications in internationally prominent, indexed journals, analyzed using key terms (Open Science, Education, Education Research) in recent years, has increased significantly.

- The first step was selecting keywords, during which it was advisable not to designate too narrow conceptual areas. Since more than 95 percent of the literature sources are in English in the three selected international databases, the analysis was carried out according to thematic key terms – Open Science (OS), Educational Research (ER), and the publications that make up the common set of ER&OS.
- The analysis was carried out using data from 2007-2025. The beginning of the interval was justified by the magnitude of the publications, which is several hundred, and the establishment of Frontiers. The last year of the interval is 2025 due to the complete annual data provision.

Table 1. Number of scientific articles published between 2007 and 2025 according to the key terms searched in the examined online publishing databases

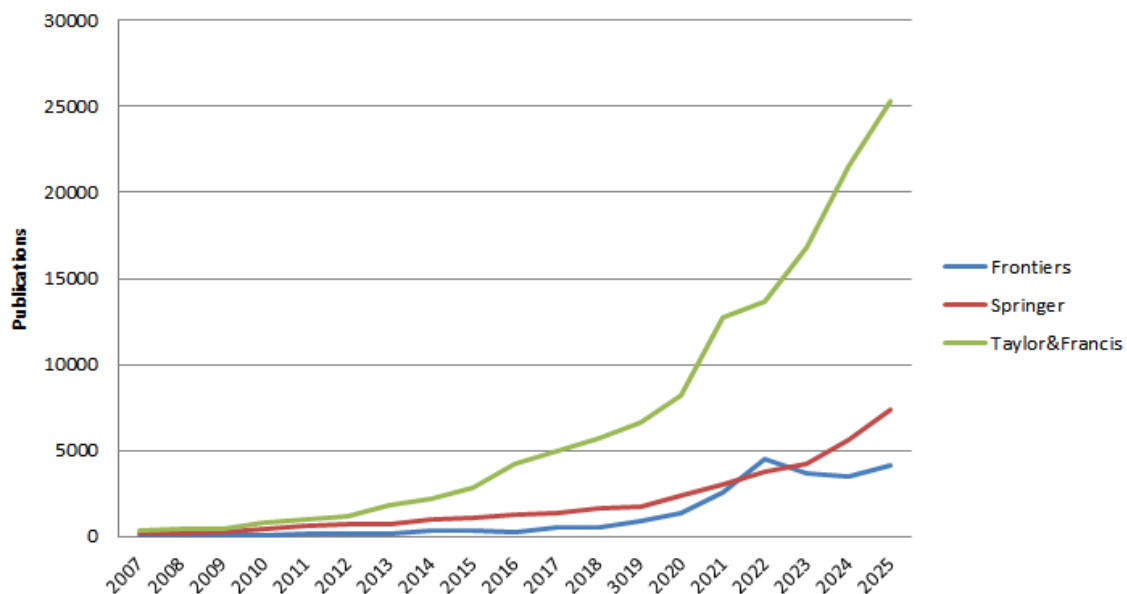
Keywords/Publishers	Frontiers	Springer	Taylor&Francis
Education Research (ER)	57540	258867	219490
Open Science (OS)	29725	121305	238651
ER&OS	24580	37371	138211

According to the data presented in Table 1, the primary search returned several thousand publications using key terms; therefore, it is justified to narrow the analysis to the set of key terms. The 86 and 118-item reference lists thus obtained in the two databases may already meet the more differentiated aspects of the further analysis.

Some correlations that indicate the dynamics of change: by 2010, the number of publications published within the given publishing framework in the ER&OS topic exceeded 100. This number increased almost 10-fold by 2020 to 11892, then doubled the following year, increasing by 20 percent annually in recent years. Figure 1 graphically illustrates changes in the data from the three publishing databases, showing the dynamics of increases in the number of publications on a given topic.

After this, a more differentiated processing of the literature sources and the creation of thematic databases may be possible. In connection with this paper, in order to illustrate the dynamics of the change, the number of publications with the given key terms and ER&OS keywords per publisher (2007-2025) has changed as follows, Figure 1. These data are graphically presented in Figure 1, which shows the significant dynamics of the process, with growth in the common thematic set of educational research publications and Open Science.

Figure 1. Scientific publications in the topics of educational research and Open Science in journals published by Frontiers, Springer, and Taylor & Francis between 2007 and 2025



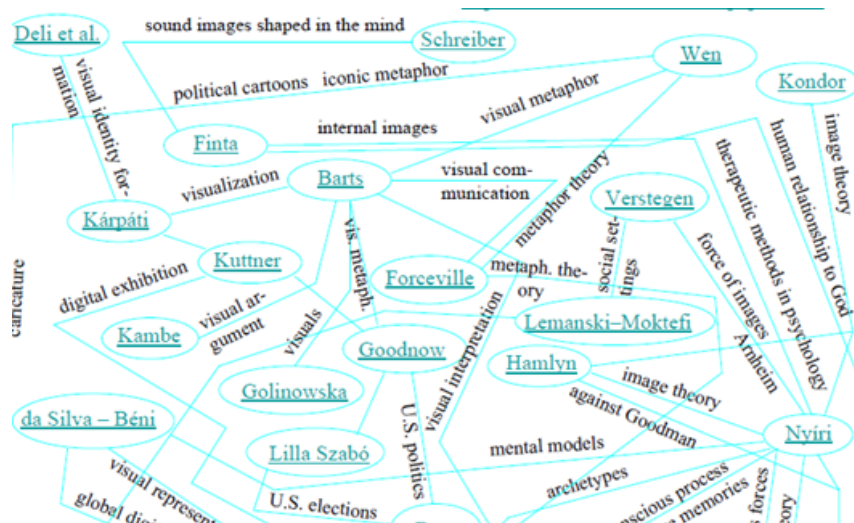
The qualitative consequences of the indicated dynamic change can be the subject of a separate analysis, but it can be stated that we are witnessing a transformation in the publication practices of scientific publications in our decade, clearly indicating that a paradigm shift is taking place in the international communication space for scientific results. Although we have presumably not yet undertaken a detailed description of the new paradigm, due to the complexity of the process, it is nevertheless noticeable that we are witnessing global changes today.

Examples of new forms of communication and methodological development

The acceleration of technological development in the 21st century, the online space, and the emergence of virtual challenges, especially artificial intelligence (AI), are changing our thinking about pedagogy on an everyday level. Our learning habits are undergoing a radical transformation, and the scientific interpretation of this process requires new approaches. The first example cited in this article is the process of publishing the results of the Visual Learning Lab (VLL), which can be considered a significant science communication experiment in its international context over the past decade and a half. The VLL was established at BME in October 2009, and at its monthly events, lectures by significant international figures in science (Özséb Horányi, Theo Hug, James Katz, Alen Knox, Kristóf Nyíri, Kurt Rütgers, Barry Smith) demonstrated the multidisciplinary nature of visual learning.

A new phase of the process began in December 2010, when the first international Visual Learning Conference was held in Budapest, and a selection of the materials from which was published in 2011 by Peter Lang Publishing (Benedek & Nyíri, 2011). Subsequently, 6 more volumes were published through 2017, documenting the scientific communication that occurred between traditional face-to-face laboratory meetings and international conferences. This example also illustrates the typical connection between the development of conference topics and the organization of communication. The scientific communication process between 2010 and 2024 was thoroughly documented through conference sequels and the three-volume summary study, which illustrate the analysis of philosophical, psychological, and pedagogical scientific questions related to imagery. In connection with all this, illustrating the impact of the online world and the social communication space that were still typical of the early 21st century, a summary conference, which is now of symbolic significance, took place in 2019 in Budapest at the headquarters of the Hungarian Academy of Sciences (MTA). Subsequently, the most significant was the three-volume synthesis of the past decade, published jointly by the MTA and BME, with the title *Perspectives on Visual Learning*, reflecting the realization of a scientific mission. The first volume of the trilogy is titled *Vision Fulfilled. The Victory of the Pictorial Turn*. The second volume, entitled *Learning and Technology in Historical Perspective*, was about the significance of the online world and the impact of virtual opportunities on education. The third volume, entitled *Image and Metaphor in the New Century* (Benedek & Nyíri, 2019), analyzed the 21st-century perspectives of the role of imagery.

In our world, which was initially beautifully documented only through traditional publications but is increasingly confronted with the spread of the online world, the change has been clearly noticeable since 2020. In November 2020, the 9th Budapest Visual Learning Conference was forced to go virtual. The publication of topics and authors (about 40 presentations) in a visual network, and the visibility of abstracts and thematic networks thanks to hypertext, represented in Figure 2. an innovation that has since become widely used in international scientific communication, with its many advantages and disadvantages (Aczél, Benedek & Nyíri, 2020).

Figure 2. Illustration from “How Images Behave”, abstract volume 9 of the Visual Learning Conference

Source: Aczél, Benedek & Nyíri, 2020

The “visual turn” in education over the past quarter century was based on the realization that adding multimedia elements to the curriculum – images, animations, sound – makes it easier to review large amounts of complex data. In today’s world, it is now clear that visual representation facilitates learning across disciplines. This theoretical recognition has had a significant impact on practice since the new mobile communication tool systems (mobile phones, broadband internet services, instant access cloud services, huge server capacities, and high-performance (quantum) supercomputers) made technological support more significant than ever before available to individuals in a “space” that combines reality with virtual elements.

The second example, which my article refers to, is the project related to the professional dissemination of the Visual Learning Workshop (BME VLL), established within the framework of BME², which was implemented within the MTA Subject-Pedagogical Research Program between 2017 and 2022. This project focused on the creation of visual content within the framework of online collaborative curriculum development. During open online content development, the introduction of curriculum units as networkable micro-contents, as a curriculum development procedure (Sun et al., 2020), was given a prominent role.

Referring to the events of the past quarter century, the emergence of online technologies and the transformation of teaching and learning into virtual space have fundamentally transformed the reality of education. If we undertake internal segmentation, then between 2005 and 2010, a “conceptual awakening” to connectivism, a learning theory approach, occurred (Siemens, 2005). LMS (Learning Management System) systems and cloud-based services have become widespread in higher education, and interactive-collaborative learning (ICL) has gained increasing ground in the world of classrooms, and in vocational training, project-based education, and training combining theory and practice.

Within the framework of this global process, the project results of the MTA-BME Open Content Development in the Vocational Training Research Group, implemented between 2016 and 2021, explicitly demonstrate the possibility of publishing and practically applying scientific results on online platforms. The online platforms created within the project³ provide a classic open, collaborative online interface for publishing development results and new local, individual professional development results.

In accordance with the specificities of Hungarian vocational training, the project undertook to develop methodological training in complex school subjects. The primary goal of the research is to support the content development applied in vocational training, which is significantly outdated, while at the same time striving towards a new digital environment through traditional teaching materials with modern methodology. These goals were related to the current modernization of professional teacher training, in the process of which the demand for digital education based on the application of info-communication technologies appeared. The theoretical background of the research was digital pedagogy, based on the connectivist learning theory approach in Hungarian professional teacher training and introduced in the 2010s (Benedek & Horváth Cz., 2016; Hod et al., 2019; Szűts, 2020), on which specific experiments in online collaborative learning were already taking

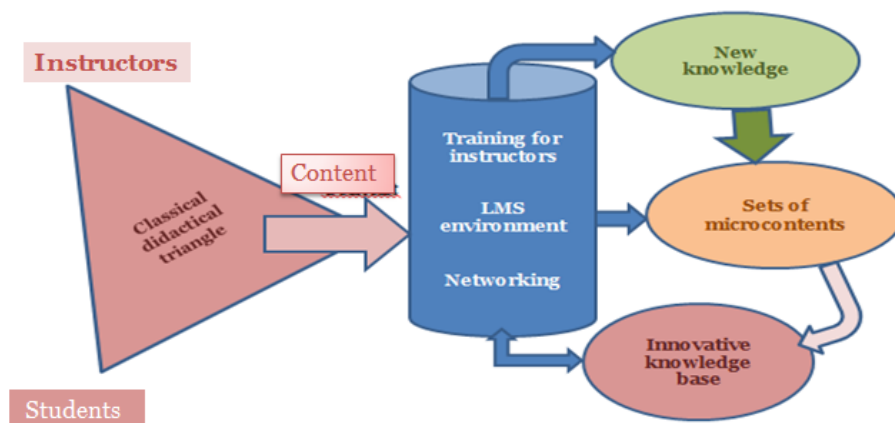
² Project website: <https://www.oed.bme.hu/>

³ Mikropedia: www.mikropedia.hu, Sysbook: sysbook.sztaki.hu

shape in the years before COVID-19. New methodological solutions – such as online content development and the creation of thematic sets of micro-contents related to learning units – have been integrated into teacher training practice in recent years.

The exemplary value of this research lies in the rapid introduction of the Open Content Development approach in vocational training and higher education. Our project considered the curriculum units of our micro-content repository, developed in online collaborative frameworks between 2018 and 2024, as a representative set. We sought to answer the question of what patterns and methodological characteristics the new set of learning units that emerged from online collaborative activity shows. Related to this was the question of what development opportunities can be explored from the interconnectivity of micro-contents, and how the addition and functional expansion of a given micro-content can be interpreted as a development task. The other goal is to open up the possibility of shared data storage by creating repositories that provide open access to micro-content developed and uploaded by different developers, which allows for a variable solution of the connections between learning units, and thus, in a system that is differentiated locally, also by developers, by connecting content elements to each other, new networks can be created, and thus new quality can be created. Figure 3 shows the interrelation between the main contributors by the classical didactical triangle and functional elements of the Open Content Development Model introduced into the vocational education practice.

Figure 3. Factors and effects in the Open Content Development Model



Due to the nature of the effects between educational factors and actors, the research and development required the application of a complex methodology, from which this analysis highlights the consistent application of the Open Science approach, which is particularly important in the implementation phase, as reflected in the communication sources, channels, and new professional portals related to the project. The strong implementation of the Open Access principle in scientific communication also has a noticeable longer-term impact on the content of professional training, as illustrated by the results of the open curriculum development model (OCD - Open Content Development). Although the formal research concluded in 2022, dissemination is ongoing and successful, and the project's impact on the renewal of professional teacher training content is increasingly evident. The latest experiences of the project implementation show that the applied digital sources and repositories, which, thanks to Open Access solutions, effectively support micro-content-based developments from both thematic and methodological perspectives.

Instead of conclusions

Suggested form: Looking back on the past quarter century, the trajectory from early connectivist theory to today's AI-driven pedagogical challenges is clear. The LMS environments and interactive-collaborative learning methods that gradually took hold in higher education were further accelerated by COVID-19, ultimately creating the hybrid and hyflex learning contexts we now navigate.

This article uses a few examples to illustrate the emergence of Open Science in educational research within the broader Open Science framework, and, at the same time, examines international trends, noting that the change that has begun will affect our pedagogical thinking in even more complex ways in the future. The spread

of the online world and the series of unique impulses of virtual technical solutions have become a system of effects in which the transformation of our pedagogical thinking is necessary. Nowadays, the most intense discourse is taking place in the most complex way about the impact of artificial intelligence (AI), and this topic is also at the center of publication interest. Although one should be cautious in making predictions and interpreting their results, it is a fact that the change has a significant impact on the world of education, and the need for the publication and application of scientific research results, and the acceleration of the speed of information flow related to this, is undeniable.

Acknowledgement: I would like to briefly address why this article was written. The timing is definitely related to the significant anniversary of Professor Gabriella Pusztai, whose domestic and international work in educational science is not only outstanding, but her results, thematically, in their contexts and dynamics, excellently illustrate the process that has taken place in our domestic pedagogical thinking and scientific publication practice in the last two decades. The change in the theory of technology transfer and pedagogy, and in the practice of university education, is perfectly illustrated by the process associated with the emergence of open science and its becoming a general practice. However, this story is not nearly as processed as a whole and can even be considered a challenge that concerns many and requires individual and institutional responses. I wanted to modestly comment on this story, acknowledge and thank Professor Gabriella Pusztai for her significant initiatives in the renewal of scientific journals in the field, and join in the birthday congratulations.

We thank Johnathan Dabney for the English language editing.

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