Navigating the Digital ''Infodemic'': Scientific Communication, Openness, and Governance in the 21st Century

التعامل مع "وباء" المعلومات الرقمية: التواصل العلمي والانفتاح والحوكمة في القرن الحادي والعشرين



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Abstract:

This report examines the complex challenges and opportunities facing scientific and technical communication in the digital age. The report is structured around five core themes: the evolution of scientific information practices, the management of digital data and the role of artificial intelligence, the changing professional ethics of science communication, the influence of public policy and digital sovereignty, and a detailed case study of Algeria. It argues that while digitalization offers unprecedented opportunities for open access and global collaboration, it also exacerbates systemic issues such as misinformation, a "crisis of mediators," and the tension between open data and national sovereignty. The report concludes with recommendations aimed at fostering a more resilient and trustworthy scientific ecosystem.

key words: Scientific Communication; Digital Environment; Open Science; Misinformation; Digital Sovereignty.

الملخص

تتناول هذه الدراسة التحديات والفرص المعقدة التي تواجه التواصل العلمي والتقني في العصر الرقمي. ينظم التقرير حول خمسة محاور أساسية: تطور ممارسات المعلومات العلمية، وإدارة البيانات الرقمية ودور الذكاء الاصطناعي، والأخلاقيات المهنية المتغيرة للتواصل العلمي، وتأثير السياسة العامة والسيادة الرقمية، ودراسة حالة مفصلة عن الجزائر. يجادل التقرير بأنه على الرغم من أن الرقمنة تقدم فرصًا غير مسبوقة للوصول المفتوح والتعاون العالمي، فإنها تفاقم أيضًا قضايا نظامية مثل المعلومات المضللة، و"أزمة الوساطة"، والتوتر بين البيانات المفتوحة والسيادة الوطنية. يختتم التقرير بتقديم توصيات تهدف إلى تعزيز نظام علمي أكثر مرونة وجدارة بالثقة.

الكلمات المفتاحية :التواصل العلمي؛ البيئة الرقمية؛ العلوم المفتوحة؛ المعلومات المضللة؛ السيادة الرقمية.

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1. Introduction

The advent of the digital era has precipitated what can be described as "tectonic shifts" in the landscape of scientific and technical communication. The traditional, hierarchical model, in which knowledge flowed from the researcher to the public through professional intermediaries such as journalists, is being reconfigured. Digital platforms have democratized access and participation, allowing scientists, institutions, and the public to interact directly and with unprecedented speed. This profound transformation has lowered barriers to entry for both communicators and audiences, leading to a "pluralization of voices" and a rapid acceleration in the diffusion of scientific information.

This new communicative context is also fraught with challenges, including the widespread proliferation of misinformation and disinformation, which pose significant threats to public understanding and evidence-based decision-making. The report is situated within this dynamic environment, exploring how the fundamental nature of scientific communication has changed and what is at stake.

Importance and Objective

The objective of this study is to provide a holistic and nuanced analysis of the complex issues at the intersection of science, technology, and society in the digital age. It moves beyond a simplistic cause-and-effect narrative, seeking to illuminate the interconnected nature of these challenges and to propose a comprehensive framework for future action. The central importance of this subject lies in the fact that the credibility of science and its capacity to contribute to societal well-being are inextricably linked to the quality and integrity of its communication. This report synthesizes diverse academic perspectives—from open science and artificial intelligence ethics to national policy and a specific regional case study—to offer an integrated understanding of the current state.

Problem Statement

In a constantly evolving digital environment characterized by the rapid and unfiltered flow of information, how can the quality, integrity, accessibility, and ethics of scientific knowledge be ensured? What are the specific roles and responsibilities of key stakeholders—including researchers, academic institutions, media professionals, and policymakers—in structuring and leveraging this information for the public good? Furthermore, how do these global challenges manifest in the unique socio-political and institutional context of the Arab world, with a specific focus on the Algerian experience? The research seeks to answer these questions by examining the practices and policies

that define the present and will shape the future of scientific and technical communication.

Research Questions and Hypotheses

This report is guided by the following research questions:

1. How have new practices in producing, publishing, and accessing scientific information reshaped the digital environment?
2. What are the ethical and practical challenges in managing and utilizing scientific data, digital infrastructure, and AI-driven tools?
3. What are the evolving professional practices and ethical considerations for scientific communicators, particularly in combating misinformation?
4. How do public policies and legal frameworks define and govern scientific information and the concept of digital sovereignty?
5. What is the current state of scientific and technical communication in Algeria, and what are its challenges and future prospects?

Based on a preliminary review of the available literature, the following hypotheses are posited:

- **H1:** The adoption of Open Science practices, supported by robust digital infrastructure, is a necessary but insufficient condition for ensuring the quality and integrity of scientific information in a digital age.
- **H2:** The proliferation of scientific misinformation is a complex systemic issue, driven by a convergence of technological (algorithmic amplification), professional (waning fact-checking), and cultural (eroding trust) factors.
- **H3:** The effective governance of scientific information requires a delicate balance between promoting global open access and implementing policies that protect national digital sovereignty and data security.
- **H4:** Challenges to scientific communication in Algeria are not solely a product of the digital environment but are deeply rooted in longstanding institutional and infrastructural deficits.

Previous Studies

This report builds upon a body of research that has explored various facets of digital science communication. Prior studies have documented the failures of the "knowledge deficit model", which assumed that providing more information would automatically lead to greater public support for science. Research has also documented the rise of social media platforms as new channels for scientific discourse. This report distinguishes itself by providing a comprehensive, multi-thematic synthesis, linking seemingly disparate areas such as AI ethics, digital infrastructure, and national policy to a specific regional case study.

2. Transformation of Scientific Information in the Digital Environment: New Practices and Openness

2.1. Production and Dissemination in a Digital Age

The digital era has ushered in a new paradigm for the production and dissemination of scientific knowledge, moving away from a traditional, one-way "knowledge deficit model". This model, which was based on the premise that a lack of scientific literacy was the primary barrier to public support, has been largely discredited by a lack of consistent empirical evidence[1].

In its place, digital media has lowered participation barriers for both communicators and audiences, facilitating the direct engagement of scientists with the public without the involvement of traditional mediators. This new environment has led to a "pluralization of voices" in science communication, with platforms such as YouTube and Twitter increasing the visibility of scientists and their research. The speed and dynamics of information diffusion have been accelerated, allowing for both synchronous and asynchronous communication and the long-term storage of information for future use.

Digital tools have made learning about complex topics, such as sustainability, more interactive, flexible, and connected to real-world issues, thus playing an important role in helping people understand and adopt new practices[2].

A significant consequence of this shift is the emergence of a new challenge for public understanding. As scientists and institutions communicate directly, the public is exposed to the inherent nature of science as a "discourse" involving debate, questioning, and the evolution of knowledge over time. This is in contrast to the public's expectation for a singular, authoritative truth. When the public witnesses this scientific debate, it can be misinterpreted as a lack of consensus, potentially leading to mistrust in science itself.

The issue is not a failure of scientists to communicate but a potential deficit in the public's understanding of the scientific process. This phenomenon suggests that a new role for media and other intermediaries is required: one that translates not just the findings but also the process of scientific inquiry itself.

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[1] Dietram A. Scheufele. Science communication as political communication, journal of the National Academy of Sciences (NAS). Vol. 111, 2014, p. 13585-13592, https://doi.org/10.1073/pnas.1317516111

[2] Tin Shine Aung; Cláudia Faria; Joana Sousa; Mónica Mendes. Digital science communication for sustainability literacy: A scoping review. *Open Res Europe*, Vol. 5, p. 239, https://doi.org/10.12688/openreseurope.20966.1

The changing dynamic in science communication, as highlighted by the article, significantly alters the role of **traditional media and intermediaries**. Historically acting as essential gatekeepers, science journalists provided **accuracy and impartiality** by translating complex research for the public. However, the digital environment has led to a **"crisis of mediators"** and a **"pluralization of voices,"** allowing direct communication between scientists and the public. This bypass weakens media's traditional authority. The effectiveness of traditional intermediaries in combating misinformation is now challenged by two main factors: **waning fact-checking resources** due to financial pressures, and the need to **translate the scientific *process* (debate and uncertainty) rather than just the *findings***. Ultimately, their role must evolve from mere translation to **knowledge brokerage**, focusing on building **media literacy** and **critical thinking skills** among the audience to help them navigate the unfiltered digital infodemic.

2.2. The Open Science Revolution and its Pillars

The transformation of scientific communication is intrinsically linked to the Open Science movement. Open Science seeks to "further open up the entire research and publication process" beyond the traditional open access to publications[1]. This comprehensive approach is built upon a number of key pillars that aim to enhance transparency, reproducibility, and collaboration.

The most recognized pillar is **Open Access (OA)**, which provides for the "free, immediate, online availability of research outputs" with minimal restrictions on use. OA content, whether in fully open journals (Gold OA) or through archival in repositories after an embargo period (Green OA), has been shown to increase the citation and usage of articles[2].

Beyond open access, Open Science includes:

- **Open Data:** The principle that research data, including files and code, should be as "open as possible" to facilitate validation and replication of results.

[1] Open science, The *Royal Society*, Retrieved Sep. 9, 2025, https://royalsociety.org/journals/open-access/open-science/
[2] The fundamentals of open access and open research, *Springer Nature*, 2025, Retrieved Sep. 9, 2025, https://www.springernature.com/gp/open-science/about/the-fundamentals-of-open-access-and-open-research

Data repositories like Figshare and Mendeley Data are central to this practice, offering platforms where researchers can share and cite their data with unique DOIs.

- **Open Peer Review:** This practice makes reviewer reports and decision letters accessible alongside published articles. It is a means of ensuring the integrity of the academic record and enhancing the quality of published research[1].

- **Preprints:** These are versions of scientific manuscripts posted on public servers before formal peer review, offering a way to accelerate the communication of research findings[2].

- **Open Citations:** A collaboration that promotes the unrestricted availability of scholarly citation data, which enhances the discoverability of content and benefits individuals without institutional subscriptions to commercial databases[3].

- **Registered Reports:** A publishing format where methods and proposed analyses are peer-reviewed prior to data collection, enhancing the credibility of the research process and virtually guaranteeing publication if conditions are met[4].

These practices collectively promote a culture of collaboration and interdisciplinary conversation, enabling researchers to build on existing knowledge more quickly. The shift in focus to article-based metrics, such as those promoted by the Declaration on Research Assessment (DORA)[5]. also moves the evaluation of research away from the journal's impact factor to a more holistic assessment of its societal contribution.

The following table summarizes these key pillars of the Open Science movement.

[1] Carrie Figdor. (When) Is Science Reporting Ethical? The Case for Recognizing Shared Epistemic Responsibility in Science Journalism. Sec. Science and Environmental Communication, Vol. 2, no. 3, 2017. https://doi.org/10.3389/fcomm.2017.00003
[2] Open science, Op.cit.
[3] Ibid.
[4] Ibid.
[5] Open science, Op.cit.

Table 1: Key Pillars of Open Science and their Implications

Pillar	Definition	Significance in the Digital Age
Open Access (OA)	The free, immediate, online availability of research outputs with rights for full digital use.	Increases citation and usage; widens collaboration; enhances public engagement; ensures compliance with funding mandates.
Open Data	The sharing of research data, including files and code, to support publications and promote re-use.	Facilitates validation and replication of results; enhances scientific integrity; enables greater interdisciplinary conversation.
Open Peer Review	The public availability of reviewer reports and decision letters alongside published articles.	Increases the transparency of the review process; ensures the integrity of the academic record.
Preprints	The public posting of manuscript versions before formal peer review.	Accelerates the communication of research; allows researchers to claim priority for discoveries and receive early feedback.
Open Citations	The unrestricted availability of scholarly citation data.	Enhances the discoverability of published content and creates a global public web of linked knowledge.
Registered Reports	A publishing format where methods are peer-reviewed and accepted before data collection begins.	Increases the credibility of research findings and mitigates publication bias.

Source: Open science, Op.cit.

3. Management and Utilization of Scientific and Technical Information

3.1. Digital Infrastructure for Open Science

The implementation of open science practices requires a robust and resilient digital infrastructure. These infrastructures are not merely technical

products but are complex systems that embed a set of tools, institutions, and social norms. Successful digital infrastructures are often "durable and resilient," becoming an "integral part of routine research activities" to the point of being "invisible".Core components of this infrastructure include platforms for data sharing and management. Repositories like Figshare and Mendeley Data enable researchers to "store, share, [and] discover" their research, including non-traditional outputs and large datasets. A key feature of these platforms is the ability to assign unique Digital Object Identifiers (DOIs) to datasets, making them citable and ensuring they are part of the permanent scientific record.

This practice is increasingly being mandated by funding bodies and national policies to promote scientific and research integrity. University libraries have a pivotal role in this ecosystem, as they are responsible for creating and managing institutional repositories that facilitate access to academic research outputs[1].

Federated digital infrastructures, such as D4Science, are designed to enhance collaboration and data-driven discovery by integrating external systems and providing tailored, on-demand services to research communities. This collective approach to infrastructure development ensures that research outputs are "accessible, reusable, and transparent," contributing to a more inclusive and equitable scientific ecosystem[2].

3.2. Artificial Intelligence and Automated Information Processing

Artificial intelligence (AI) has emerged as a transformative force in scientific communication, with the potential to "revolutionize scientific publishing" by assisting at various stages of the process. AI-driven tools can analyze large datasets, identify trends, and generate hypotheses, significantly accelerating the research process. In publishing workflows, AI can assist with manuscript screening, peer review, and content generation, providing researchers with tools to organize information and even predict peer review outcomes[3].

The rapid adoption of AI presents a new layer of ethical and practical challenges. A fundamental concern is the phenomenon of "hallucinations,"

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[1] Ecaterina Scherlet. The role of the university library in promoting Open Science, Conference: Science and education: new approaches and perspectives, international scientific conference, 2024, p229-233. https://doi.org/10.46727/c.v4.21-22-03-2024.p229-233

[2] Research, D4Science, 2024, Retrieved Sep. 9, 2025. https://www.d4science.org/research

[3] Phillip Phan; Sonali Desai; Ezequiel Garcia Elorio; David Greenfield; Reece Hinchcliff; Usman Iqbal; Paul O'Connor; Anthony Staines; Rosa Sunol; Aziz Sheikh. Embracing the use of artificial intelligence in scientific publishing, *International Journal for Quality in Health Care*, Vol. 36, no. 3, 2024. https://doi.org/10.1093/intqhc/mzae071

where large language models (LLMs) generate "plausible-sounding" but factually incorrect information, including references to "non-existent articles" or incorrect attributions to real researchers. These hallucinations are considered an "inherent feature of LLM architectures" that cannot be completely eliminated, raising questions about the trustworthiness of AI-generated outputs without human oversight. The existence of these architectural flaws means that AI cannot replace the human "wisdom" and critical appraisal necessary for high-quality scholarship. The content generated by AI, while often "readable" and logical, can be superficial, lacking the synthesis and critical insight that characterizes human scholarship. This suggests that AI must be treated not as a substitute for human intellectual labor but as an augmentative tool. Its use requires rigorous human verification and transparent disclosure. Without these safeguards, AI has the potential to introduce a new and widespread form of misinformation directly into the scientific record, undermining the very integrity it is meant to support. The risk of AI-driven misinformation is particularly acute in health and policy-related domains, where false or missing information can have direct real-world consequences[1].

4. Professional Practices in Scientific Communication: Ethics and Misinformation

4.1. The Evolving Roles of Communicators

The digital environment has fundamentally altered the roles of scientific communicators. Historically, science journalists served as critical mediators, tasked with translating dense, jargon-filled research into a format accessible to the public[2]. Their role was to ensure accuracy and impartiality[3].

Digital platforms enable scientists and institutions to engage directly with the public, bypassing traditional journalistic channels. While this direct engagement offers opportunities for greater transparency and dialogue, many scientists have not been systematically trained for this role, expressing

[1] Ariel Yuhan Ong; David A Merle; Siegfried K Wagner; Pearse A Keane. Exploring the Dilemma of AI Use in Medical Research and Knowledge Synthesis: A Perspective on Deep Research Tools, *Journal of Medical Internet Research,* University College London (Jisc), Vol. 27, 2025, https://doi.org/10.2196/75666

[2] Maximilian Schäfer, Science journalism and fact checking, *Journal of Sciences Communication,* Vol. 10, no. 4, 2011. https://doi.org/10.22323/2.10040302

[3] Stuart Allan. Introduction: Science journalism in a digital age, Journalism Vol. 12, no. 7, p. 771-777, https://doi.org/10.1177/1464884911412688

uncertainty about how to effectively present their findings to a lay audience without sacrificing scientific correctness[1].

4.2. Combating the "Infodemic"

The proliferation of misinformation and disinformation has become a critical challenge. Misinformation is the unintentional spread of false information, while disinformation refers to the deliberate dissemination of falsehoods. Both contribute to what has been termed an "infodemic" in science communication. High-profile examples, such as anti-vaccine falsehoods and climate change denial narratives, pose "real threats to the health of millions of people and the protection of the environment"[2].

Several strategies have been proposed and tested to combat this issue:

- This is a rigorous process of verifying factual assertions against source materials. While it is a cornerstone of journalistic integrity, the practice has waned due to financial pressures on newsrooms, with staff fact-checker jobs shifting to freelance or disappearing entirely[3]. This decline in a crucial professional practice is not an accident but a systemic issue rooted in the economic vulnerabilities of the media industry in the digital age.
- Educational interventions that either "inoculate audiences against falsehoods before they encounter them" (prebunking) or "expose and correct false claims after they have spread" (debunking)[4].
- The problem of misinformation cannot be solved by a single group. Researchers and practitioners advocate for proactive collaboration between scientists, communicators, and journalists to improve the accuracy of information reaching the public. Strengthening critical thinking skills and media literacy in the general public is also considered a crucial strategy to help individuals discern credible information from false claims.

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[1] Nina Lorenzoni; Lára R. Hallsson; Magdalena Flatscher-Thöni; Lina Förster; Claudia Schusterschitz. Science communication during the COVID-19 pandemic: experiences, challenges and expectations from the perspective of scientists in Austria, *Frontiers, Sec. Disaster Communications,* Vol. 10, 2025. https://doi.org/10.3389/fcomm.2025.1519438

[2] Andrea Tomassi; Falegnami Andrea; Romano Elpidio. Disinformation in the Digital Age: Climate Change, Media Dynamics, and Strategies for Resilience, *Publications,* Vol. 13, no. 2, 2025, p. 24. https://doi.org/10.3390/publications13020024

[3] KSJ Staff. Checking in Science Journalism, *Knight Science Journalism,* Massachusetts Institute of Technology, 2018, Retrieved Sep. 9, 2025, https://www.moore.org/docs/default-source/default-document-library/fact-checking-in-science-journalism_mit-ksj.pdf?sfvrsn=a6346e0c_2

[4] Andrea Tomassi. Op.cit, p. 24.

4.3. Ethics and Scientific Integrity in a Digital World

Scientific integrity is a broad concept that encompasses a set of professional rules and best practices for scientists. It is defined by four main principles: reliability, honesty, respect, and accountability. In the digital age, integrity faces new challenges. While fabrication, falsification, and plagiarism are well-known forms of misconduct, the digital environment makes it easier for **Q**uestionable **R**esearch **P**ractices to occur and spread. QRPs are ambiguous and difficult to eliminate, existing on a continuum between fraud and carelessness.

A key strategy for enhancing scientific integrity in the digital age is the open sharing of scientific outputs—including data and code—as a means to "limit questionable research practices and to enhance reproducibility". By making data and analysis code publicly available, researchers enable others to independently validate their results or uncover problems in their analyses, a practice increasingly mandated by national and international codes of conduct[1].

The primary conflict of interest in today's scientific climate is often not financial but between the pursuit of "publishability" and the pursuit of "truth"[2]. Digitalization, with its pressures for rapid publication and high visibility, can exacerbate this conflict. Thus, the emphasis on transparency and open practices is paramount to ensuring that the scientific record remains robust and trustworthy.

The difference between misinformation (unintentional false information) and disinformation (deliberate falsehoods) poses severe real-world challenges in the wider Arab world, including Algeria. A key case study is the COVID-19 Infodemic. Misinformation was prevalent as social media users, driven by a desire to help, widely shared unproven home remedies or misinterpreted medical advice, leading to potential harm or delayed proper care. Conversely, disinformation was driven by organized anti-vaccine campaigns deliberately spreading fabricated narratives—such as claims that vaccines altered DNA or contained tracking chips—which were circulated extensively across Arab digital platforms. The real-world impact was significant vaccine hesitancy in countries like Algeria, undermining public health efforts and contributing to avoidable morbidity and mortality. Additionally, disinformation relating to climate change denial, often supported by actors with economic interests, can slow crucial

[1] DOE Requirements and Guidance for Digital Research Data Management, U.S. Department of Energy, Retrieved Sep. 9, 2025, https://www.energy.gov/datamanagement/doe-requirements-and-guidance-digital-research-data-management
[2] Carrie Figdor. Op.cit.

governmental responses in the MENA region to water scarcity and desertification, further exacerbating environmental instability. The distinction is vital: misinformation is an error of carelessness, while disinformation is an act of intent, both ultimately eroding public trust in science.

5. Public Policies for Regulating Scientific and Technical Information

5.1. Governance and the Science-Policy Interface

The integration of scientific evidence into public policy is a critical component of effective governance. While global support for evidence-informed policymaking is increasing, persistent institutional and political barriers often constrain the effective use of research in decision-making. Key barriers include fragmented advisory systems, political resistance that leads to the selective use of evidence, and weak communication between researchers and policymakers. Conversely, several factors enable the successful integration of science into policy. These include the establishment of dedicated scientific advisory bodies, the use of "knowledge brokerage" mechanisms that facilitate dialogue between scientists and policymakers, and the promotion of international collaboration to align national strategies with global evidence standards. The successful implementation of these policies depends on building "epistemic trust" and fostering strong inter-professional relationships[1].

5.2. Digital Sovereignty and Data Governance

A central challenge for public policy in the digital age is the concept of digital sovereignty, which refers to a state's ability to "manage and regulate its own digital infrastructure, data management and technological development". This concept is in a state of continuous tension with the global, borderless nature of the internet, which allows for the seamless flow of information across national borders[2].

The Open Data is a pillar of Open Science, implicitly raises a conflict with the ethical principle of privacy. While open sharing of data is crucial for reproducibility and scientific integrity, it creates risks, especially when dealing with human subject’s data (e.g., medical, social, or demographic information). To mitigate the risks, Open Science practices mandate data anonymization and

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[1] Iván Claudio Suazo-Galdames; Mahia Saracostti; Alain Manuel Chaple-Gil. Scientific evidence and public policy: a systematic review of barriers and enablers for evidence-informed decision-making. *Front. Commun*. Vol. 10, 2025, 1632305. https://doi.org/10.3389/fcomm.2025.1632305

[2] Elena G. Popkova & Bruno S. Sergi. *Modern Global Economic System: Evolutional Development vs. Revolutionary Leap,* Springer, Berlin, Germany, 2021, p.1703-1710. https://doi.org/10.1007/978-3-030-69415-9_188

aggregation to prevent re-identification of individuals. Crucially, the tension between Openness and Ethics is formally recognized in the concept of Indigenous Data Sovereignty (IDSov), which asserts that communities must govern their own data, preventing open access from violating collective rights or cultural sensitivities. Effective implementation requires a "as open as possible, as closed as necessary" approach, governed by strict data use agreements and institutional review boards.

National governments are increasingly adopting policies to assert their control over data. For example, the US government has enacted the Open Government Data Act to make federally funded research data open to the public[1]. The Department of Energy has also established requirements for digital data management and sharing, which emphasize the use of persistent identifiers like DOIs to ensure scientific integrity and attribution[2].

The governance of scientific data in the digital age presents a complex trilemma that pits openness against sovereignty and ethics.

The first principle, **Openness**, advocates for the free and unrestricted flow of data to accelerate scientific progress[3].

The second principle, **Sovereignty**, compels states to control and secure their digital infrastructure and data for national security and economic reasons[4].

The third principle, the **Ethical dimension**, as exemplified by the Indigenous Data Sovereignty (IDSov) movement, asserts that data relating to specific communities must be governed by those communities themselves, rather than being made freely and openly available without their consent[5].

These three principles are often in direct conflict. A policy that prioritizes total openness could compromise a nation's digital sovereignty or violate the ethical principles of a specific community's data. This suggests that a truly effective governance framework cannot simply advocate for one principle over the others. Instead, it must be a nuanced, multi-layered system that navigates the

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[1] The Home of the U.S. Government's Open Data, *Data.gov,* Retrieved Sep. 9, 2025, https://data.gov/

[2] DOE Requirements and Guidance for Digital Research Data Management, Op.cit.

[3] The fundamentals of open access and open research, Op.cit.

[4] Elena G. Popkova, Op.cit, p.1703-1710. p.1703-1710.

[5] Maui Hudson; Stephanie Russo Carroll; Jane Anderson; Darrah Blackwater; Felina M. Cordova-Marks; Jewel Cummins; Dominique David-Chavez; Adam Fernandez; Ibrahim Garba; Danielle Hiraldo; Mary Beth Jäger; Lydia L. Jennings; Andrew Martinez; Rogena Sterling; Jennifer D. Walker; Robyn K. Rowe. Indigenous Peoples' Rights in Data: a contribution toward Indigenous Research Sovereignty. *Frontiers in Research Metrics and Analytics.* Vol. 8, 2023. https://doi.org/10.3389/frma.2023.1173805

complex relationships between them, ensuring that data is "as open as possible, as closed as necessary". This approach requires political leadership committed to bridging the gap between scientific evidence and the normative processes of decision-making[1].

The Open Data is a pillar of Open Science, implicitly raises a conflict with the ethical principle of privacy. While open sharing of data is crucial for reproducibility and scientific integrity, it creates risks, especially when dealing with human subjects data (e.g., medical, social, or demographic information). To mitigate the risks, Open Science practices mandate data anonymization and aggregation to prevent re-identification of individuals. Crucially, the tension between Openness and Ethics is formally recognized in the concept of Indigenous Data Sovereignty (IDSov), which asserts that communities must govern their own data, preventing open access from violating collective rights or cultural sensitivities. Effective implementation requires a "as open as possible, as closed as necessary" approach, governed by strict data use agreements and institutional review boards.

6. Scientific and Technical Communication in the Arab World: The Algerian Case Study

6.1. General Context in the Arab World

Scientific communication in the Arab world faces a unique set of challenges that are both similar to and distinct from global trends. Studies on science journalism in the Middle East and North Africa (MENA) region reveal a general lack of knowledge and capabilities among journalists, particularly concerning the analysis of statistical data. This deficit is a significant impediment to the verification of scientific claims. Furthermore, there is a limited public interest in science, technology, engineering, and mathematics (STEM), which results in lower consumption of science news. Government restrictions on access to information also act as a formidable barrier to the free flow of scientific knowledge[2].

Arab researchers face systemic challenges when publishing in international journals. A significant number of researchers believe they face bias in the review process based on their origin, and they report that poor English language skills are a major factor contributing to manuscript rejection. These challenges are not merely practical; they can erode researchers' confidence and adversely

[1] Iván Claudio Suazo-Galdames; Op.cit.
[2] Nada Shakir. Science Journalism in the Arab World: The Quest for ‘Ilm’ and Truth. *Türkiye Ortadoğu Çalışmaları Dergisi.* Vol. 12, no. 1, 2025. https://doi.org/10.26513/tocd.1634298

affect their academic progress, even when the scientific content is sound. While some studies suggest that this is a result of language bias, others argue that regional bias may be an even more significant factor, highlighting a complex interplay of systemic issues[1].

6.2. The Algerian Scientific Landscape

Scientific research and communication in Algeria are marked by a history of institutional and political impediments. There has been a long-standing "conflict between scientific research and political independence", with a trend toward institutional control that has often come into tension with the professional aspirations of researchers for greater autonomy. This dynamic has shaped the conditions under which the scientific community has emerged and consolidated itself in its relationship with the state[2].

Specific challenges facing the Algerian scientific ecosystem include:

- **Infrastructural and Institutional Deficits:** The rapid expansion of student enrollment at Algerian universities has not been accompanied by a commensurate increase in technical resources, such as computer centers and internet access. There is a "discernible absence of a well-defined methodological framework for research endeavors" and a "deficiency in substantive field oversight". These issues are deeply rooted in the institutional context and make it difficult for Algerian research to compete and gain visibility on the global stage[3].
- **The Problem of Brain Drain:** The country has experienced a significant "brain drain," with a high percentage of scholarship holders not returning to the country after studying abroad[4]. This exodus of talented scientists and researchers further depletes the national pool of expertise and makes it more difficult to foster a robust scientific ecosystem.
- **Challenges in Scientific Publishing:** Algerian scientific publishing faces a challenge of quality. A conference on the topic noted a failure to adhere to international standards and a focus on "quantity" over "quality" to elevate these publications to the ranks of leading international publications. Researchers

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[1] Mamoun Ahram; Ahmed Samir Abdelhafiz; Zeinab Mohammed; Samar Abd ElHafeez; Alya Elgamri; Karima El Rhazi & Henry J. Silverman. Perceptions of Arab researchers regarding publishing scientific research: A cross-sectional study. *Accountability in Research*, 2025, p. 1–19. https://doi.org/10.1080/08989621.2025.2489544

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[3] Khalida Elbachari, Challenges Encountered by Algerian Master Students in Conducting Research on Digital Public Relations: A Descriptive Study (Défis rencontrés par les étudiants algériens en master dans la conduite de recherches sur les relations publiques numériques : Une étude descriptive), *Revue algérienne des lettres,* Vol. 8, N°1, 2024, p. 231-250. Retrieved Sep. 9, 2025, https://journals.univ-temouchent.edu.dz/index.php/RAL/article/download/416/391/747

[4] Hocine Khelfaoui. Op.cit, p. 168-169.

also report difficulty publishing in prestigious international journals due to a lack of mechanisms for choosing a suitable journal and understanding its publishing requirements[1].

- **Disparity between Expectations and Reality:** There is a stark discrepancy between the importance that Algerian students and researchers attach to practical coursework and the use of new media and technologies and the actual fulfillment of these aspects. This disparity can be accounted for by the general infrastructure problems and a shortage of resources, training opportunities, and knowledge coordination[2]. The digital environment, with its global reach and transparency, does not automatically solve these problems; rather, it makes them more visible and, in many cases, more acute, as it highlights the gulf between what is possible and what is practiced.

The following table provides a structured summary of the key challenges to scientific communication in Algeria.

Table 2: Key Challenges to Scientific Communication in Algeria

Challenge Category	Specific Challenge	Impact
Institutional	Conflict between professional autonomy and institutional control.	Stifles researcher independence and professional development.
Infrastructural	Shortage of resources, references, and technological capabilities.	Creates a disparity between student expectations and reality; limits the scope of research projects.
Professional	Deficit of a well-defined methodological framework and field oversight.	Hinders the quality and credibility of research endeavors.
Cultural/Global	Brain drain; language and regional bias in international publishing.	Depletes the national talent pool; erodes researchers' confidence and hinders academic progress.
Publishing/Evaluation	Focus on quantity over quality; failure to adhere to international standards.	Negatively impacts the ranking of national journals; makes it difficult for Algerian research to gain global visibility.
Legal/Regulatory	Absence of a cohesive legal and legislative framework for private media.	Limits professional journalistic practice and media content.

Source: Quoted from the following references with adaptation[3].

[1] The 2nd international conference, Evaluation of scientific publishing in Algeria in the light of international experiences: The inevitability of reality and future challenges, January 5th & 6th, 2022, https://esp-conference.com/en/

[2] Hocine Khelfaoui. Op.cit, p. 168-169.

[3] Khalida Elbachari et al. Op.cit, p. 231-250. & Mamoun Ahram et al. Op.cit, p. 1–19. & The 2nd international conference, Evaluation of scientific publishing in Algeria in the light of

6.3. Future Prospects and National Aspirations

Despite the significant challenges, there are signs of positive aspirations and initiatives in Algeria. The government's new national strategy for higher education and scientific research emphasizes innovation and the use of artificial intelligence. This strategy aims to foster a knowledge-based economy and create wealth through scientific contribution[1]. The existence of institutions like the Scientific and Technical Information Research Center (CERIST) provides a foundational infrastructure for developing digital research capabilities and promoting scientific publishing[2]. The focus on strengthening scientific publication and aligning with international standards, as highlighted by a national conference on the subject, demonstrates an awareness of the need to improve the quality and visibility of Algerian research on the global stage.

The Algerian experience illustrates a broader truth: a nation's ability to navigate the digital transformation of science is inextricably linked to its internal political, institutional, and infrastructural health. The digital environment acts as a mirror, reflecting and amplifying pre-existing systemic weaknesses while simultaneously providing new tools to address them. The future of scientific communication in Algeria wild depends on the nation's capacity to resolve the long-standing tensions between institutional control and professional autonomy, to invest in its human and digital infrastructure, and to foster a culture of open and transparent scientific practice.

The infrastructural and institutional weaknesses in Algeria, are typical of challenges faced by countries in various stages of digital transition and emerging research economies (ERE).

Algeria's difficulties—such as the brain drain, institutional control, and a deficit in robust digital infrastructure—compare primarily with:

Other MENA/African nations: Many share similar struggles with digital sovereignty versus global openness and face language/regional bias in international publishing, leading to low global visibility.

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international experiences, Op.cit. & تحديات الإعلام المرئي الخاص في الجزائر - مركز المستقبل للأبحاث والدراسات المتقدمة، 2017، مركز المستقبل للأبحاث والدراسات المقدمة، تم الوصول بتاريخ: 2025/9/8. www.futureuae.com/ar/Mainpage/Item/2935/انطلاق-معطل-تحديات-الإعلام-المرئي-الخاص-في-الجزائر

[1] Zakia Bouhali. The launch of a new digital platform to assist new baccalaureate holders, 2024, https://www.mesrs.dz/index.php/en/2024/04/

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Developing Economies: The lack of commensurate technical resources for rapid university expansion mirrors issues in many countries where quantity (of graduates) has outpaced quality (of research support and IT infrastructure).

States with Strong Centralized Governance: The "conflict between professional autonomy and institutional control" is a common hurdle in systems where the state maintains tight control over information flow and academic priorities, often leading to a weaker science-policy interface and slower adoption of Open Science practices compared to Western models.

In essence, Algeria's challenges are an intersectional blend of resource scarcity (a developing economy trait) and governance rigidity (a centralized state trait), which the digital environment has exposed rather than created.

7. Conclusion

This report has demonstrated that the digital environment presents a profound and multifaceted challenge to scientific and technical communication. The same forces that enable open, collaborative, and immediate knowledge sharing also contribute to the proliferation of misinformation, the erosion of trust, and the tension between global data flows and national sovereignty. The paradigm shift from a mediated, one-way dissemination model to a pluralistic, multi-stakeholder ecosystem is a reality that necessitates a re-evaluation of roles, responsibilities, and ethical principles. The Algerian case study provides a stark illustration of how these global challenges are magnified in contexts with pre-existing institutional and infrastructural vulnerabilities. The future of science communication lies not in simply adapting to new technologies but in strategically designing a system that balances openness with integrity and global standards with national priorities.

Addressing the Research Questions

In response to the research questions, the report concludes the following:

- New practices like Open Science and preprints have profoundly transformed scientific dissemination, but their full potential is hindered by systemic issues such as a lack of reproducibility and the challenges of evaluating non-traditional outputs.
- The use of digital infrastructure and AI offers unprecedented opportunities for data management and analysis but also introduces new ethical dilemmas, particularly regarding citation integrity and the risk of AI-generated "hallucinations."
- Professional practices in science communication are in flux, with a crucial need for renewed investment in fact-checking and media literacy to

combat the "infodemic."

- Public policy must navigate the delicate balance between promoting global open access and safeguarding national digital sovereignty, a tension that is particularly acute in the context of data governance.
- The Algerian experience highlights that while the country has begun to embrace digital transformation and AI, it must first address underlying challenges related to institutional control, a lack of resources, and systemic brain drain to fully leverage these opportunities.

Recommendations

Based on the evidence presented, a multi-layered approach involving all stakeholders is required to foster a resilient and trustworthy scientific ecosystem in the digital age.

- **For Academics and Researchers:** Actively engage in public communication with a strategic mindset[1]. Prioritize reproducible research by adopting Open Science practices, including the use of preprints and the public sharing of data and code[2]. Advocate for institutional training in effective communication and data management to bridge the gap between scientific expertise and public understanding.
- **For Academic Institutions and Libraries:** Invest in national and institutional repositories that support data sharing with persistent identifiers like DOIs. Develop and enforce clear policies on the ethical use of AI in research and publishing. Reform publishing and promotion metrics to reward quality, transparency, and the societal impact of research over a narrow focus on journal impact factors[3].
- **For Media and Journalists:** Reinvest in dedicated science journalism and professional fact-checking roles to provide a crucial layer of verification for the public. Foster proactive collaboration with scientists and institutions to create nuanced and contextualized narratives that accurately reflect the scientific process. Champion media literacy initiatives to empower the public to critically evaluate scientific claims in the digital environment.

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[2] Open science, Op.cit.

[3] Marina Joubert; Heather Ndlovu; Nelius Boshoff. Public science communication in Africa: views and practices of academics at the National University of Science and Technology in Zimbabwe *JCOM*, Vol. 15, no. 6, 2016. https://doi.org/10.22323/2.15060205

- **For Policymakers:** Develop a comprehensive national digital sovereignty strategy that balances open access with data security and protection[1]. Create and strengthen dedicated science-policy advisory bodies to ensure that decisions are informed by scientific evidence. Implement legal and regulatory frameworks that encourage media integrity and accountability, and invest in a national scientific infrastructure that can compete on the global stage.

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