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Science communication in the age of influencers

La comunicación de la ciencia en la era de l@s influencers

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Abstract

This article examines online science communication in Spain and the impact of influencers and social media. The aim of the research is to identify the main online sources of scientific information and assess their effectiveness and reputation. The methodology for the study combined quantitative and qualitative techniques, distributed in four phases: identification of scientific information sources; assessment of online reputation; content analysis, and development and validation of a code of best practices for online science communication. The results show that while influencers have a higher number of followers, research centres are perceived as more trustworthy. Influencers were found to use more accessible language, thus capturing the attention of younger

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audiences, while research centres tend to be more formal. The study concludes by recommending a combination of strategies from both in order to improve the dissemination and public understanding of science, and a code of best practices to optimise online science communication in the age of influencers.

Keywords: science communication, scientific dissemination, Internet, social networks, online reputation, influencers, communication best practice

Resumen

La investigación aborda el proceso de comunicación de la ciencia en España a través de Internet, condicionado claramente por el impacto de los *influencers* y de las plataformas sociales. El objetivo es identificar las principales fuentes de información científica y evaluar su efectividad y reputación. Para ello, se ha desarrollado una metodología que combina técnicas cuantitativas y cualitativas distribuidas en cuatro fases: identificación de las fuentes de información científica, evaluación de su reputación *online,* análisis de contenidos y elaboración y validación de un decálogo de buenas prácticas para la comunicación de la ciencia a través de Internet. Los resultados destacan que, aunque los *influencers* tienen un mayor número de seguidores, los centros de investigación son percibidos como más confiables. Se observó que los *influencers* utilizan un lenguaje más accesible, captando la atención de audiencias jóvenes, mientras que los centros oficiales tienden a ser más formales. La investigación concluye que combinar estrategias de ambos puede mejorar la difusión y comprensión pública de la ciencia, proponiendo un decálogo de buenas prácticas para optimizar la comunicación científica *online* en la era de l@s influencers.

Palabras clave: comunicación de la ciencia, divulgación científica, Internet, redes sociales, reputación online, influencers, buenas prácticas comunicativas

1. INTRODUCTION

The prestigious scientific proponent Carl Sagan (1934-1996) cautioned about the paradox regarding the ever-increasing influence of science and technology in our society and the degree of unawareness of such concerns among the average citizen accounting for the fact that such matters act directly individually and collectively. In an ever-increasing dependency of society on technological knowledgeability, it is of paramount importance to be equipped with trustworthy, critical and comprehensive information with respect to science and technology (Nelkin, 1990). Notwithstanding, not even democracies seem to account for the necessity of fostering public understanding concerning science in disregard of the enhancement and enrichment that wields over

democracy (Calvo, 2002). In view of this situation, science communication plausibly plays a key role in that regard. Effective scientific communication shall empower research and innovation systems to tackle global challenges by bringing to the fore the production, sharing, and applicability of knowledge at the core of public interest (Jensen & Gerber, 2020). In the current context, communicating science seems more necessary than ever before amid a society which confronts ever-increasing complex and global defiance. (Gértrudix & Fernández, 2021; Leon et al., 2023).

In parallel, social networks have revolutionized the way we communicate by altering the conventional venues to access information in conjunction with opinion formation. (Casero-Ripollés, 2018). Over the last decade, we have witnessed the emergence of a new prescriber's profile and opinion leaders whose role in the arrangement of public agenda is ever-increasing (Castelló Martínez & Pino Romero, 2015) and whose digital reputation entitles them to benefit from high interacting rates and engagement (Castelló Martínez, 2016). The *influencer* portrays himself as an updated version of the traditional opinion leader (Fernández Gómez et al. 2018), whose impact in science communication is deemed convenient to be analyzed and construed.

In an Open Science advancement framework conceived as a cornerstone in global academic research leveraged by initiatives such as Horizon Europe, disseminators' contribution has gained importance when it comes to facilitating a rather diaphanous and pragmatic scientific knowledge applicable to everyone. Thereby, not only Open Science boosts efficiency and transparency in research, but also reinforces the connection amid science and society by increasing reassurance on scientific work whilst advocating for a rather inclusive science.

Therefore, if we are to contribute to the enhancement of the dissemination of science popularization, and subsequently, the scientific culture of our society, it is imperative to raise awareness with respect to the functioning of the current science communication in Spain, most notably via the Internet – the current mainstream broadcast channel.

2. THEORETICAL FRAMEWORK

2.1. The paramount importance of science communication

Science communication has its roots in the outreach conducted by scientists. Irrespective of the fact that this realm emerged as a literary genre in the 17th and 18th centuries, significant erudite individuals in history such as Leonardo da Vinci (1452-1519), perceived communication as the primary obligation of scientists. Gerolamo Cardano (1501-1576), who was one of the predecessors of scientific dissemination due to his contributory literature in the realms of mathematics, medicine and physics (Calvo, 2002; Barberá-Forcadell & López-Rabadán, 2024). However, it was not until the late 19th century, and particularly at the turn of the 20th century that Public Communication of Science and Technology (PCST) was established as a core

component in the cultural constituency of our contemporary society gearing towards different models (Tinker, 2013; Alcibar, 2015). Concomitantly, a progressive professionalization was consolidated over the last decades of the last century (Rodríguez, 2013).

Amongst the main turning points regarding the comprehension and management of science communication, the evolution ever since the so-called deficit model transitioning to a dialogical model whereby science and society are intertwined is to be underlined. That implies the transitioning stage from a unidirectional communication from the ivory tower of the scientific community towards a participatory and interactive general audience breeding new avenues of liaison between science and society (Fernández Beltrán et al., 2017). In that respect, Tinker (2013) alludes to the transitioning phase from a model of public appreciation of science and technology (PAST, Public Appreciation of Science and Technology), whereby the information flow revolves around science – the active disseminator and the body in charge of monitoring whether specifics qualify or disqualify as scientific and non-scientific to the public. This audience turns to be a passive repository of information which happens to be object of criticism as a deposit model towards a model of public commitment with science and technology (PEST, Public Engagement with Science and Technology), which perceives communication as a bidirectional flow amidst science and society. Hereinafter, communication is conceived as a bidirectional flow amid science and society; and subsequently the model of critical impression of science in public (CUSP, Critical Understanding of Science in Public), which overcomes the two when considering critically all the aspects that interfere in the science-society interaction, underlining the contextual and multidimensional nature (Tinker, 2013; Alcibar, 2015).

It is ultimately a matter of establishing venues to enable critical comprehension attainment on the part of the public concerning the scientific phenomenon, and, hence, facilitating enquiry and response of the pros and cons that technoscience causes. (Horst, 2008).

These models are complementary and coexist over time. Be that as it may, it is expected that current scientific dissemination goes far beyond than providing increasing approachable scientific knowledge to non-expert audiences. Further, the establishment of bidirectional channels is required in conjunction with efforts for the purpose of including stakeholders at an earlier time point in terms of the evaluation of technology and the regulatory processes aiming at reaching a rather social innovation (Jensen & Gerber, 2020). Thus, urgent action needs to be taken to increase engagement among the scientific community of knowledge, of all their risks and benefits. Concomitantly, it is paramount to promote reasonable dialogue among those in charge of scientific research and citizenship (Calvo, 2002), substantiating communicative channels that are

to be advantaged due to the opportunities provided by the Internet and the technological tools.

The data collected with regards to the *Survey on social awareness about science 2022* undertaken by FECYT (2023) show that society has a considerable positive image with respect to science aligned in such a way that two thirds reckon that the benefits of science and technology outweigh its detriment. Irrespective of this positive perception, most of the population (60,3%) is far from being interested in getting involved in decision-making on scientific issues. Albeit that percentage being slightly below in comparison with previous years – 62% in 2018 and 64,5% in 2020 – it proves to be remarkable accounting for the effects that science exerts in society. It is deemed necessary to further progress boosting science communication conceived from a broad perspective, as an indispensable tool when it comes to generating enhanced scientific culture and the increase in citizen engagement in terms of science development in concert with the technology that is shaping the present and the future of our society.

The paramount importance of scientific communication results evident given the fact that all human activities have been transformed in a continuum by scientific and technological activity. Despite this, the public lives relatively detached from science and its avenues (Calvo, 2002, Moreno-Castro et al., 2024).

2.2. Science and *influencers*

In accordance with Castelló Martínez and Pino Romero (2015), different influencers profiles can be categorized, ranging from the natural social leader – a leading figure in the respective discipline of expertise, in this case in the science realm – that leverages the professional prestige of this subject to acquaint the public with the addressed concerning criteria on social networks. Secondly, the figure of the expert on social networks – someone who qualifies as a specialist in the eyes of the user – can also be observed. The users conceive that individual as a specialist in a field of expertise in a specific given topic based on the premise of the subject's activity on the Internet, with completely void of a real activity in such realm. At opposite ends of the spectrum, a variety of profiles can be encountered ranging from the specialist journalist in science who concomitantly displays a profile on social media up to the blogger who has specialised in the field.

According to a global survey conducted by socialpubli.com in 2018, the main social network platforms on the part of *influencers* are in descending order, Instagram, followed by Facebook, twitter (now renamed X) and YouTube.

Conversely, science communication has had a clear tendency towards YouTube since the down of its existence on the Internet (Tomás & Marín, 2020; Vizcaíno-Verdú et al., 2020) since irrespective of the fact that it came into existence as an entertainment platform, the community in that respect has prompted a breadth thematic scope amid

the audiovisual content therein (Zaragoza & Roca, 2020), fostering scientific dissemination in Spain between the years 2014 and 2016. This community of disseminators professionalizes with the purpose of conveying their knowledge to society.

On another note, as evidenced in consistency with recent research (Fernández-Beltrán et al., 2019; Macho & Bermúdez, 2020; Cambronero Saiz et al., 2021), the masculinization of the independent voices talking about science on YouTube is of concern. By the same token, that shows in a survey on the subject of the *youtuber* movement with the intention of popularizing science on behalf of Zaragoza and Roca (2020) in terms of defining the scientific disseminator prototype as a male person, young and highly educated who advocates for an audiovisual format that combines a formal layout with the youtuber aesthetics in concert with a distended tone (Buitrago & Torres, 2022). The popularization in this platform seeks to reach a youth target by approaching scientific rigor and high-quality information.

Buitrago and Torres (2022) analyzed beforehand the influencers performance on science in another online video platform, fledging, as is the case with Twitch. Therein results show how scientific disseminators apply a specific format termed 'personality vlog', featuring a didactic discourse and synchronous interaction with the user. By implementing a user-friendly tone aiming at catching the attention of the youngest audience, which is the audience that uses this platform to a larger extent.

As for Instagram social network and its role in science popularization and dissemination, the use of audiovisual content in a selfie fashion in the stories seems noticeable (Pérez & Castro, 2023) in concert with accessible language with completely void of technicisms with a view to reaching larger audiences.

Further, there has been an increased presence of scientific disseminators in the TikTok platform, a social network that shows ephemeral content at random (Cervi, 2021), whereby short videos gain a wider interaction with the audiences therein. Nonetheless, much remains to be done for the channel news profiles to take advantage in a much-optimized form (Martín et al., 2023). *Influencers* cover all sort of themes as research has shown (Martínez et al., 2023), wherein analyzed pharmaceutical accounts employed the tool to create disseminating videos regarding health by employing communication codes accounting for the young segments of the population – as noted above – enabling their integration in the science community.

3. METHODOLOGY

The main objective of this appraisal is to become acquainted with the best science communication practices developed by different *online* disseminators, as in the case of *youtubers* – the most influential in social networks – *influencers* – along with the official research centers, primarily CSIC, OPIs and universities aiming at attaining an ensemble

of practical recommendations targeting an enhanced science dissemination on the Internet.

As for secondary objectives, we have aimed to conduct a comprehensive analysis regarding science communication on the Internet, given the absence of a census or public list concerning the primary sources of scientific information in Spain. Most of these sources are managed by individuals in platforms such as YouTube and other social networks, whose objective tends to be personal. However, varied levels of professionalization likewise coexist and hence turn this activity into a sort of remunerated employment or at least into a significant source of revenue. Thereupon, we have identified and categorized those sources with the purpose of providing a clear vision that reflects the current reality. This first step has permitted us to formulate further objectives, such as identifying the influencers with greater impact, be it in terms of audience or reputation.

Accounting for such objectives as the point of departure, the methodology was distributed in four phases of action:

1. Identification and categorization of the science communication sources on the Internet in Spain.
2. Assessment of online reputation.
3. Analysis of content and communicative practices.
4. Validation of catalogue regarding good practices.

3.1. Identification and cataloguing of science communication sources on the Internet in Spain

This phase implied a search for the primary sources of scientific information on social networks and digital platforms based on a bibliographical review regarding the main prevailing scholarly databases – Scopus, Web of Science and Google Academic. We opted for a combination of a threefold database search, and subsequently implemented a human filtering of the documents to be utilized.

Based on the collected references gathered from the scientific bibliography queried, a list of the major *influencers* in Spain regarding science was compiled and 46 results were included (Table 1). Subsequently, all social networks where these personalities had individual profiles were sought. Specifically, their profiles were tracked in the 7 social networks featuring the highest degree of pervasiveness among Internet users in concordance with the 2022 IAB Spain study: Twitter (now X), Facebook, YouTube, LinkedIn, Instagram, Twitch, Tik Tok. The aim was to inquire the number of followers pertaining to the profiles on each social network respectively with a view to establishing a map displaying the prominence of the different science *influencers* in Spain.

Table 1. Prevailing science *influencers* in Spain (source: own compilation)

Rocío Vidal (La gata de Schrödinger)	Glóbulo Azul (Amyad Raduan)
Dot CSV (Carlos Santana)	Viajando por planetas (Laura M. Parro)
Raíz de Pi (Santi Gª Cremades)	SizeMatters (Ana Morales)
Derivando (Eduardo Sáenz de Cabezón)	Ciencia de Sofá
Vary Ingweion (Álvaro Bayón)	Sígueme la corriente (Rubén Lijo)
Hiperactina (Sandra)	VillDiv (Guillermo Pérez)
Preventiva et al (Daniel Orts)	Pablo Abarca
Ciencia XL	Pero eso es otra historia (Andoni Garrido)
Alimentólogo	Alberto Peña Chavarino
Cerebrotes (Clara García)	Historiador al rescate (José Mª García)
Alimentacion Holística	Antiguo acero español
Mi dieta cojea (Aitor Sánchez)	Rincón de Historia TV
Deborahciencia	Jaime Altozano
Huele a Química (Pedro Juan Llabrés)	Apología de la Historia
Antroporama (Patri Tezanos)	Elsa Punset
Geological Legacy (Guillermo Prados)	La cuna de Halicarnaso (José Antonio Lucero)
Ciencias de la Ciencia (J.J. Priego)	Ter
Sinapsis: Conexiones entre el arte y tu cerebro	El Cubil de Peter (Pedro Pérez)
CdeCiencia (Martí Montferrer)	El Pakozoico (Francesc Gascó)
Date un voltio (Javier Santaolalla)	Entelekia Filosofik
Quantum Fracture (José Luis Crespo)	Héroes del Pensamiento
Fiscalimite (Guillermo Suárez)	Filosofía divertida
Diario de un MIR (Pau Mateo)	Alba CeColl

In parallel, an identical scope of research applied through the Network of Scientific Culture Units (UCC+i) and Innovation of Spanish research centers (Table 2), accounting for the fact that targeting universities shall jeopardize the monitoring and tracking data. The reason for that is that the latter not only communicates science by dint of the social networks therein, but also all forms of academic and institutional content. This quest was undertaken based on the FECYT list concerning UCC+i, encompassing 47 investigation centers.

To conduct this analysis on the grounds of their web pages, the profiles pertaining to these units were sought in 6 social networks: Twitter (now renamed X), Facebook, YouTube, Instagram, Vimeo y LinkedIn. In this instance, neither Twitch nor Tik Tok were accounted for since these lacked social profiles on such platforms. Thereupon,

Vimeo – a service analogous to YouTube – was included instead accounting for the fact that various research centers utilize it for the purpose of circulating higher-quality audiovisuals. Likewise, this section encompassed a search aiming at discerning the number of followers pertaining to these profiles on each social network.

Table 2. UCC+i from the research centers analyzed (source: own compilation)

Consejo Superior de Investigaciones Científicas (CSIC)	Fundación Incliva
CSIC delegación Valencia	Fundación Institut de Salut Global de Barcelona
Associació Catalana de Comunicació Cientifica	Fundación Pública Andaluza Progreso y Salud
Barcelona Supercomputing Center-Centro Nacional de Supercomputación (BSC-CNS)	IDIBAPS
Centro de Astrobiología (CSIC-INTA) (RRSS del CSIC)	Institut de Recerca de l'Hospital de la Santa Creu i Sant Pau (IBB Sant Pau)
Centro Nacional de Experimentación de Tecnologías de Hidrógeno y Pilas de Combustible	Instituto de Astrofísica de Canarias
Centro Nacional de Investigación sobre la Evolución Humana (CENIEH)	Instituto de Ciencias Matemáticas
Consorcio para la Construcción, equipamiento y explotación del laboratorio de Luz Sincrotrón (Cells)	Instituto de Investigación Biomédica de A Coruña (INIBIC) (RRSS non-available on the web)
Estación Experimental del Zaidin (CSIC)	Instituto de Salud Carlos III
Federación Española de Centros Tecnológicos	Real Sociedad Española de Física
CSIC delegación Galicia	Fundació Privada Centre de Regulació Genòmica
AINIA	Fundación Canaria General de la Universidad de La Laguna
AZTI-Tecnalia	Fundación de Investigación del Cáncer de la Universidad de Salamanca (RRSS de la Universidad de Salamanca)
Campus de Excelencia Internacional en Agroalimentación	Fundación Gaiker
Centro Nacional de Aceleradores (CSIC-Universidad Sevilla-Junta Andalucía)	Fundación Institut de Recerca Biomédica (IRB Barcelona)

Centro Nacional de Física de Partículas, Astroparticulas y Nuclear (CPAN)	Fundación Parque Científico y Tecnológico de Castilla-La Mancha
Consorcio para el Diseño, la construcción, el equipamiento y la explotación de la plataforma oceánica de Canarias	Fundación Séneca
Consorcio Parque de Investigación Biomédica de Barcelona (PRBB)	Institut Català de Paleontología Miquel Crusafont
Euskampus Fundazioa	Instituto de Astrofísica de Andalucía
Fundació Institut de Bioenginyeria de Catalunya (IBEC)	Instituto de Biomecánica de Valencia
Fundació per a la Universitat Oberta de Catalunya (Lleva a las redes sociales de la UOC)	Instituto de Ciencias Materiales de Aragón
Fundación 3CIN (No tiene RRSS en su página web)	Instituto de Investigación y Formación Agraria y Pesquera (IFAPA)
Fundación Canaria parque científico tecnológico de la Universidad de Las Palmas de Gran Canaria	Parc Científic de Barcelona
Fundación Descubre	

After uncovering the collected data regarding *youtubers* and *influencers* conjoined with official sources, in this case the UCC+i, the 30 profiles with the greatest number of followers were selected, 15 of which were *influencers* and the other half were UCC+I and representative of the final sample associated with the present object of study (Table 3).

Table 3. *Influencers* and UCC+i analyzed Universe (source: own compilation)

Influencers	UCC+i
Rocío Vidal (La gata de Schrödinger)	Consejo Superior de Investigaciones Científicas (CSIC)
Dot CSV (Carlos Santana)	Associació Catalana de Comunicació Cientifica
Raíz de Pi (Santi Gª Cremades)	Barcelona Supercomputing Center-Centro Nacional de Supercomputación (BSC-CNS)
Derivando (Eduardo Sáenz de Cabezón)	Centro Nacional de Investigación sobre la Evolución Humana (CENIEH)
Hiperactina (Sandra)	Consorcio Parque de Investigación Biomédica de Barcelona (PRBB)
Mi dieta cojea (Aitor Sánchez)	Fundación Descubre

Deborahciencia	Fundación Institut de Salut Global de Barcelona
Antroporama (Patri Tezanos)	IDIBAPS
CdeCiencia (Martí Montferrer)	Instituto de Astrofísica de Canarias
Date un voltio (Javier Santaolalla)	Instituto de Ciencias Matemáticas
Quantum Fracture (José Luis Crespo)	Instituto de Salud Carlos III
SizeMatters (Ana Morales)	Real Sociedad Española de Física
Pero eso es otra historia (Andoni Garrido)	Fundació Privada Centre de Regulació Genòmica
Elsa Punset	Fundación Canaria General de la Universidad de La Laguna
Ter	Fundación Institut de Recerca Biomédica (IRB Barcelona)

The representativeness concerning the final sample of *influencers* and research centers was to be determined, henceforth, accounting for their respective level of audience so that the profiles with the greatest number of followers were selected in absolute terms. In that regard, specifics regarding detailed data in terms of the audience in each of these profiles shall be available on the web associated to the project (https://comciencia.uji.es/mapa-de-la-comunicacion-cientifica-por-internet-en-espana/).

3.2. Online reputation appraisal

In this phase, an online reputation analysis concerning the scientific communicators identified in the previous phase was conducted. These analytics included the compilation of data regarding the number of followers, their posts' interactions and the perception of credibility on the part of the public. To this effect, quantitative research was implemented, based on 61 survey participants who agreed to take part through an open call on social networks.

3.3. Communicative practices and analysis of contents

The third phase of the research consisted of an in-depth analysis of the published content and the communicative strategies utilized by the sample of 30 communicators so as identify patterns and best practices in terms of science communication. This analysis allowed us to revisit the characteristics and core definitory elements of their respective activities. Concomitantly, the exploration was valuable in terms of composing an outset with regards to the cataloguing of best communicative practices regarding science communication on the Internet accounting for a twofold objective – acquisition of greater audiences and the attainment of the best reputation from their part.

3.4. Good Practices Validation Catalogue

The catalogue of best communicative practices, ultimately, was rigorously scrutinized by a Delphi Panel of science communication experts comprised of scholars and communicators. Upon request, they were asked to provide a valuation regarding the practices considered herein and to offer input for the purpose of incorporating unaccounted for elements that shall not have been adequately reflected. In the first phase, the Delphi Panel was solicited to rate on a 0-5 scale concerning the importance of each of the good plausible practices and, in parallel, were given the opportunity to comment and provide a justification thereof. Based on these results, accounting for a second wave, a questionnaire was elaborated anew with a view to allowing the participants to adjust or ratify their rating and provide further commentary in that respect, if deemed appropriate.

The team of panelists participating in both waves encompassed the following professionals:

- María del Carmen Erviti, Climate Change and Environmental Communication Professor at Navarra University.
- Susana de Andrés, Tenure Professor of Communication Ethics at Valladolid University.
- Pilar Buil Gazol, Professor of Corporate Communications at Internacional University of Catalunya.
- Maite Mercado Sáez, Senior Lecturer of Journalism at Valencia University València, and member of the board of directors at the Association of Environmental Information Journalists (APIA).
- Gemma Teso, Professor at the Complutense Madrid University and Coordinator of the Climate Change Communication Observatory.
- Laura Chaparro Domínguez, specialized journalist on Scientific Information and Responsible for Scientific Information at Media Centre Spain.
- Rocío Vidal, science *youtuber*, also referred to as "La Gata de Schrödinger" – the Schrödinger's cat.

4. RESULTS

In addition to the identification of the major sources of scientific information operating in Spain via the Internet, as illustrated in tables 1 and 2, the present inquiry has elucidated the creation of a relevant map based on the number of followers and the interactivity attained in the different social platforms, available for download on the project website of reference: www.comciencia.uji.es.

Further substantial results have been obtained regarding the perception of credibility and reliability concerning the stated sources in this research. The outcome of which

indicated that irrespective of the fact that *influencers* and *youtubers* hold a greater number of followers, the official research centers are perceived as rather reliable. This finding highlights the paramount importance of institutional support concerning the perception of credibility.

In phase 2, the results of the quantitative research suggested that 88,5% of the survey respondents expressed greater interest in scientific subjects. Further, 67,2% seem to consult sources of scientific communication on a regular basis.

The data appraised regarding the qualitative research developed in phase 3, indicated that *influencers* and *youtubers* utilize plain, accessible language and visually appealing content, enabling drawing the attention of younger and diverse audiences. By contrast, the official research centers tend to employ a rather formal, formative, instructional approach, which happens to be more effective for audiences seeking detailed and rigorous information. Additionally, the present research has elucidated the fact that regular interaction with the targeted audience is fundamental to fostering trust and credibility.

Full research results with reference to the quantitative and qualitative appraisal are available for consultation at www.comciencia.uji.es.

5. DISCUSSION AND CONCLUSIONS

This investigation has revealed various significant tendencies in the science communication era. First and foremost, *influencers* and *youtubers* play a crucial role in scientific dissemination, particularly among young audiences. Its capacity to convey communication in an effective and appealing manner permits science to be more accessible to a wider audience. Be that as it may, misinformation continues to pose a significant risk since not all *influencers* account for adequate scientific training at their disposal.

On another note, the official research centers, perceived as more reliable, are faced with the challenge of presenting the communication therein in a more appealing and accessible format without compromising scientific accuracy. The adoption of some strategies being used by *influencers* might assist in improving these research institutions to expand their reach and contributing to an increased involvement among more diverse audiences. To that effect, the recommendations for action regarding the following decalogue, structured hierarchically in accordance with the valuation obtained by the Delphi panel shall be of great assistance.

5.1. Good practices of science communication via the internet

1. Evincing the sources. The science communicator has the obligation to inform about the sources and references utilized to generate the contents therein, in a manner that the information transparency approached contributes to acquiring greater credence.

Aiming at publishing scientific content, prior consultation regarding some source of reliable information and bringing it to the fore in all communication is thought to be imperative. The results of the research must be in connection with the scientific journals or institutional websites wherein the information or data concerned has been accessed.

2. Reporting on the informant. The science communicator must clearly inform with respect to the given tenure and knowledge in conjunction with the entrepreneurial or economic relationship concomitant with its disseminating activities, if any. Transparency is fundamental to ensure credibility on behalf of the communicator and the messages therein, primarily, regarding any possible conflict of interests, not just on the part of the communicator, but also extending to the communication medium and the consulted sources.

3. Void of technicisms. The science communicator is expected to refrain from technical and specialised language. Indeed, the prime function to be implemented in that regard is to translate the scientific language therein into common parlance. To this end, accounting for analogies and metaphors that enlighten the audience in terms of comprehension by getting a grasp of the given concepts and ideas therein is deemed fundamental.

4. Fostering questions and change. The science communicator must apprehend the audience and encourage followers to quest for answers concerning the impact that the new scientific knowledge proffered exerts on their daily lives. Further, the audience shall be encouraged to make substantive changes in their lifestyles or attitudes to achieve greater articulation, connection and interaction.

5. Subtitling of audiovisuals. In audiovisual contents, it is fundamental to include the subtitling text of the science communicator's voice-over for a twofold reason: not only to facilitate the consumption of information in contexts where the use of audio is disregarded – such as in libraries, train settings – but also to reinforce the message through a double-track – simultaneity of audio and text. Equally important, it is indispensable to guarantee accessibility and legibility of the message when it comes to accounting for disabled people – those not speaking the language properly, etc.

6. Including gender perspective. The science communicator must integrate gender perspective in the generated contents. In other words, this subject must deploy concepts that encompass both men and women, the scope of which applies and extends to research personnel, the scientific community, as well as the assertion that the female sources cited are referred to as expert sources.

7. Narrating science via storytelling. The use of the narrative on the part of the science communicator that intersects the content with a real or fictitious account by dint of the *storytelling* techniques proves to contribute to an enhancement of interest and comprehension of the themes and topics on the part of the audience.

8. Encouraging participation. The science communicator should favor the participation and discussion of the audience regarding the analysis and debate of the subjects addressed. Leaving a door open to dialogue and replication cultivates and fosters citizen appropriation of knowledge and social critique. Notwithstanding the risk of receiving malicious messages, science communication must be overt and open to dialogue. Otherwise, that would conform to unidirectional information.

9. In contact with present reality. It is equally important that the scientific subjects covered are connected to the current reality in a manner that the science communicator benefits from the expansive wave or the newsletter hype of the moment. The hook of the news enhances the content positioning with reference to scientific communication via the Internet, the production value of which is representative of creations made in the audiovisual sector.

10. Regular publications. Recurrence in the publication of contents is fundamental to achieve proper positioning as a science communication source. In that regard, a minimum of 2-3 publications should be attained per week in each of the platforms or social networks wherein it is targeted to be present to reach accomplishment.

Ultimately, further concluding remarks to be accounted for would be as follows:

- The science communicator must promote the formation of a community proximal to its personal hallmark athwart being present in various social networks, such that the speech and rhetoric shall adjust to the characteristics of each one of them. Science communicators should integrate the greatest number of webs and social platforms in their activity and operations to reach the widest possible audience whilst fostering synergies amidst their different social profiles.
- In compliance with the statement herein, YouTube is presented as a platform that enhances the circulation of audiovisual messages, albeit qualifying as unfavorable for dialogue and interaction.
- The best-performing videos targeting science communication in YouTube have a duration of 10-20 minutes.
- As for TikTok, it is presented as a platform that enables establishing links more profoundly with the science communicator's audience when generating a greater connection regarding the contents therein albeit binding obligation to primarily simplify its messages.
- TikTok permits to reach a high number of comments from the audience, wherewith the science communicator is to interact and respond with a view to enhance dialogue and the building of community.
- Regarding audiovisual contents, it is paramount for greater personal prominence to be given to the science communicator as an element conferring

credibility to the message whilst combining with other image sources with a view to attaining an appealing and dynamic audiovisual discourse.

- Despite the sharp decrease of user figures, Facebook is of prevailing interest as a social platform, particularly across age groups over 40 and willing to establishing broad-based dialogue with the science communicator.
- For its part, Instagram is an interesting platform for science communicators aiming at targeting younger audiences. Nonetheless, it happens to feature a lower level of interaction and dialogue than Facebook.
- As for the parties from LinkedIn, it constitutes a communication platform peer-to-peer rather than a window for science communication into mainstream society. Notwithstanding, by dint of segmentation and the search of specialised groups shall serve as a complementary tool enabling the science communicator to reach very specific audiences.
- For its part, Twitter is constituted as a platform that brings to the fore content originally generated targeting other platforms such as TikTok or YouTube, rather than a space wherein to create own contents with reference to scientific communication.app

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6. REFERENCES

Alcíbar, M. (2015). Comunicación pública de la ciencia y la tecnología: una aproximación crítica a su historia conceptual. *Arbor, 191 (773), 1-13.* https://doi.org/10.3989/arbor.2015.773n3012

Barberá-Forcadell, S., y López-Rabadán, P. (2024). Evolución de las UCC+i como agente dinamizador de la comunicación de la ciencia. Percepciones profesionales sobre su estructura y retos de futuro en el contexto digital. *Doxa Comunicación*, *Revista Interdisciplinar de Estudios de Comunicación y Ciencias Sociales*, *39*. https://doi.org/10.31921/doxacom.n39a2025

Buitrago, Á., y Torres Ortiz, L. (2022). Influencers de ciencia en Twitch. Divulgación científica a través de vídeo-streaming en tiempos de COVID-19. Teknokultura. *Revista de Cultura Digital y Movimientos Sociales*, *19*(2), 165-176. https://doi.org/10.5209/TEKN.77941

Buitrago, Á., y Torres Ortiz, L. (2022). Influencers de ciencia en YouTube. Divulgación científica en el contexto español de la plataforma hegemónica de vídeo online. *AdComunica*, (24), 177-200. https://doi.org/10.6035/adcomunica.6558

Calvo, M. (2002). El periodismo científico, reto de las sociedades del siglo XXI. Comunicar. *Revista Científica de Comunicación y Educación*, *19*, 15-18 https://www.revistacomunicar.com/ojs/index.php/comunicar/article/view/C19-2002-03

Cambronero Saiz, B., Segarra-Saavedra, J. y Cristófol-Rodríguez, C. (2021). Análisis desde la perspectiva de género del *engagement* de los principales *youtubers* de divulgación científica. Cuestiones de género: de la igualdad y la diferencia. *Revista del Seminario Interdisciplinar de Estudios de las Mujeres de la Universidad de León,* 16, 521-535.

Casero-Ripollés, A. (2018). Research on political information and social media: Key points and challenges for the future. *Profesional de la información*, *27*(5), 964-74. https://doi.org/10.3145/epi.2018.sep.01

Castelló-Martínez, A. (2016). El marketing de influencia: Un caso práctico. En I. Zacipa, V. Tur-Viñes y J. Segarra-Saavedra (Coords.), *Tendencias publicitarias en Iberoamérica: Diálogo de saberes y experiencias* (pp. 49-65). Colección Mundo Digital.

Cervi, L. (2021). TikTok and generation Z. *Theatre, Dance and Performance Training*, *12*(2), 198-204. https://doi.org/10.1080/19443927.2021.1915617

Fernández-Beltrán, F., García-Marzá, D., Sanahuja Sanahuja, R., Andrés Martínez, A., y Barberá Forcadell, S. (2017). La gestión de la comunicación para el impulso de la Investigación e Innovación Responsables: propuesta de protocolo desde la ética dialógica. *Revista Latina de Comunicación Social*, *72*, 1.040-1.062. https://nuevaepoca.revistalatinacs.org/index.php/revista/article/view/665

Fernández Beltrán, F., Sanahuja Sanahuja, R., y Picó, M. J. (2019). La comunicación de la ciencia en YouTube ¿Oportunidad o amenaza para superar la brecha de género en los ámbitos STEM? En *Congrés Dones, Ciència i tecnológica 2019*. Terrassa, 6 y 7 de marzo de 2019.

Fernández Gómez, J. D., Hernández-Santaolalla, V., y Sanz-Marcos, P. (2018). Influencers, marca personal e ideología política en Twitter. *Cuadernos.info*, (42), 19-37. https://doi.org/10.7764/cdi.42.1348

Fundación Española para la Ciencia y la Tecnología (FECYT) (2023), Encuesta de percepción social de la ciencia y la tecnología en España 2022. Fundación Española para la Ciencia y la Tecnología (FECYT). Microdatos 2022 – edición 1.0. https://doi.org/10.58121/msx6-zd63

Gértrudix, M. y Fernández, M. (2021). *Comunicar la ciencia. Guía para una comunicación eficiente y responsable de la investigación e innovación científica*. Editorial Gedisa.

Horst, M. (2008). In search of dialogue: staging science communication in consensus conferences. En Cheng, D.; Claessens, M.; Gascoigne, T.; Metcalfe, J.; Schiele, B. y Shi, S. (Eds.), *Communicating Science in Social Contexts. New models, new practices*, (pp. 259-274). Springer.

Jensen, E. A., and Gerber, A. (2020). Evidence-based science communication. *Frontiers in Communication*, *4*, 513449. https://doi.org/10.3389/fcomm.2019.00078

Leon, B., Bourk, M., Finkler, W., Boykoff, M. and Davis, L. S. (2023). Strategies for climate change communication through social media: Objectives, approach, and interaction. Media International Australia, *188* (1), 112-127. https://doi.org/10.1177/1329878X211038004

Moreno-Castro, C., Krzewińska, A. and Dzimińska, M. (2024). *How citizens view science communication: pathways to knowledge*. Routledge. Taylor y Francis.

Macho Reyes, R. D. y Bermúdez Vázquez, M. (2020). La comunicación de la ciencia en YouTube España, ¿divulgación, difusión, comunicación o sólo polémica? *Revista Prisma Social*, (31), 410–422. https://revistaprismasocial.es/article/view/3929

Martín Neira, J. I., Trillo-Domínguez, M. y Olvera-Lobo, M.-D. (2023). De la televisión a TikTok: Nuevos formatos audiovisuales para comunicar ciencia. *Comunicación y Sociedad*, 1-27. https://doi.org/10.32870/cys.v2023.8441

Martínez-Sanz, R., Buitrago, Á. y Martín-García, A. (2023). Comunicación para la salud a través de TikTok. Estudio de influencers de temática farmacéutica y conexión con su audiencia. *Revista Mediterránea de Comunicación*, 14(1), 83-98. https://doi.org/10.14198/MEDCOM.23435

Nelkin, D. (1990). *La ciencia en el escaparate*. Fundesco.

Pérez Ordóñez, C. y Castro-Martínez, A. (2023). Creadores de contenido especializado en salud en redes sociales. Los micro influencers en Instagram. *Revista de comunicación y salud*, *13*, 23-38. https://doi.org/10.35669/rcys.2023.13.e311

Rodríguez, C. (2013). Periodismo Científico y de Salud. En: Cebrián Enrique, Bernardino y Mirón, Luis María (coord.) *Áreas del Periodismo. Comunicación Social*, 202-230.

Tinker, P.S. (2013). *Communicating popular science. From deficit to democracy*. Palgrave Macmillan.

Tomás, J. C. Z. y Marín, D. R. (2020). El movimiento youtuber en la divulgación científica española. *Prisma Social,* (31), 212-238.

Vizcaíno-Verdú, A., de-Casas-Moreno, P. y Contreras-Pulido, P. (2020). Divulgación científica en YouTube y su credibilidad para docentes universitarios. *Educación XXI, 23(2), 283-306.*

Zaragoza, J. C. y Roca Marín, D. (2020). El movimiento youtuber en la divulgación científica española. *Revista Prisma Social*, (31), 212-238. https://revistaprismasocial.es/article/view/3942