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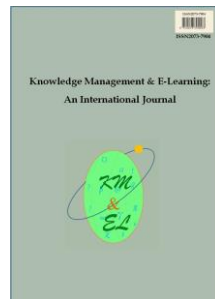
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A study of social media use for scientific communication and dissemination among Spanish education researchers

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Abstract: This work focuses on understanding how researchers in Spain perceive the importance of social media in scientific communication and dissemination and deepening their understanding of the influential underlying factors. From the initial identification of 5,314 researchers affiliated with higher education institutions in Spain, who published in journals indexed in Scopus and Web of Sciences from 2016 to 2020, 487 were surveyed, and 20 were interviewed. The results show how despite the potential of non-academic social media for the social dissemination of scientific knowledge, use remains low among the researchers surveyed in this study. Also, data allow us to recognize how the time of use of social media and the perception of the training needed influence the perception of the usefulness of social media by Spanish researchers on education. Use that does not seem to be oriented toward dialogue and citizen participation. Higher education institutions should improve the communication and scientific dissemination led by researchers through training and the design of dissemination policies that guarantee an active and general use of them (not only academics but also generalists like Facebook or Youtube) to transfer scientific knowledge to society better.

Keywords: Social media; Scientific communication; Dissemination; Knowledge; Higher education

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1. Introduction

The rise of social media in our societies has implied the transformation of traditional communicative referents from the general point of view and an increasingly necessary awareness of the challenge that scientific actors and agents must assume, especially in using this type of digital scenario to guarantee the visibility of the knowledge generated from the academy through the active communication and dissemination of the results generated in the different research processes and activities aimed at society's culture or scientific education. This challenge has been approached through various avenues. One approach involves studying the utilization and initiatives implemented to promote digital communication scenarios in different scientific fields involving various actors (De Filippo et al., 2019; Fressoli and De Filippo, 2021). Additionally, efforts have been made to foster a research culture that connects the academic world with educational practices and contributes to societal development (Spanish Foundation for Science and Technology, 2020). Since the beginning of the 21st century, movements such as Open Access and Open Science have highlighted the potential that the increasing interconnection of the Internet brings for developing our societies. It also promotes culture or scientific education based on innovation, collaboration, transparency and open access to academic and societal knowledge (Mirowski, 2018).

If one reviews scientific production in terms of scientific communication in social media, one can realize that the academic debate on this topic is still incipient. Since the second half of the 2010s, when this topic begins to have a greater relevance within the academic discussion, until reaching its most significant production milestones with the emergence of the Covid-19 Pandemic. This fact has heightened the awareness of the importance of comprehending how social networks communicate and disseminate scientific knowledge. A debate that has focused to date, within the field of Social Sciences, as can be seen in Fig. 1, around five main axes of debate: 1) trying to understand the methodologies associated with production, visibility and participation patterns of scientific communication through social networks (Gertrudix et al., 2021; Güneri et al., 2022; Striewski et al., 2022; Dalyot et al., 2022); 2) recognizing the use of social networks as a resource for socio-sanitary intervention during the Covid-19 Pandemic (Broer & Pröschel, 2022); 3) from the scientific communication carried out from journalism and the digital news media (Miller & Heiland, 2021; Guenther & Joubert, 2021); 4) as a resource for improving bibliometric indicators associated with scientific production (França et al., 2021; Aguaded, Civilá & Vizcaíno-Verdú, 2022) and 5)

conceiving the scientific communication carried out from social networks as a training resource for students (Felahi & Saqri, 2022).

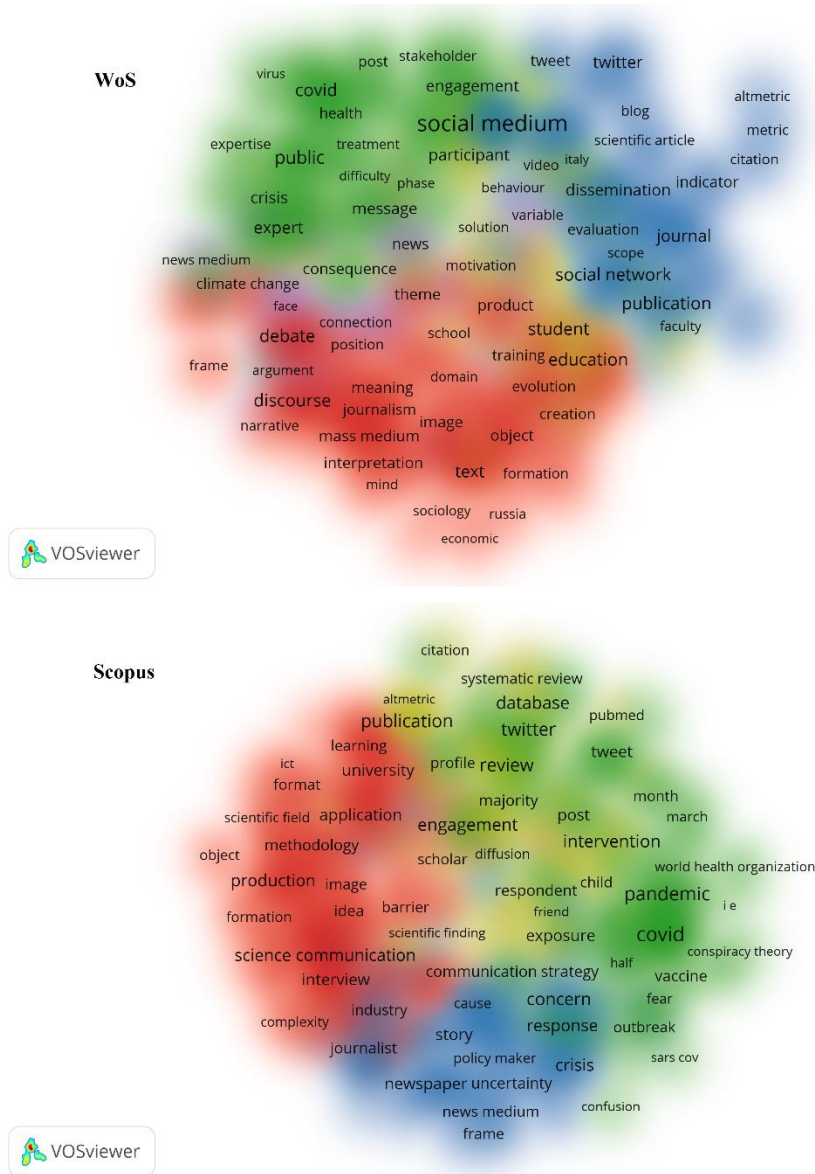


Fig. 1. Thematic density in scientific publications associated with scientific communication and social media in WoS and Scopus (from 1985 to 2022).

Note. The analysis was conducted using VosViewer, utilizing the binary counting method to estimate the co-occurrence of terms within the titles and abstracts of scientific publications indexed in WoS ($N = 1,022$) and Scopus ($N = 765$) that were associated with the search topics of scientific communication and social media.

Despite the growing increase in the knowledge and use of current digital scenarios (e.g. social networks) at the university academic level, what is indicated in the previous paragraph and Fig. 1, shows us a scenario of academic debate that continues to be low, around the topic raised in this paper. Above all, if we take into account that the level of communication and dissemination carried out for scientific promotion is still low, as pointed out by studies carried out by authors such as Rodríguez-Fernández et al. (2018) or Chugh and Ruhi (2018). The context mentioned above does not favour using this knowledge generated by groups outside the academic area, both at a social (general) level and a professional level. A reality that authors such as Lalangui et al. (2017), Girón Escudero et al. (2019), as well as Boeskens et al. (2020), among others, have not missed an opportunity to account for the necessary promotion of processes aimed at promoting and guaranteeing a framework for continuous training at an educational level, capable of responding to current socio-educational challenges.

Zhang and Gao (2014), Cassaniti et al. (2014), Pimmer et al. (2018), and Wong et al. (2022) have emphasized the effectiveness of social networks in informal science learning. Consequently, researchers are believed to be capable of effectively disseminating scientific knowledge through digital platforms and mobile devices. These spaces promote a stronger dedication to learning and enhance the creativity and productivity of researchers and other educational stakeholders, such as students.

Due to what has been exposed so far, this work is proposed as an action aimed at promoting access to knowledge, which helps to understand, identify recommendations and promote training actions aimed at improving communication strategies and scientific disclosure through social media by researchers. A purpose that is expected to be achieved from understanding these researchers in Spain's perception of the importance of social media in communication and scientific dissemination at a social level and identifying the influential underlying factors in this regard.

2. Conceptual framework

2.1. Help-seeking in e-learning

The Fourth Industrial Revolution and digitization are changing how people communicate through expanding social media (RRSS), which have been consolidated as channels for socialization, communication and collaboration. Following the COVID-19 outbreak in 2019, social media have been amplified within the academic-scientific field due to the need to disseminate the most recent research and provide the public access to information and Science at the health, societal and educational levels (Calvo Iglesias, 2021). This helps Science attract the necessary social support to prosper from its understanding and use, according to Vizcaíno-Verdú et al. (2020). Science benefits from promoting results associated with a particular topic or speciality and making this knowledge available to society (Escobar-Ortiz and Rincón-Álvarez, 2018).

Since the beginning of 2000, the academic world has been promoting movements to promote science transmission in society. Such is the case of the Open Science Movement, aimed at the public distribution of knowledge generated from the research by university professors Bautista-Puig et al. (2019). This movement requires a culture change in the exercise of scientific work by requiring researchers, non-university actors and social disseminators to build solid relationships oriented to creating, storing and sharing contributions (Ayris et al., 2018). The role exercised by researchers must

transcend the generation of knowledge associated with their field of study in favour of scenarios aimed at circulation, deliberation and social participation available via contemporary communication channels (Brossard, 2013), the generation and production of the scientific content in multimedia formats (e.g., audio, video and text), published in traditional contexts (e.g., conferences, books and scientific articles) and non-traditional digital contexts (e.g., webinars, blogs and social media). This would favour the public understanding of Science and participation, from the interaction and appropriation of knowledge through comments, likes and sharing information with other social actors (Esarey & Wood, 2018; Hargittai, Füchslin & Schäfer, 2018).

Currently, three models have dominated and conditioned the debate associated with the digital dissemination of scientific communication, according to authors such as Bucchi (2008) and Palmer and Schibeci (2014). First, a deficit model considers that citizens have a common understanding of the usefulness of scientific knowledge and its practical applicability in their daily work. Second, a model of dialogue contends that citizens must actively work with the scientific knowledge generated to solve local social problems. Third, a participatory model gives citizens an active role in configuring the scientific agenda based on mutual understanding between scientists and citizens, driven by deliberative procedures oriented toward investigating the issues.

There are studies within the field of research that highlight the benefits of the use of social media networks, from optimization and access to shared resources, dissemination of research in the international arena, and projection and professional recognition, among others (Fuentes Cancell et al., 2021; Meishar-Tal & Pieterse, 2017; Roig-Vila et al., 2016). Despite these efforts, reports published by organizations such as Wellcome (2021) or the Spanish Foundation for Science and Technology (2020) highlight an actual distance between science and society. These reports point out a disconnect between the public and scientists about the usefulness or benefit of scientific knowledge outside of academic spaces and the benefit of promoting scientific communication and dissemination models aimed at dialogue and citizen participation. The context is characterized by the influence of individuals' age and socio-educational background in determining their engagement with contemporary social media networks. Therefore, for authors such as Farias and Maia (2020), it is necessary to continue reflecting on the factors that may be conditioning scientific communication and dissemination, beginning with how communication is conducted in academia.

In academic contexts, we found that scientific collaboration is the strongest predictor of the use of social media (Huang et al., 2020). In academia, collaborative work is enhanced, not only disciplinary but also interdisciplinary. It is common to find on the websites of research centres, scientific journals and research groups collaborating through social media to disseminate the latest news and scientific findings. As shown by the studies of Campos-Freire and Rúas-Araújo (2016) and Rodríguez-Fernández et al. (2018), researchers have highlighted the role of social media as essential tools in communication, access to scientific knowledge and collaboration. However, in practice, the reality is very different; communication and dissemination for scientific promotion and development of educational practices on social media channels remain underutilized (Kilis et al., 2016; Rodríguez-Fernández et al., 2018).

It is important to know the types of social media currently used to continue promoting them in the field of research. We can classify social media within the scientific field into academic-social media and non-academic-social media. Campos-Freire et al. (2014) highlight the emergence of countless academic RRSS over the years depending on the area of knowledge of the researchers. Some RRSS that can be highlighted is

ResearchGate, Academia.edu, Google Scholar, Sciver, Quartzly, Frontiers, Biomedex, MyScienceWork, Cosis.net, ScienceStage, and CiteULike. Authors such as Boudry and Durand-Barthez (2020); Işık and Gökkurt Demirtel (2021); Mandiá-Rubal et al. (2019) state that the most preferred academic network for profile management is ResearchGate since it has a high number of users and consequently presents greater dissemination of its works and research. ResearchGate allows researchers to share publications in open access and preprint before their official publication. Thus, the work is visualized and disseminated among academics and non-academics for feedback before publication. This network's communication behaviour is characterized by rigorous professional and non-emotional objectivity (Ostermaier-Grabow & Linek, 2019).

Regarding non-academic social media, Alonso-F et al. (2019) believe these are potential gateways for disseminating research. However, most researchers do not have active profiles in non-academic networks despite the benefits obtained and demonstrated in some studies (Montesi et al., 2019).

Linek et al. (2018) reveal in their research how the number of reciprocal followers of researchers on Twitter is conceptualized as a more robust indicator of community development. For their part, Vizcaíno-Verdú et al. (2020) show the YouTube platform as an informal channel for scientific dissemination since it allows Science to reach the general public. As the authors indicate, it is an "informal means of emerging scientific literacy". Despite the above, works such as those carried out by Gertrudix et al. (2021) point to an unequal use of social media by scientists, in which Twitter and Facebook are the leading digital platforms used, in a minimal way, for the tasks indicated above. A use mainly made for contact with academic peers and not for communication with other (non-academic) social agents. Whereas generalist (e.g. YouTube) or more specialized (professional) social media, such as LinkedIn, are rarely used. No other antecedents specify the social media in which the scientific debate is developed according to social science researchers' communication and dissemination plans.

According to Meishar-Tal and Pieterse (2017), the rewards that motivate users to access social media are related to four specific dimensions: self-promotion and reinforcement of the ego, the acquisition of professional knowledge, a sense of belonging to a community of peers and an opportunity to interact with other users or researchers. Salinas Ibáñez and Marín Juarros (2019) point out in their study that researchers use social media mainly to disseminate their results in search of personal visibility, and collaboration purposes are in the background. However, it seems that the possibility of interaction for collaboration in social media by researchers is largely wasted (Meishar-Tal & Pieterse, 2017). Regarding the presence of scientists on social media, Gil-Fernández and Calderón (2021), Rodríguez-Fernández et al. (2018), and Martín et al. (2020) highlight that there is an increasing trend in the use of RRSS by researchers, but they remain hesitant to share their research results and collaborate with colleagues through these digital channels. Therefore, there seems to be an unfavourable bias against promoting scientific communication and dissemination oriented to the dialogue and participation of users who may not be associated with academia (citizens, in general).

An important aspect that can interfere with university researchers' assessment and use of social media is the level of development of their digital skills for communication and collaboration. Zaragoza and Roca Marín (2020) show that the time and dedication involved in having an active life on social media may be too demanding, and this is sometimes related to how competent they are in digital environments. This finding was reaffirmed by Finkler and Leon (2019), who pointed out that science communicators must provide content in the format generally consumed by society. However, researchers

often lack basic knowledge about how to design scientific communication materials for social media. Further, researchers' fears about the invasion of privacy or the risks of exposure to the Internet (Gil-Fernández and Calderón, 2021) could adversely affect their active incorporation of social media.

Undoubtedly, university professors are called to contribute to the scientific knowledge they produce under the protection of research centres at higher education institutions. In the era of information and knowledge with the emergence of Web 2.0 and social media, it is possible to transcend the small circles of inter-institutional contacts towards greater reach in communicating and disseminating their research results. This development has raised awareness of social media, their use and their value for communicating and disseminating scientific research (Campos-Freire et al., 2014; Simón, 2016; Fernández Bayo et al., 2019). From this point of view, this study proposes to investigate researchers' perceptions of social media, the importance and utility they provide, and their presence and patterns of use. A literature review was conducted, and the characteristics of researchers from Spanish universities were subsequently analyzed.

3. Research method

This work aims to understand the perception that researchers in academia in Spain have about the importance of social media in scientific communication and dissemination at the societal level. In addition, we delve into the understanding of the factors that would be influencing the perception the researchers considered in this work have around the topic raised. This objective will help to answer the questions that will guide the development of this work: What are the studied researchers' perceptions and habits of use around scientific communication and dissemination through social media? What factors affect the perception of the importance of these digital scenarios? How can researchers be grouped based on their perception of the importance of social media in promoting communication and dissemination of their scientific work?

Both the general objective and the questions that guide this work will be achieved from the following specific objectives (SO) will be taken:

SO1: Determine the perception that researchers linked to the field of education about the importance and usefulness of social media.

SO2: Determine researchers' social media usage habits.

SO3: Establish the reasons researchers use social media.

SO4: Identify the sociodemographic, academic, user habits and institutional variables associated with social media.

SO5: Establish the profile of the researchers according to their perceptions of the value of digital social media.

The following hypotheses, based on what has been stated by authors such as Finkler and Leon (2019), Zaragoza and Roca Marín (2020), Gertrudix et al. (2021) and Gil-Fernández and Calderón (2021), among other authors mentioned in the theoretical section of this article, guide the study:

H1: Despite the potential of non-academic social media for disseminating scientific knowledge, researchers make little use of social media for this purpose.

H2: The lack of digital skills, time and dedication affects the researchers' perception of the importance of social media in scientific communication and dissemination.

H3: The perception and reasons for using social media do not favour promoting communication and scientific dissemination models oriented towards dialogue and participation in scientific discussion at the societal level.

The study is based on the results generated from qualitative-quantitative research carried out between September 2021 and January 2022, following the procedure indicated by Said-Hung (2021), shown in Fig. 2.

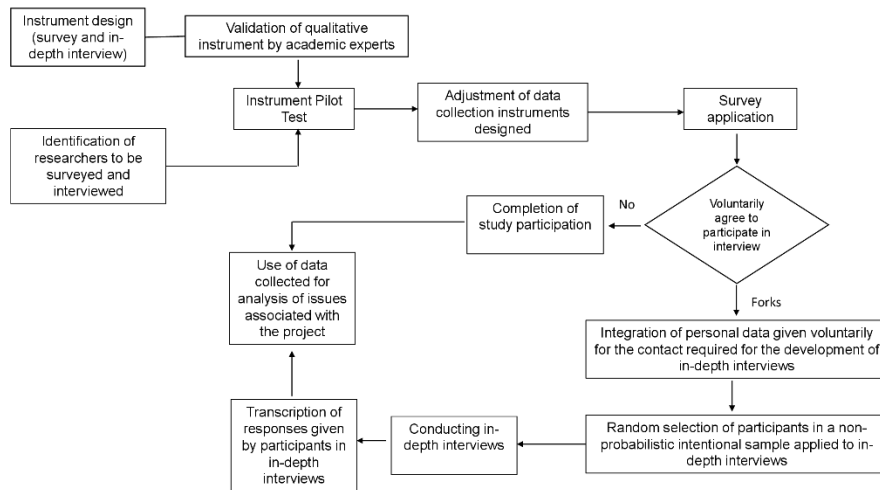


Fig. 2. Methodological procedure based on Said-Hung (2021)

The identification of researchers who participated in the study on which this work was based took into consideration all researchers who had published scientific content (e.g., articles, books, book chapters) related to the field of education in academic journals indexed in Scopus or Web of Science (WoS) in the past five years (2016-2020) were eligible. Of the 12,044 academic works identified, 5,314 researchers were identified, and their profiles were included in this study. From the total number of researchers identified, a simple random sample was applied, consisting of 554 researchers surveyed ($e = \pm 4$ and $1-\alpha = 95\%$). Of these, 67 researchers (12% of the total sample) participated during the design and validation ($\alpha = 0.885$) of the survey applied in this study, and a total of 487 researchers were surveyed ($e = \pm 4.2$ and $1-\alpha = 95\%$).

The final survey applied¹ and validated ($\alpha = 0.885$) from a pilot test² was made up of a total of 37 questions, based on the work done by Said-Hung (2021), distributed in:

- Questions aimed at obtaining the socio-educational and academic profile of the university professors surveyed (e.g., age, gender, educational level, public or private nature of the institution where they work, years of experience)

¹ For access to Survey design please enter <https://doi.org/10.6084/m9.figshare.17005750>

² The pilot report can be access <https://doi.org/10.6084/m9.figshare.17005735>

- Questions focused on better understanding the habits and use of social media (e.g., Perception of the importance of social media in the scientific work in charge, number of times a week that social media are used to access advanced scientists, social media used for scientific communication and dissemination).

The objective of the survey was to understand researchers' perceptions regarding their habits and utilization of social networks for disseminating scientific knowledge. The aim was to ascertain educational scientists' role in digital scientific communication models, as proposed by Bucchi (2008) and Palmer and Schibeci (2014). This perspective is informed by researchers' understanding of the potential benefits social networks can offer for scientific dissemination, as discussed by Fuentes Cancell et al. (2021). It also takes into account the insights from studies conducted by Kilis et al. (2016), the Spanish Foundation for Science and Technology (2020), Farias and Maia (2020), Gertrudix et al. (2021), and other authors considered in this work.

To delve into the reasons associated with the habits and use of social networks for the dissemination of science by the population studied, in-depth semi-structured interviews were applied, following the design made in the study framework of the project on which this work was based (Said-Hung, 2021) based on an intentional sample of researchers participating in developing the previously applied survey. The interview delved into aspects or topics addressed in the survey, namely, how and in what way they make use of RRSS for the dissemination of scientific advances, perception of the usefulness of these tools to publicize scientific results, impact generated by the RRSS in the communication and dissemination of science; dissemination strategies used to promote access to scientific knowledge in the area of education; and training in the use of social media. All the responses from the researchers who participated in the in-depth interview were transcribed³ and articulated in each aspect mentioned above.

The in-depth interview applied⁴ had the prior validation⁵ of ten experts from different fields of Social Sciences from the University of Cadiz, the University of Jaen, the University of Burgos, the Pompeu Fabra University, Ramon Llull University, the University of La Rioja, the Universidad Internacional de La Rioja, King Juan Carlos University and the University of Murcia. These experts validated this instrument about the understanding, the relevance of the questions to achieve, and the quantity versus quality relationship of the questions included (e.g., How or in what way do you use social media to spread the word; the usefulness of social media to publicize research results; significant impacts of social media in the communication and dissemination of Science; and perception of the use of strategies aimed at taking advantage of social media for the dissemination of the research work carried out). The instrument obtained a global score of 4/5 points, which was considered in the adjustment of the final instrument applied in this work in the following aspects:

- Improve understanding of questions (clear, precise, unambiguous, according to the target population's level of information and language).
- Separate questions in blocks, which help to delve into 1) The impact of communication strategies and scientific dissemination; and 2) the type of communication and dissemination strategies and knowledge (importance and usefulness) of the use of RRSS for the dissemination of scientific thought.

³ The transcription was made with the support of the Amberscript platform.

⁴ For access to in-depth interview, please enter <https://doi.org/10.6084/m9.figshare.19611516>

⁵ For access to validation report, please enter <https://doi.org/10.6084/m9.figshare.16915435>

- Review the quantity and quality of the questions according to what we are investigating.
- Improve the exposure and relationship of the questions associated with specific objectives.
- Include clarifying examples in questions.

Out of the 487 researchers who took part in the survey, 149 expressed their willingness to participate in the in-depth interviews conducted for this study, as indicated by a specific question in the survey. From this group, a subset of 20 individuals was randomly chosen to form the intentional sample by the project's predetermined criteria. The collected data was analysed using human intelligence, aligning with the study's objectives. Table 1 shows the average academic profile of the researchers surveyed.

Table 1
Descriptive data of participating researchers ($N = 487$)

	<i>N</i>	Min	Max	Mean	SD
Sex*	482	1	2	1.53	.500
Age	487	28	83	48.02	9.903
Type of affiliated university ***	487	1	2	1.13	.336
Years of obtaining a university degree ^	487	1	5	4.16	1.139
Branch of Knowledge associated with the primary university degree ^^	487	1	5	3.47	1.134
Possession of doctorate ^^^	487	1	2	1.06	.233
Years of obtaining the doctorate ^	459	1	5	2.95	1.453
The doctorate shares the branch and field of knowledge of the degree previously obtained ^^^	459	1	2	1.10	.303
Possession of accreditation ^^^	459	1	2	1.20	.402
Highest level of accreditation **	396	1	5	3.26	1.264
Possession of a six-year term ^^^	484	1	2	1.41	.493
Number of six-year periods recognized	487	0	7	1.86	1.801
Six-year research period, in force ^^^	285	1	2	1.04	.201
Link to a research group affiliated with Spanish universities ^^^	487	1	2	1.09	.287

Note. * 1 = Male/2 = Female; ** 1 = PhD Assistant/2 = Hired PhD/3 = Private University Professor/4 = Full Professor/5 = Professor; ^ 1 = Less than 5 years ago/2 = Between 6 to 10 years ago/3 = Between 11 to 15 years ago/4 = Between 16 to 20 years ago/5 = More than 20 years ago; ^^ 1 = Health Sciences/2 = Sciences/3 = Arts and Humanities/4 = Social and Legal Sciences/5 = Engineering and Architecture; ^^^ 1 = Yes/2 = No.

The data shown allow us to establish a profile of participants characterized by the following:

- A similar proportion of men and women were included (46.4% and 52.6%, respectively).
- The average age was between 41 and 50 years.
- They work primarily in public university institutions in Spain.
- Lines of research have focused mainly on issues associated with the educational level of professional training in Spain.
- They were in the educational system for 16 to 20 years to obtain a university degree, mainly in the social sciences.

- Most obtained a doctorate in 11 to 15 years in the field in which they were trained and worked at the time of this study.
- They were accredited by the National Accreditation Agency in Spain (ANECA) as a contracted professor at a private university.
- They had at least one six-year term recognized by the CNEAI/ANECA.
- They were linked to a research group affiliated with a Spanish university.

4. Results

When estimating the importance of social media (see Table 2) in communication and scientific dissemination by the researchers surveyed (SO1)⁶, the observed mean ($\bar{x} = 3.61$ and $\sigma = 1.038$) allows us to locate the perception around what is addressed here at a medium-high level with a high dispersion of observed responses, which allows us to see how 36.8% still have a shallow, low or medium level of perception. Only 17.9% perceived the importance of social networks as resources to promote visibility and access to scientific knowledge generated for academic peers and non-academic social agents through communication and active dissemination of the results generated in the different research processes. Therefore, many researchers still have some qualms about giving social media a prominent role in scientific communication and dissemination in the university sector in general and the education sector where they focus their research. They are also reluctant to give visibility to their research results personally.

Table 2

Descriptive statements associated with the importance of social media in scientific communication and dissemination

N	Min	Max	Mean	SD
487	1	5	3.61	1.038

Note. 1 = very low level of importance; 2 = low level of importance; 3 = neither high nor low level of importance; 4 = high level of importance; and 5 = very high level of importance.

In general, the data indicate a presence in social media (SO2), where the majority (91% of respondents) recognized using social media for academic purposes in the previous six months, with average access of 2-3 times ($\bar{x} = 3.61$ and $\sigma = 1.038$). Their participation was focused on 2.0 specialist platforms, characterized by users with similar academic profiles, rather than on platforms with a more diverse user profile (see Table 3). Therefore, communication and dissemination seem to be horizontal (between peers) rather than vertical towards other social actors interested in access to knowledge to improve their socio-professional context, for example.

⁶ The level of importance is an ad hoc variable that uses a five-point scale, created from the sum of the answers given by the respondents in terms of the level of general importance in the academic field within the education sector, and at the person level assigned to the RRSS. The sum of each of the answers given by the respondents had a minimum value of 3 points and a maximum of 15 points, which served to create the five-point scale used to address the issue raised (those with a rating of up to 3 points were assigned a very unimportant assessment; those who were 3 ≥ 6 points, were assigned an unimportant valuation; those who were 6 ≥ 9 were assigned a rating of neither very nor little important; those who were 9 ≥ 12 were assigned an important rating; and those who were 12 ≥ 15 were assigned a very important assessment).

Table 3
Use of RRSS to communicate and disseminate Science*

Name of social media	Percentage of responses
Facebook	21.7%
ResearchGate	80.6%
Twitter	35.4%
Linkedin	22.3%
Fightshare	1.3%
Instagram	8.6%
Blog or personal website	14.3%
Academia.edu	28.0%

Note. *The RRSS mentioned were those indicated by the respondents, based on the question posed in the survey applied at work: What are the social media or platforms (the three main ones) that you use to communicate or disseminate scientific advances that you obtain?

The described scenario is better understood if we integrate information from the participants who participated in the in-depth interviews. In most cases, they recognized the importance of social media, although they focused on a utilitarian context of academic communication and dissemination than a social (generalist) context and the use of social media of more significant academic or professional interest:

“They are very important... I recognize the little I use and should do more... From time to time, I use the LinkedIn network of the research teams I direct, which is quite multidisciplinary and international. But beyond that, I do not use social media.” – FJZ, researcher, female.

“A lot. They are handy because they make the research known... I prefer academic and social media to generalist networks because, for example, I was on Facebook until recently. After the pandemic began, I got off because people would comment on the news without verifying whether it was true or false. It ended up burning me out. So I removed myself from Facebook and was left with only Twitter and the academic Publons, ORCID, mainly.” –AJM, researcher, men.

“Yes, totally (important)... we have no escape, that is, we must use them all. In other words, they are necessary diffusion alternatives, not sufficient, but necessary... I use social media effectively in verticals, such as ResearchGate and academia, and then the generalists, Twitter, Facebook, and LinkedIn.” JGP, researcher, men.

“Yes, I think so (they are important) because it helps with dissemination, and then we can also network. Not only can you share what you publish, but you can get notifications from other publications. In addition, I have an active profile on ResearchGate, although I do not consider myself active.” –AG, researcher, female.

“Well, they are not very useful... I suppose you might have your circle of friends or colleagues, scientists with whom you exchanged information. You sent them your last article, and they sent you theirs... However, I do not trust social media when I have to look for needed material. They help me keep up to date (with academic progress).” –DD, researcher, female.

“I think they are handy because they greatly increase the creation of one’s own reputation, as a professional, as an academic, and they initiate discussion and generate contact networks with other people interested in the same field.” –IM, researcher, woman.

Regarding the reasons for using or not using social networks for the purposes addressed in this study (SO3), Table 4 allows us to see the main options considered by the respondents during the survey. Researchers focused on two areas: lack of time or knowledge that would allow them to make greater and better use of digital communication channels (50%) and the lack of interest or a clear vision of the utility of social media (50%). When justifying the use of social media, most of the arguments are associated with improving the scenario and academic indicators where researchers work, while only 7.9% presented reasons aimed at communication and scientific dissemination at the social level.

Table 4
Reasons for use or non-use of social media for academic purposes

Reasons for non-use	Response percentage	Reasons for use	Response percentage
I do not have time to use these resources	43.2	Improvement of my working conditions	2.9
I am not interested or do not think it is helpful for what I do academically	31.8	Construction of networks with other academics or professionals in the sector	22.6
I do not have the necessary knowledge for it	6.8	Greater professional visibility	47.6
I do not think this helps me increase the visibility of my academic work	13.6	Greater number of citations for the works that I publish	19.0
I do not consider that it serves to contact social groups	4.5	Other reasons (e.g., scientific transfer at the social level, scientific dissemination, keeping up with scientific advances)	7.9

What was observed in the survey was also reflected in the responses given in the interviews conducted with the population studied:

“They are handy because they pass along knowledge... Not everyone has access to your research. So, the moment when you publicize it on social media, it facilitates the work a lot.” –AJM, researcher, men.

“It is useful for me. As a result of my experience with this type of publication, other researchers who were in the same line of work have sometimes contacted me.” –MRH, researcher, female.

“They are worthwhile in making research results known so that other academics in my social media know a little about where and what we are doing and how it is turning out. But at the social level, people do not read things.” –SE, researcher, female.

“I do not find many topics of interest on the Internet other than through social media, especially regarding research.” –MB, researcher, female.

At the time of establishing the variables associated with the perception of the importance of social media in scientific communication and dissemination (SO4), only a low, although statistically significant, relationship was observed concerning gender or having earned a doctorate ($p = 0.049/V = 0.141$ and $p = 0.018/V = 0.156$, respectively). This means that the importance of social media in science communication at the education level will be greater among female researchers with a doctorate than in those who do not have these traits.

Suppose we apply a tree analysis to our dependent variable (importance of social media in scientific communication and dissemination) concerning our subjects' sociodemographic, academic, usage habits and institutional variables. In that case⁷, we see more significant differentiation between researchers who consider the use of social media to be important or not (SO5). The analysis reached 74.5% correct classification (see Table 5).

Table 5

Profile of researchers, according to the perception of the importance of social media in scientific communication and dissemination

Observed	Not important	Predicted important	Correct percentage
Not important	88	66	57.1%
Important	57	276	82.9%
Overall percentage	29.8%	70.2%	74.5%

Note. Prepared by the authors applying the growth method: exclusive CHAID.

According to the predictions of the tree analysis (Fig. 3), there is a difference between those who consider social media to be important or not, based on the independent variables included in it, distributed in three levels of depth and 14 nodes (9 terminals) identified in the tree.

The researchers' perception of the importance of scientific dissemination of social media depends on the frequency and moments (during all projects' lives, in the end, or only a few times) in which these digital scenarios are used for publishing their results to society. In the case of researchers that use it once or twice a week, female researchers are the ones who have a higher perception concerning male researchers. Fig. 1 allows us to identify three profiles of researchers according to the level of importance given to social media in scientific communication and dissemination:

- Researchers who regularly use social media consider these resources necessary for developing their research activities. Within this group, three profiles are distinguished according to the perceived importance of the moments in which they disclose the results of their research from this type of digital communication scenario: those who disclose only at the end of the projects, those who do so occasionally, and those who do it permanently, as soon as they have partial or final results.
- Researchers who make occasional (once or twice) weekly use of social media for the purposes mentioned here and who will be subclassified according to gender, with female researchers being the ones with the best evaluation regarding this type of resource, compared to male researchers.

⁷ Age, sex, type of affiliated university, branch of knowledge associated with the main university degree, years spent obtaining the university degree, possession of doctorate, the doctorate shares the branch and field of knowledge of the degree that was obtained, years spent obtaining the doctorate, accreditation, number of recognized research merits from the national committee for the assessment of the research action (CNEAD), link to research groups at Spanish universities, reasons for use and non-use of social media for academic purposes, use of social media to obtain results in part or total for any research associated with your academic work, use in the past six months of any social network or platform for academic purposes, perception of the training environment for the use of social media at the academic level, number of times a week (7 days) that social media are accessed for academic purposes.

- Researchers who do not use social media consider that most of these spaces are not crucial for developing their academic activities.

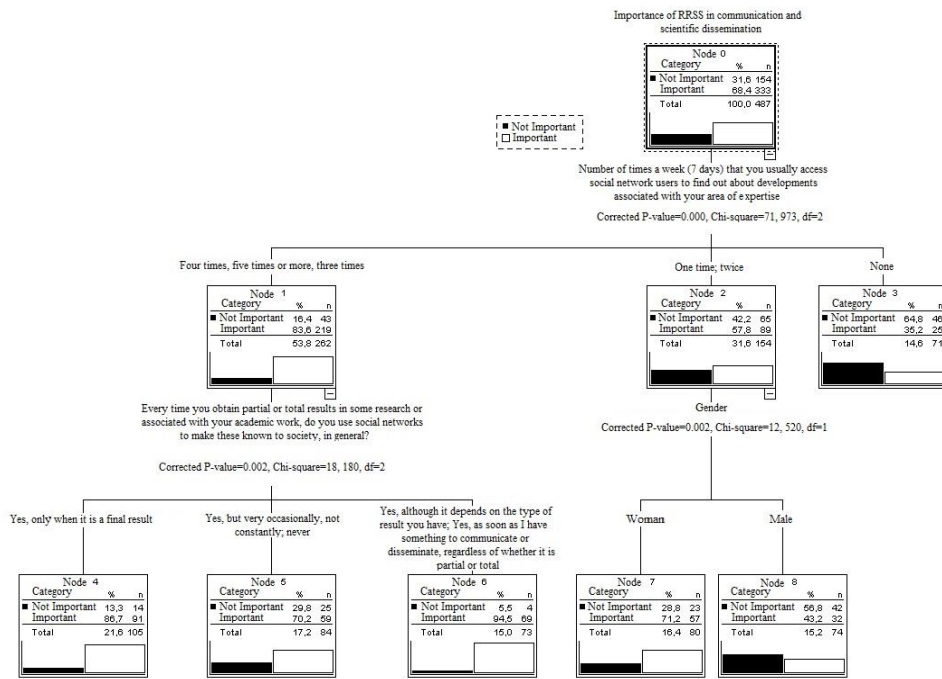


Fig. 3. Tree analysis of researchers who consider social media to be important versus not important for scientific dissemination

The tree analysis helps to identify three profiles and subgroups of researchers related to the educational field according to their perceptions of the value of digital social media. Some roles that favour a better understanding by grouping the researchers analyzed by cluster, according to the topic addressed in this work. It can be highlighted that although there is a cluster of researchers who regularly use social media to communicate and disseminate their projects, there is a subgroup that does so only at the end of their projects, which confirms H1 concerning the low use of social media by researchers. On the other hand, in the tree analysis, two other clusters are distinguished, one in which social media are used for scientific communication and dissemination only occasionally and another that considers social media irrelevant for academic activity. All this converges with H3, indicating that the perception and motives for using social media are not conducive to promoting scientific debate. Likewise, Fig. 3 shows the segmentation of researchers according to variables such as gender, frequency and motives for using social media and the importance they attach to it, favouring the understanding of the phenomena studied in this study. It stands out, for example, that among those who occasionally use social media, it is women who value these media more for communicating and disseminating their scientific projects.

5. Discussion

The results of this study demonstrate that researchers in the field of education have a medium-high perception of the importance of social media's role in communicating and disseminating scientific knowledge from the institutes of higher learning in Spain. Low utilization of social media still characterizes the perception of researchers. These findings coincide with the results of Kilis et al. (2016), Rodríguez-Fernández et al. (2018) and Gertrudix et al. (2021). Strengthening researchers' relationships with social media, especially generalist networks, continues to be challenging. As these authors point out, this implies improving researchers' perceptions of social media. Above all, we need to consider the need to disseminate scientific knowledge at the social level, according to Alonso-Flores et al. (2019) and Calvo Iglesias (2021). Above all, if we want to promote a scenario of scientific communication and dissemination through social media, more capable of dealing with the transfer of knowledge generated by its members in a more transversal way, that is, not only attending to the need that researchers have to make their scientific advances known to other peers or members of their scientific communities; but also directing this knowledge towards non-academic social agents, who should also be recipients of the knowledge generated by them, in the terms indicated at the beginning of the introductory section of this work. Actions that it is logical to think that they have motivations and patterns of differentiated use, but that does not mean they cease to be part of the social responsibility that every researcher must assume, as well pointed out by Gertrudix et al. (2021) when studying the change in the dissemination model proposed from the European Horizon 2020 programs, in favour of reaching the most significant number of interest groups of the scientific results achieved by researchers.

The researchers participating in this study expressed doubts and reservations about using generalist social media such as Facebook and Instagram to disseminate their research. However, there is a more significant presence of the researchers studied on Twitter, and they have a more positive perception and greater use of specialized networks such as ResearchGate, where they find individuals similar to themselves (Boudry & Durand-Barthez, 2020). This would be conditioning the approach of Science to a social environment other than academic/scientific circles (Montesi et al., 2019), leaving out non-university educational environments, for example, parents, students, managers and non-university professors. It implies that the social transfer of science, at least around topics of educational interest addressed by the researchers studied in Spain, is limited. What makes it challenging to take advantage of the knowledge generated from universities to society. Especially if we take into account that the results allow us to observe some features associated with the habit of use that the studied researchers make of social networks, which allows us to estimate a more focused pattern of use on specialized academic platforms (e.g., ResearchGate), aimed at peers or members of the scientific community, and not at other types of (non-academic) agents.

The results also point to what is indicated by Meishar-Tal and Pieterse (2017) and Salinas Ibáñez and Marín Juarros (2019), a relationship of researchers with social media oriented to self-promotion and reinforcement of professional ego and the construction of networks that enable academic or professional collaboration, as one of the main reasons for the use of social media. A context similar to that mentioned by authors such as Zaragoza and Roca Marín (2020) is the lack of time and dedication required by this type of digital communication scenario and the lack of apparent "utility"; these seem to be the main reasons for nonuse. What is shown here would imply being in a scenario where the perception of the usefulness of social media and the time dedicated to their use would focus, above all, on the search for visibility and the formation of contact networks between academic peers. Although it is true, something that is important within the

academic work carried out by researchers would be leaving aside another of its primary functions, favouring access to knowledge to other social agents external to higher education institutions. And therefore, a reduction in the possibilities of social development from the social dissemination of science.

What has been stated thus far would lead us to confirm Hypothesis 1, that despite the potential of non-academic social media for the social dissemination of scientific knowledge, use remains low among the researchers surveyed in this study. What limits access to scientific knowledge through social media to social actors outside the research environment.

In the case of Hypothesis 2, the data show that the factors of time and dedication that the researchers say they have to use the RRSS and the perception of the training needed influence the perception of usefulness and subsequent use of social media. However, the results also point to another series of factors (i.e., gender and educational level of university professors) that should be considered when designing actions or strategies to improve the perception and use of digital communication resources from higher education institutions in Spain. Actions that should consider the profiles of researchers pointed out in this paper. The profiles could help focus their attention on researchers who do not consider social media's role in disseminating the knowledge generated through their work as researchers to be significant enough. In this case, review the possible strategies applied by higher education institutions when encouraging the use of this type of digital communication resources by researchers interested in the study of issues associated with education, in our case. Above all, the level of researchers who do not make any use or who make occasional use of social media when disseminating the results of their research; and whose availability of time and received institutional training seem to be conditioning their perception of the usefulness and use of social media.

The data shown in this study would also confirm Hypothesis 3. The importance of social media and the reasons for their usefulness expressed by researchers in the field of education in Spain does not seem to be oriented towards dialogue and citizen participation. Sharing the approaches of Bucchi (2008) and Palmer and Schibeci (2014), we could find ourselves in a communication context that favours a deficit model where the use and exploitation of digital communications seem to be more focused on specialized (academic) social media rather than generalist social media, visibility and formation of professional networks and specialized contact with other academic/scientific actors. This scenario shows the limited capacity of citizens (participation and dialogue) to engage with researchers. What makes us find ourselves in a deficient context of knowledge transfer to society, by the actors analyzed in this work, and a questioning of the role of transformers of the social context of the application of their research, by directing the dissemination of knowledge to specialized areas, whose users have a similar profile to these and less to the population that directly benefits from the knowledge generated. Especially if we take into account that the knowledge generated from higher education institutions should make use of digital communication resources, such as those considered here, to communicate and disseminate the knowledge generated in favour of improving practices (carried out by teachers) and educational environments related or unrelated to these areas (non-university education). What now does not seem to be being carried out efficiently or effectively.

6. Conclusion

The study reveals that researchers' utilization of social networks for scientific communication and dissemination is still far from optimal. General digital platforms are less effective than specialized social platforms designed for the scientific community. Moreover, there are considerable gaps and ample room for improvement in perceived skills required to leverage these platforms and their perceived usefulness for the intended purposes. As a result, the study concludes that the current conditions within the study population and academic sector do not provide the necessary framework to ensure comprehensive scientific dissemination across the knowledge generated. Instead, the focus remains on building academic networks, inadvertently sidelining the important work of reaching a broader range of interested groups, including non-academic actors, who would benefit from researchers' scientific findings.

The practical implications of this research encompass several key aspects. Firstly, it highlights the necessity for higher education institutions to reassess and propose tailored strategies that align with the identified profiles of researchers in this project. Specifically, an institutional model should be devised to enhance training on social media usage and foster communication and dissemination policies that ensure active and consistent utilization of social media platforms. These efforts should be financially supported by research projects funded or endorsed by higher education institutions.

Additionally, measures ought to be formulated to support and recognize users on generalist social media platforms in their efforts to transfer scientific knowledge. These measures should be advocated at both the individual level and within research groups, emphasising empowering and providing prominent roles for female researchers. By promoting inclusivity and gender equality, these actions can contribute to a more balanced and effective dissemination of scientific knowledge across various social media platforms.

We acknowledge the inherent limitations of this study, particularly regarding the scope of the instruments used and the need to explore new methodological approaches that can provide deeper insights into the proposed topic. To address these limitations, we recognize the importance of initiating new projects, as suggested by Farias and Maia (2020), that can examine factors contributing to a better understanding of the role of women researchers within the context under discussion. Moreover, we believe it is crucial to conduct additional studies that enable the examination of these perceptions in conjunction with other potential recipients of scientific knowledge, such as non-university professors. Additionally, studies with a stronger focus on contrasting the observed perceptions with the actual activities conducted by the actors analyzed on social networks would be valuable. Pursuing these lines of research will contribute to advancing new dimensions of analysis related to the topic addressed in this article.

It is important to highlight that our work will serve as a valuable reference for future research endeavours associated with the mentioned lines of inquiry and other areas that emerge from engaging with our study. Researchers can draw upon our findings and insights to inform their investigations and expand upon the topics discussed. By utilizing our work as a foundation, future studies can further advance the understanding and exploration of these research directions.

Author Statement

The authors declare that there is no conflict of interest.

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