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Strategies of creators of scientific content on social networks: climate change and circular economy as emerging fields

Estrategias de los creadores de contenido científico en redes sociales: cambio climático y economía circular como ámbitos emergentes

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Abstract
The phenomenon of creators of scientific content on social networks represents a way of bringing scientific knowledge closer to society, outside of institutional channels. This article tries to identify these strategies and to analyse the impact of incorporating content related to climate change and the circular economy into their publications, as emerging areas. To obtain information, we chose to collect data by means of a questionnaire distributed among a group of creators of scientific content with a diversity of profiles on social networks. Among the results, the use of strategies typical of the digital field in the generation of the message is prominent, a perception of one's own credibility still linked to the verification of the academic field, as well as a positive opinion regarding the possible social impact of the contents referring to the climate change and the circular economy highlight. The latter perception differs from the effects that the creators themselves observe when they develop publications related to climate change and the circular economy, and denotes a relative interest of the audience towards these topics.

Keywords
scientific communication; content creators; circular economy; climate change; social networks; digital formats

Resumen
El fenómeno de los creadores de contenido científico en redes sociales representa una forma de acercar el conocimiento científico a la sociedad, fuera de los canales institucionales. Este artículo trata de identificar dichas estrategias y analizar el impacto de la incorporación a sus publicaciones de contenidos relativos al cambio climático y la economía circular, como ámbitos emergentes. Para la obtención de información se ha optado por realizar una recogida de datos a través de un cuestionario distribuido entre un grupo de creadores de contenido científico con diversidad de perfiles en redes sociales. Entre los resultados destaca especialmente la utilización de estrategias propias del ámbito digital en la generación del mensaje, una percepción de la propia credibilidad todavía ligada a la verificación del ámbito académico, así como una opinión positiva en cuanto al posible impacto social de los contenidos referentes al cambio climático y la economía circular. Esta última percepción difiere de los efectos que los propios creadores observan cuando desarrollan publicaciones relacionadas con el cambio climático y la economía circular y denotan un relativo interés de la audiencia hacia estas temáticas.

Palabras clave
comunicación científica; creadores de contenido; economía circular; cambio climático; redes sociales; formatos digitales

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1. Introduction

The 2030 Agenda on Sustainable Development is a call to action, not only globally and locally, but also as regards individuals. It asks people to act to promote a transformation (United Nations, 2015) requiring, among other things, that the urgent challenges posed by climate change and a hardly sustainable, traditional, linear model of production and consumption be addressed. The circular economy is understood as the transition from a traditional paradigm to one that extends the life cycle of products (European Parliament, 2023). It has become a cornerstone of a process requiring efficient scientific communication that is capable of generating social- (Gertrudix et al., 2021) and action-oriented impacts.

Few studies have been published on the circular economy in communication-related publications in the field of social sciences (Romero-Luis et al., 2021). However, the urgency of contemporary challenges requires studies that shift their focus from traditional channels of scientific communication to others, such as social networks. These are used by an increasing number of scientific content creators to disseminate scientific information, and overcome the obstacles posed by misinformation and disinformation. This is the case not only as regards denialist arguments, which are difficult to sustain in the face of scientific evidence, but also sceptical discourse (Jiménez-Gómez and Martín Sosa, 2022) that sows doubt and discourages action (Lavik, 2016).

1.1. Science and society

Since the *Science and European Public Opinion* report was published in 1977 (European Commission, 1977), the available data show that European society has declared its trust in science and preoccupation with the issues of greatest concern to citizens. Chief among them are those relating to health, but also the environment, especially since this issue became the focus of the political agenda of the European Union (European Commission, 1990). However, trust is not synonymous with understanding. The distance between science and society has been marked by the obscurity of scientific and academic language (Morales da Silva and Baronas, 2019), and the narrow channels for dissemination of scientific knowledge.

The COVID-19 pandemic has accelerated the rapprochement between science and Spanish society. Starting in 2022, an increase in interest in science and technology has been observed compared to 2020 (FECYT, 2023). Since then, people have sought scientific answers more frequently in areas affecting their daily lives, such as public health or the environment. The FECYT report (2022) indicates that in 2022, the Internet was the most frequently used medium to obtain information about science and technology with a frequency of use of 71.2%. However, a large amount of misinformation spreads in the digital sphere, causing people to become more fearful and share information without prior verification (Matta, 2020).

The dissemination of science is a particularly important area of knowledge within the field of communication (Parejo-Cuéllar, de-Casas-Moreno and Méndiz-Rojas, 2022). An increasing number of countries view the dissemination of science as a core strategy for action (Elías and Catalán-Matamoros, 2020). This trend has arisen in response to crisis situations and anti-science movements, such as vaccine and climate change denialism, combating misinformation and highlighting the importance of science in society.

It is essential that the language used when disseminating scientific advances adopts the styles of journalism, social networks and videos (Ross-Hellauer et al., 2020). Following this trend, scientists have recognised the need to move beyond exclusively academic debates and make scientific knowledge more accessible to the masses (Sanz-Lorente and Guardiola-Wanden-Berghe, 2019). This involves not only communicating with journalists and others in society, but also being conscious of the risk of imprecise communication or lack of communication, which could reduce the credibility of science among citizens (Elías and Catalán-Matamoros, 2020).

Creators of scientific content on social networks have emerged as disseminators of science with the goal of effectively communicating science to society. This role allows for better understanding and dissemination of scientific knowledge by facilitating the public communication of science (PCS). This is understood as the process of conveying scientific information in a precise and contextualised manner using specialised knowledge to people who are not experts in the particular field concerned (Sánchez Mora and Macías Nestor, 2019).

1.2. Changes in the media context

In Spanish society, the Internet has become firmly established as the pre-eminent means of communication. With its progressive integration, collaboration between the Internet and traditional media has become stronger. At the same time, social networks have become increasingly relevant and are now being used by institutions to showcase their work (Levis, 2010). It has been established

that sharing information on climate change is a social practice that affects not only media but also non-media institutions (Teso Alonso and Lozano Ascencio, 2020). Likewise, digital convergence has also had a significant impact on users' habits when using the medium not only for information but also for entertainment.

The Internet's expansion has transformed the way in which people consume content, since they are now offered new formats and ways of interacting with it (Navarro Robles and Vázquez Barrio, 2020). Social networks have emerged with the purpose of bringing people together to interact according to their interest in various topics (Rubio-Romero, Jiménez and Barón-Dulce, 2019). The interactivity inherent to the medium has made it possible to promote varied opinions, encourage demonstrations, establish support groups for specific causes or even create trends (Caldevilla Domínguez, 2010). Social networks, therefore, establish new forms of consumption that are especially attractive to young people. In this regard, people aged 18 to 24 spend the most time connected to social networks, and they do this to obtain entertainment, interaction and information (IAB Spain, 2022).

People belonging to Generation Z are more interested in constantly interacting with other users compared to those belonging to previous generational groups, and they seek immediate answers. They show a clear preference for visual content and are able to learn how to operate in virtual environments on their own (Álvarez Ramos, Heredia Ponce and Romero Oliva, 2019). As a result, the act of communication becomes more dynamic and is the basis on which they relate to their environment. 39% of this age group indicate that social networks are their main source of information (Newman et al., 2022). This means that this generation prefers to use TikTok as a digital search tool instead of Google to find information that suits their tastes (Huang, 2022).

The possibility of finding content based on users' interests has two crucial implications for understanding social media addiction. On the one hand, users receive personalised information according to their consumption habits, so people are more receptive to information biases (Rodríguez Cano, 2017). On the other hand, social networks have led to the dual roles of the 'prosumer', understood as the person who both produces and consumes content (Scolari, 2018). This does not mean that prosumers carefully process information, but rather that they produce based on their own way of thinking (Niño-González, Barquero Cabrero and García García, 2017). These two communicative phenomena lead to an information overload—sometimes referred to as an infodemic—where fact-checking becomes impossible.

1.3. Information crisis in scientific dissemination

Scientific dissemination plays an essential role in society, since it makes scientific knowledge and its advances accessible to the public. However, in the era of digital information and the proliferation of media, society faces an information crisis in terms of public communication of science, considering the rise of online content and the absence of scientific literacy among audiences.

The impact of social networks and other online platforms have encouraged the rapid distribution of unverified information that contributes to the infodemic (Mena Young, 2022), generating negative effects on the public perception of science. The lack of regulation and effective mechanisms to correct misinformation make this problem worse (Zimmer et al., 2019). Likewise, this overabundance of content can overwhelm the public and make it difficult to identify reliable and verified sources (Valera-Ordaz et al., 2022).

Through information bubbles, users surround themselves with like-minded people and tend to ignore or reject scientific perspectives that are contrary to their beliefs. This polarises and hinders scientific, evidence-based debate (Ross Arguedas et al., 2022) and makes it more difficult to disseminate verified information. Several indicators suggest that attempts to correct misinformation about scientific topics among people with more deeply held beliefs can be counterproductive and reinforce their false opinions (Scheufele and Krause, 2019). In the case of climate change deniers, social networks have amplified their narratives, increasing their visibility and public recognition (Abellán López, 2021).

This problem is compounded by the lack of appropriate filters to assess the quality and veracity of scientific information, the absence of which can lead to the spread of fake or inaccurate news. This is especially so when greater trust is placed in content shared by peers who are considered to be disinterested sources of information (De Frutos Torres, Pastor Rodríguez and Cruz-Díaz, 2021). Given this situation, many dissemination professionals carefully produce content to improve the understanding of scientific work on social networks (Gil and Guallar, 2023). However, for there to be a greater understanding of science, it is necessary to improve scientific literacy. In Spain, there is a low level of this type of literacy in students who have completed compulsory studies (Balastegui, Palomar and Solbes, 2020). Consequently, the absence of this literacy among the public, which is essential to critically assess information and understand scientific concepts (Pedrinaci, 2013), can lead to misunderstandings,

erroneous interpretations and the unconditional acceptance of information that is not scientifically supported.

1.4. Social networks as a channel for the dissemination of science

Social networks have revolutionised the way we communicate and exchange information. Their influence has permeated the field of science, and they are used as valuable dissemination resources, allowing scientists and disseminators to reach a wider audience. These resources are used to share scientific knowledge, interact with the public and promote scientific literacy. However, as recent literature has shown, their use also poses new risks and challenges (Scheufele and Krause, 2019).

Social networks can be a channel for the spread of hoaxes and misinformation. The speed and ease of sharing content without proper verification can lead to the spread of conspiracy theories, myths, and scientifically unsupported data, undermining public trust in science (Wang et al., 2019). By making a CPC (cost-per-click) more accessible and given the limitations of the digital sphere, any message may be excessively simplified (Bortoliero and León, 2017), leading to misunderstandings that distort scientific reality and reduce the quality of the information.

Regardless, social networks remain increasingly relevant for the dissemination of science (Gutiérrez-Manjón, 2023). They both encourage the democratisation of scientific knowledge and foster greater public participation in this area, given that discoveries can be shared easily, with video able to reach global audiences (Buitrago, Martín García and Beltrán-Flandoli, 2022). Also, thanks to greater direct interaction, a two-way dialogue can be established (Gutiérrez-Manjón, Álvarez García and Mena Muñoz, 2022), strengthening the dissemination and public understanding of science (Zaragoza and Roca Marín, 2020). These factors have led to a greater interest on social media in topics linked to the dissemination of science, such as climate change (Zhang and Skoric, 2018). TikTok is a case in point, where "users are aware of the seriousness of climate-related issues and see them as pressing problems" (Nieto-Sandoval and Ferré-Pavia, 2023: 326).

In the context of information overload, effective scientific communication on social networks requires, among other things, that communicative action be adequately defined and planned, adapting to the audience, goals and particularities of each social network. The same can be said of the importance of defining the key performance indicators of the action (Gálvez de la Cuesta, 2020). It also entails the need to master the various audiovisual formats, especially video and, consequently, the most appropriate narrative techniques for each situation, thereby capturing the attention of the public (Rajas Fernández, 2021). The goal would be to go beyond the mere dissemination of content and, in the words of De Santis-Piras and Jara Cobos, to promote "the transfer of knowledge to society" (2020: 127).

Several studies indicate that content elicits the greatest level of interest when it is presented with humour and an air of novelty, as this awakens the audience's interest. This is why scientific institutions with a digital media strategy are still less relevant than content creators, as they have struggled to adapt to the language of social networks (Sidorenko-Bautista, Cabezuelo-Lorenzo and Herranz-de-la-Casa, 2021; Buitrago and Torres Ortiz, 2022).

This adaptation to social media codes has generated large communities among content creators specialising in science. These disseminators of science use multiple screens and audiovisual language to connect with the emotions of their followers, thereby capturing their attention more effectively and retaining their audience for longer periods (Martínez-Sanz, Buitrago and Martín-García, 2023).

This form of interaction creates parasocial relationships with their community and a more immersive experience in which the subject feels that they are part of an initiative (Caro Castaño, 2015). This increases the impact of science influencers' messages on their audiences, making it more likely that audiences will share them with their contacts.

1.5. General goal and research questions

The main goal of this research is to analyse the strategies applied by scientific content creators on social networks, and identify their perception of the incorporation of climate change and the circular economy as emerging areas of their posts.

In addition, the following research questions have been put forward:

- Do content creators think that their activity is comparable to that of traditional media specialising in the dissemination of scientific knowledge?

- Do content creators believe that their work on social networks achieves a higher level of credibility than that of experts in the field?

- Is using a single message for all social networks a common technique among content creators?
- Is there a tendency for content creators to obtain their information from other content creators, or are they more likely to consult academic sources?
- Do content creators believe that the dissemination of science on social networks makes society more informed about the circular economy?
- Do content creators think that the dissemination of science on social networks helps raise awareness of climate change?

2. Methodology

As previously stated, the main goal of this research is to analyse the strategies applied by creators of scientific content on social networks and their perception of the incorporation of climate change and the circular economy as emerging areas. Three specific goals have been identified. The first is to identify how information is obtained and contrasted by the creators of scientific content themselves; the second focuses on how scientific content creators plan and diversify on the various social networks; and the third is to determine how important content creators think it is to disseminate science relating to the circular economy and climate change on social networks.

The methodological process is then described, where the different formulas adopted depend on research requirements and the possibilities of gathering information from the subjects contacted. The detail of this design is due to the interest in potentially replicating the methodology in other studies related to scientific communication on social networks. It is critical to describe and transfer the process in all its phases to ensure it can be reused. For this purpose, both the questionnaire model and the results have been published in the ZENODO open access repository (the European OpenAIRE Programme). How the data was collected, selected, and ultimately processed and analysed scientifically is explained below.

2.1. Definition of the data collection process

A descriptive statistical analysis of content creators' varying perceptions and assessments has been carried out based on the analysis of frequencies in a multiple choice model. The starting point of the research was a semi-structured interview with 15 open questions, designed using Google Forms. This was distributed in a self-administered manner, through an agency with a prominent profile in the field of science that specialises in representing influencers. However, there was almost no participation in this interview. Due to the difficulty in obtaining answers, a survey was generated. The questionnaire was constructed taking the previous interview as a reference, and ten questions were formulated with a structure linked to the Likert Scale. This questionnaire is available in the ZENODO ´open repository for open download and reuse.

2.2. Sample selection

The parameters of the study are content creators in the field of science who post their work on social networks. They have been defined as content creators and not influencers, as most of their profiles focus on the dissemination of science and do not tend to act on behalf of an advertising brand. However, influencer-specific classifications have been used to classify and frame them at different audience levels.

A convenience, non-probabilistic sample has been selected in accordance with the following criteria:

- Each content creator should be represented on at least two social networks.
- Depending on their number of followers, the profiles had to be included in the categories of mega-influencers (more than one million), macro-influencers (between one million and 100,000), micro-influencers (between 100,000 and 10,000) and nano-influencers (less than 10,000), following the classification put forward by Campbell and Farrel (2020). It was decided not to incorporate celebrity influencers into the study, according to the same classification and as suggested by Villegas-Simón et al. (2022), who consider them to be less authentic and with a lower level of engagement than micro-influencers. It is important to note that the mega-influencer profiles selected are in the minority; in general, they exceed one million users on a single social network, and not excessively so.

Taking these criteria into account, the selection of initial profiles can be seen in table 1:

Table 1 – Content Creators. Impact on Social Networks (March 2023)

Creator	Area	Followers – March 2023
Santi García Cremades @santigarciacc	Mathematics	38,900 (Instagram), 65,000 (Twitter-X), 59,000 (YouTube), 27,000 (Facebook), 1,323 (TikTok)
Ignacio Martín Lerma @I_MartinLerma	Prehistory	11,100 (Twitter-X), 7,646 (Instagram)
Marta Macho @MartaMachoS	Mathematics	11,100 (Twitter- X)
Lydia Gil – @TuSocialMedia	Documentation and Social Networks	5,275 (Twitter- X), 1,272 (Instagram)
Francisco Gómez Esquer @PasiónAnatomía	Anatomy	7,000 (Instagram), 103,700 (Twitter-X), 1,857 (Facebook), 41,300 (TikTok)
Esther Samper @shora	Medicine	36,700 (Twitter- X), 1,360 (Instagram)
Laura Morán @veneciana1981	Psychology and Sexology	3,478 (Instagram), 9,241 (Twitter- X)
Azucena Santillán @Ebevidencia	Nursing	21,000 (Twitter-X), 28,000 (Facebook), 2,840 (Instagram)
Astronauta Lili @AstronautaLili	Planetary Sciences	9,094 (Instagram), 21,400 (YouTube), 4,360 (Twitter- X)
Belén Hinojar and Carmen Huidobro @climabar	Environmental Sciences	41,400 (Instagram), 2,150 (YouTube), 1,921 (Twitter- X)
José Luis Crespo @quantumfracture	Physics and Astronomy	3.17 million (YouTube), 395,000 (Twitter-X), 509.00 (Instagram), 5,784 (Twitch), 498,000 (TikTok)
Martí Monfttferrer @CDeCiencia	Physics	1.47 million (YouTube), 190,000 (Twitter-X), 59,400 (Twitch), 167,000 (Instagram)
Javier Santaolalla @jasantaolalla	Physics	1.7 million (YouTube), 385,000 (Twitter-X), 4.1 million (TikTok)
Juanma Romero @juanmaromero	Meteorology	27,400 (Instagram), 29,300 (Twitter- X)
Carlos Santana Vega @dotcsv	Artificial intelligence	54,500 (Instagram), 150,300 (Twitter- X)
CienciaDeSofá @cienciadesofa	Chemistry and Geology	217,000 (Facebook), 583,000 (YouTube), 15,000 (Twitter X), 33,200 (Instagram)
Sandra Ortonobes @lahiperactina	Biomedicine	1.43 million (YouTube), 248,000 (Instagram), 82,300 (Twitter-X), 256,500 (TikTok)
Miguel Camarasa @matesmike	Mathematics	240,000 (YouTube), 33,300 (Twitter-X), 15,400 (Instagram), 2,276 (TikTok)
Diario de una científica @diariodeunacientifica	Biotechnology	78,600 (Instagram), 3,427 (Facebook)

Source: created by the author

2.3. Tools and information collection

The final questionnaire was administered using FORMS Office 365, which is provided by Universidad Rey Juan Carlos to teaching and research staff. Personal data was collected in an anonymous fashion, as per Organic Law 3/2018 of 5 December on Personal Data Protection and the Guarantee of Digital Rights. This tool was chosen to ensure control of the responses obtained in a secure corporate environment. The participants have not provided any personal data that required their prior consent, and for the distribution of the survey only the public information offered by them in their different accounts on social networks is processed.

The survey remained open between 22 March and 22 May 2023. It was distributed via email with a cover letter about the research goals and its framing within the activities of the research project entitled "New interactive narratives and immersive activities to promote the circular economy and social innovation through scientific communication and citizen science at the eComciencia school", funded by the Spanish Ministry of Science and Innovation (Call for the year 2021). This Call requested not only that it be completed, but also distributed among other content creators with characteristics similar to those who were contacted. A high percentage answered in the affirmative, confirming that it had been completed and redistributed, the latter involving profiles with fewer followers, falling into the categories of micro-influencers and nano- influencers.

Lastly, 23 responses to the questionnaire were obtained and exported from FORMS Office 365 to Microsoft Excel for information extraction. As previously indicated, the complete data extraction has been published in the ZENODO open repository for open consultation.

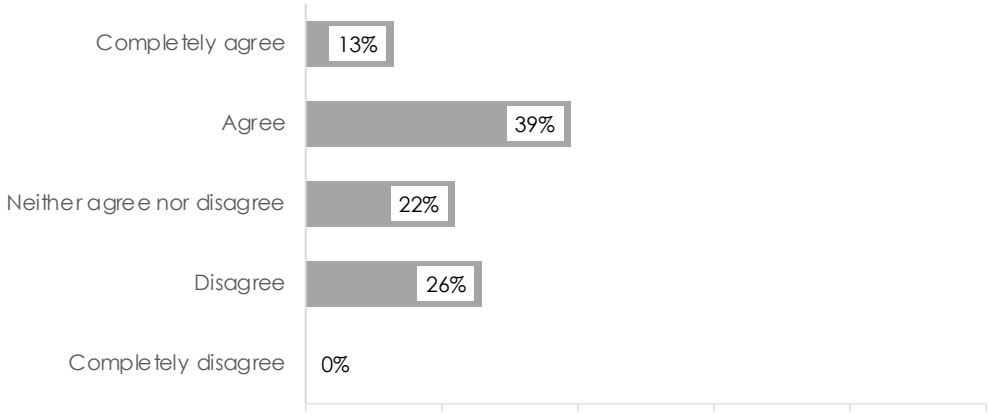
3. Results

3.1. Content creators and their perception of their own activity

For the most part, content creators state that their activity on social media is beneficial for improving the dissemination of science in society. This is a very commonly held opinion, shared by 100% of the participants (n=23). However, differences arise when asked whether their activity on social networks is comparable to traditional media specialising in the dissemination of knowledge. 65% (n=15) declare that they agree or completely agree with this comparison, while 22% (n=5) do not specify their opinion, and 13% (n=3) state that they disagree. This range of disagreement widens when they are asked about the credibility of the scientific content of their activity on social networks as compared to that possessed by experts in the field. As can be seen in Graph 1, 52% (n=12) believe that their level of credibility is higher than that of experts in the field, while 22% (n=5) do not define themselves, and 26% (n=6) reject the statement. This demonstrates that a significant number of those consulted do not view their activity as more credible than that of experts.

Graph 1 – Perception of content creators regarding their levels of credibility

I believe that the work of scientific content creators on **social networks** or science-related actions carried out by the public on social networks is **more credible than that of experts** in the field.



Source: created by the author

Therefore, it can be observed that, although content creators think their activity brings science closer to society, there is a tendency not to equate this with the activity carried out by traditional or specialised

media, and there is a growing diversity of opinion when comparing their own levels of credibility with the messages of experts in the specific subject.

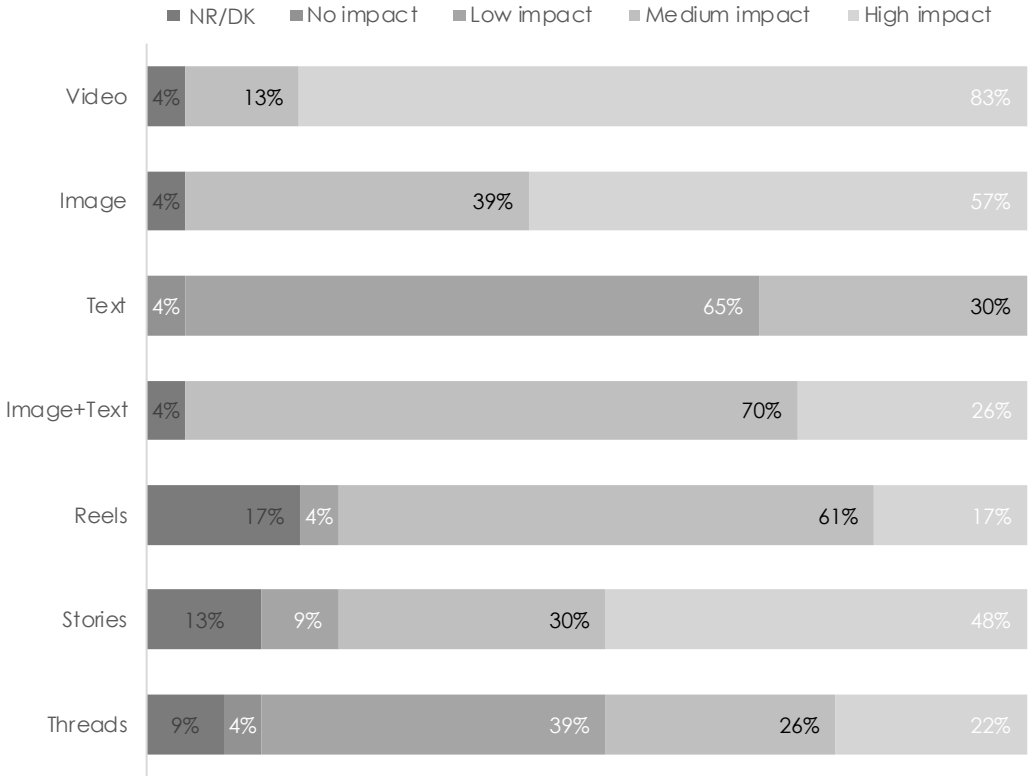
3.2. Message construction on social networks

Defining the type of message and the strategies used for its construction is decisive to determine and characterise the elements facilitating success in the process of disseminating science on social networks.

The content creators of the selected sample state that video is one of the formats with a high impact on social networks (83%), in terms of reach, going viral or interaction with the content, followed by images (57%) and *stories* (48%). These responses are framed, on the other hand, in the usual trend that social networks have been following in recent years, characterised by the predominance of this format over any other. The combination of text and image (70%), and reels (69%), are generally considered to be of medium impact. There is almost 65% agreement that text without other elements has a low impact. It is striking that threads, one of the most current formats on Twitter (X) and commonly used among creators of scientific content, are considered by 39% to have low impact, and by 4% to have no impact. Likewise, in several cases, a certain number of creators do not choose to indicate the impact of some formats, as is the case with reels (17%), stories (13%) and threads (9%), as can be seen below in graph 2:

Graph 2 – Impact of formats and types of content when published on social networks.

Indicate your degree of agreement or disagreement with the **impact (reach, virality or interaction with the content) that the following formats and types of content** produce when you post them on your social networks to disseminate scientific knowledge



Source: created by the author

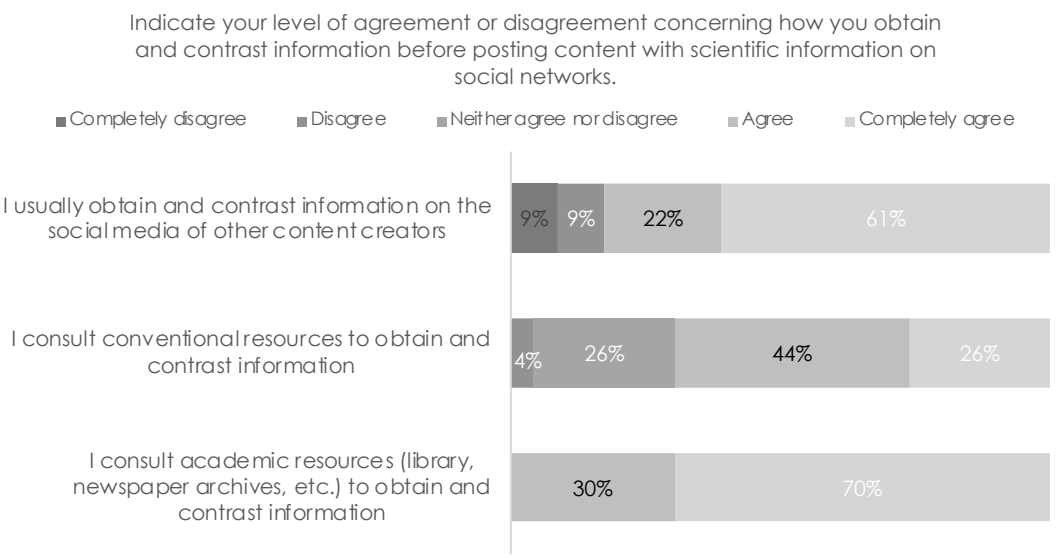
Continuing with message construction, we have tried to discover if the creators of scientific content produce their work for each social network specifically, reusing content and creativity on each of them. We would like to determine if they address different types of digital audiences in a specific manner, even though the content and its creativity are reused.

The majority of respondents indicated that they agree (n=9) or completely agree (n=8) that they construct a unique message for each social network and reuse the content and creativity on all social

networks (74%). In turn, 13% (n=3) state that they neither agree nor disagree, and 13% (n=3) declare that they disagree with the said model.

Another important aspect concerning message construction on social media was that respondents were asked about how they obtained and contrasted information prior to posting content with scientific information or about science. This question aimed to determine whether they tend to consult academic resources, following on from the previous question about their supposed credibility among experts in the field. Along these lines, 83% of the analysed sample declare that they usually obtain or contrast information on the social networks of other disseminators, with 9% disagreeing and another 9% not expressing an opinion (NR/DK). Comparatively, concerning the statement indicating whether they consult conventional media to obtain and contrast information, responses differ to a greater extent, given that 26% indicate that they completely agree, 44% agree, 26% NR/DK and 4% disagree. Much more significant and closely related to their perception about their dissemination of science, 100% fully agree with the statement that they consult academic resources to obtain and contrast information, as shown in graph 3:

Chart 3: How content creators obtain and collect information



Source: created by the author

3.3. Success factors and the credibility of scientific content creators on social networks

One of the first issues analysed in this research is the perception that creators have regarding the credibility of their own messaging on social networks. We decided to analyse what factors they believe have impacted on the credibility of their activity. Among these, the use of language that appeals to young people is particularly noteworthy, as 100% of those surveyed agree or completely agree. Moreover, offering information that can be consumed quickly and understood effectively is also an important credibility factor, as 91% of respondents declare that they agree or completely agree.

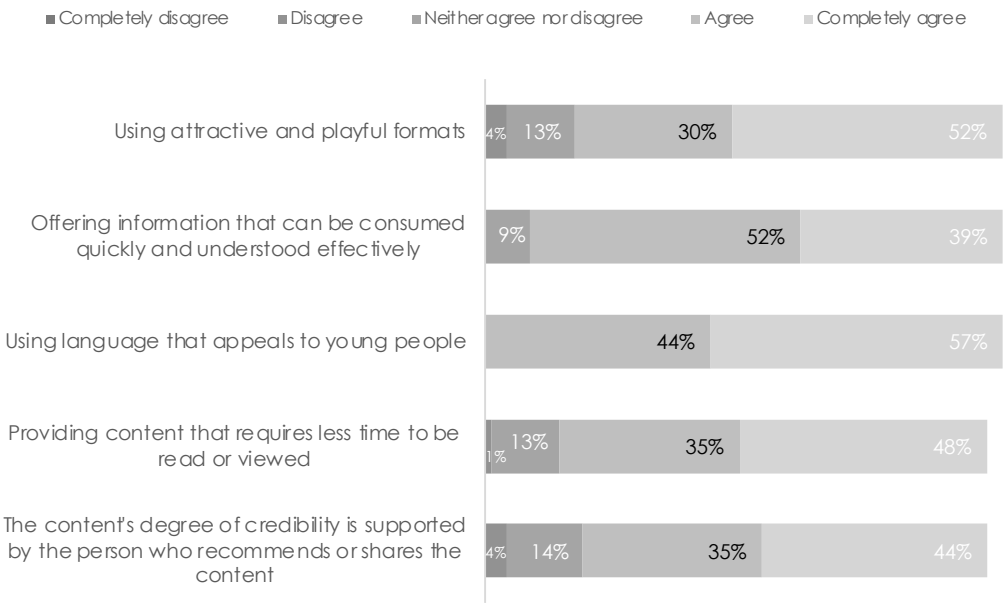
Another variable potentially affecting the degree of success refers to the reduction of time spent on reading or viewing scientific content on social networks. Here, 82% of the sample agree with this statement, while 17% do not express a clear opinion.

The use of attractive and playful formats, as opposed to formal and academic scientific communication, garners 82% agreement on the part of the content creators surveyed (within the two different ranges of agree or completely agree), although 13% are undecided (NR/DK) and 4% disagree.

Comparatively, the lowest percentage of agreement can be seen in the impact that the person recommending or sharing the content may have on the creator's successful credibility. It is not low in general terms, but it is lower than the other factors, with 79% of respondents agreeing or completely agreeing, 17% expressing no opinion and 4% disagreeing. Below, the ranges of opinion described in graph 4 can be seen:

Graph 4 – Factors in the credibility success of content creators on social networks

Indicate your degree of agreement or disagreement with the level of influence of the following factors on the credibility success of content creators on social networks.



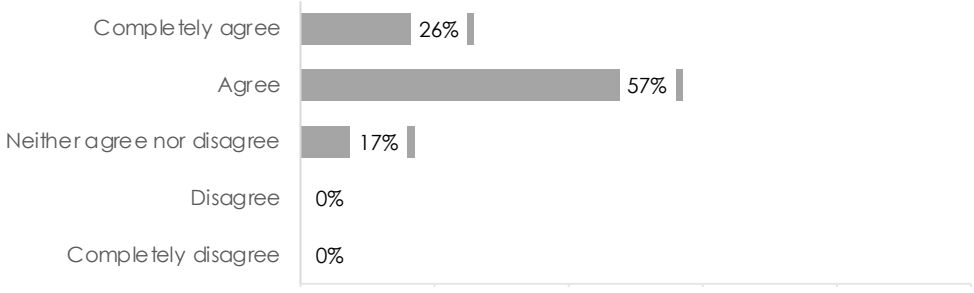
Source: created by the author

3.4. The emergence of climate change and the circular economy in the messaging of scientific content creators

One of the goals of this research is to determine how the issues of climate change and the circular economy are being treated by content creators when disseminating science on social networks. This will reveal the extent to which social media represents a new area of creation and a strategy to increase connection with young audiences. For this reason, respondents were informed of the results obtained in the 10th Survey on the Social Perception of Science and Technology, carried out by FECYT. According to this survey, people aged 15 to 24 and 25 to 35 were those who most frequently posted images or videos on environmental issues on social networks. Starting on this premise, they were asked their opinion on whether the dissemination of scientific content on social networks increased the awareness of climate change in this age group. Of those surveyed, 57% said that they agree with the statement, 26% completely agree, and 17% do not share an opinion (NR/DK), as can be seen in graph 5:

Graph 5 – The dissemination of science on social networks and awareness of climate change

I think that the dissemination of science on **social networks** increases **awareness of climate change** in people aged **15-24 and 25-35**

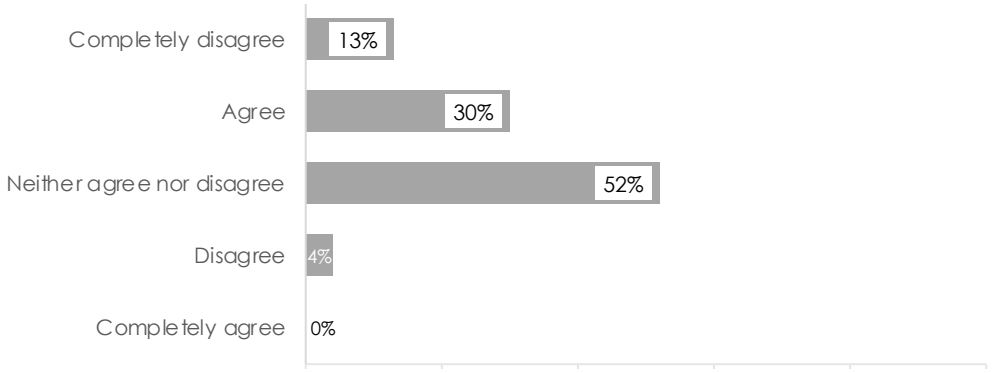


Source: created by the author

The circular economy—an indispensable tool in a society committed to solving climate change—is an important emerging area in terms of the construction of scientific content on social networks. Along these lines, 30% of creators surveyed agree with the statement that the interest of followers grows with this type of posts (n=7) and 13% completely agree (n= 3). However, the volume of respondents who neither agree nor disagree is higher, at 52% (n=12), casting some doubt on this issue, as can be seen in graph 6:

Graph 6 – Level of public interest in posts relating to the circular economy

When I post content about the **circular economy**, I notice **greater interest** among my followers

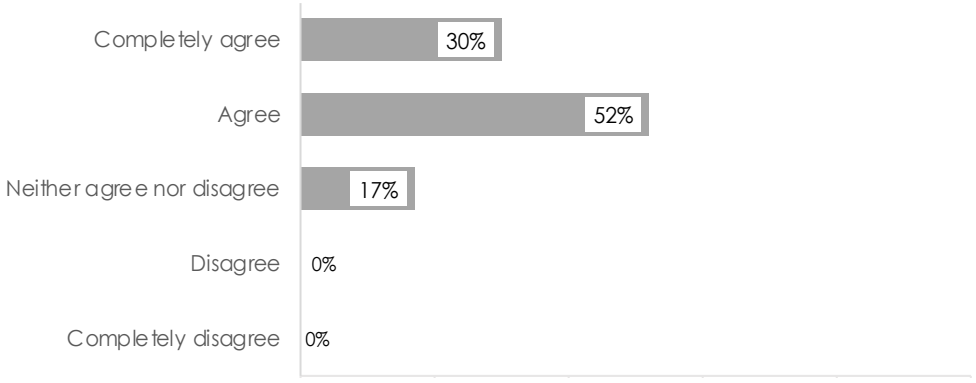


Source: created by the author

Lastly, an attempt was made to link the opinion of creators on this issue with that expressed at the beginning of the survey concerning the importance of the activity of scientific creators in the dissemination of science in society. The creators were asked if they thought that the dissemination of science on social networks could be a tool to foster society's interest in the circular economy. Unlike the question posed previously, in this case, 82% (n=19) agree or completely agree with the statement made, while only 17% (n=4) do not express an opinion (NS/NC), and no one disagrees. Detailed information can be seen in graph 7:

Graph 7 – The extent to which the dissemination of science on social networks fosters society's interest in the circular economy.

I believe that the dissemination of science on **social networks** can foster society's **interest in the circular economy.**



Source: created by the author

4. Discussion and conclusions

For years, science has observed society from a watchtower that protected it from critical scrutiny and unfounded doubt. Anchored as it was in the rigorous nature of academia, it believed that society

would be unable to understand the meaning and importance of science in its daily life. However, this watchtower has crumbled with the appearance of social networks and the prosumer (Scolari, 2018). The scientific content creators examined in this research are halfway between academia and influencers, and this paper has identified trends in message construction on social networks. In so doing, the formulas and processes used to develop scientific content have been analysed, as well as the perception that these creators have of their activity, its importance and its impact. This highlights the manner in which the role of scientist has evolved towards content creator in order to reach global audiences and provide universal access to scientific knowledge (Buitrago, Martín García and Beltrán-Flandoli, 2022). However, in response to one of the questions posed in the study, it is noteworthy that content creators continue to consult academic sources to obtain information, and a not-so-negligible percentage of these creators question their own credibility as compared to scientists. This has allowed us to characterise their general perception of their own activity in relation to that conducted by experts, despite the fact that they prefer the accessible language used on social networks to the specificity of scientific and academic language (Morales da Silva and Baronas, 2019).

As for message creation, the results offer two clear answers to the subject of development and verification of such messages. First, we can see how content and creativity developed for the dissemination of scientific messages are reused, although different strategies are employed on each of the social networks in which content creators participate. We should note how communication is defined and planned depending on the audiences, goals and particularities of each social network (Gálvez de la Cuesta, 2020), since on the one hand, content that has been contrasted and verified with academic sources is generally used, as indicated by the respondents, and on the other hand, an effort is made to approach the target audiences of each social network in the best possible way, adapting language and forms of communication. This form of action supports the evidence that more trust is given to content shared by peers, as they are considered to be disinterested sources of information (De Frutos Torres, Pastor Rodríguez and Cruz-Díaz, 2021). Along these lines, they state that using attractive and playful formats when planning and diversifying their content positively impacts its credibility. This is a clear indication that content creators should master the main narrative techniques used on social networks (Rajas Fernández, 2021).

As was noted at the beginning of the research process, society is suffering from an infodemic (Mena Young, 2022), making it difficult for reliable, verified scientific information to flow smoothly. The study's results show a positive response to another of the research questions, revealing that content creators are aware that their activity can generate science-based, verifiable, relatable and reliable narratives around climate change and the circular economy. This could counteract discourse seeking to foster inaction in the face of the urgency of the challenges posed, encouraging greater awareness. Moreover, as pointed out in the latest Survey of the Social Perception of Science and Technology 2022 (FECYT, 2023), people perceive climate change to be less urgent compared to 2020. This means that the action of scientific content creators on social networks is decisive in increasing society's level of awareness, bearing in mind the failure of conventional communication formulas, which in many cases cause the opposite effect (Palm, Lewis and Feng, 2017).

Here are some conclusions that can be drawn from a careful examination of the results of the survey:

- Firstly, content creators firmly hold the view that the dissemination of science on social networks is beneficial to society and that their activity has a positive impact.

- Content creators construct their messages according to the audience profiles of the different social networks they use, and are aware that the use of current, dynamic and playful formats produces a greater impact. Yet, for the moment, their own credibility compared to that of experts in the field is somewhat controversial. Consequently, there is a tendency to try to act in a specific way to ensure that credibility. On the one hand, they seek verification from their peers, while on the other there is also a broad consensus on the need to consult academic resources (libraries, newspaper archives, etc.).

- From the point of view of strategies, the perception of content creators of the suitability and effect that different formats have on social media audiences is especially interesting. They state that video is the format that produces the greatest impact, followed by the multimedia combination of image and text, stories and reels. Although there is less consensus on this point, text and threads are said to have a lower impact or even no impact at all.

- Concerning how scientific content creators on social networks treat the issues of climate change and the circular economy, opinions are unclear, and it cannot be stated emphatically that the interest of followers grows when posts are made on this topic. However, they do state, for the most part, that the dissemination of science on social networks can be a tool to foster society's interest in the circular economy.

The study's greatest stumbling block was ensuring access to the participants when gathering data, and this made it difficult to obtain a solid sample. As a result, methodological strategies were changed depending on the needs arising during the process. Another limitation was that no distinction was made concerning content creators' activity on the social network used, as we sought to provide an agile questionnaire that would be more likely to be answered by respondents.

A comprehensive approach, in line with the research's general goal, points to how scientific content creators on social networks largely focus on achieving credibility comparable to that of academia, while also making use of the main audience acquisition trends on their digital mediums. They approve of including climate change and the circular economy among the usual themes of their posts, but they have not yet noticed a particular interest from followers that might indicate a new trend. This paradigm offers new possibilities and opens avenues for research from the perspective of content consumers on social networks.

6. Contributions

Contributions	Authors
Conceptualisation	Author 1, Author 2, Author 3, Author 4
Methodology	Author 1, Author 2, Author 3
Validation	Author 1, Author 3
Documentary search	Author 3, Author 4
Data collection	Author 1, Author 3
Critical data analysis and interpretation	Author 1, Author 2
Writing the original draft	Author 1, Author 2, Author 3, Author 4
Final writing (review and editing)	Author 1, Author 2, Author 4
Supervision	Author 1

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9. Declaration of conflicts of interest

The authors declare that there is no conflict of interest.

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