GOOD PRACTICES IN SCIENCE COMMUNICATION AND CITIZEN SCIENCE

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Contents

Chapter 1

A Rhetorical Approach to Science Communication: Six Building Blocks as Guidelines for Researchers

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The scientific system is closely intertwined with social and political discourses – and as current mega-topics such as the COVID pandemic, artificial intelligence, or climate change show, successful science communication is crucial in a world of uncertainties and competing world models. In this sense, Scheufele (2022) refers to these intersections as science-society interfaces, where problems are particularly common when it comes to issues of science communication and public understanding. When science goes public, it enters an arena that is not only determined by neutral information and rational choices, but also by group-specific interests, conflicting beliefs, and strong emotions. Through science communication, research and the public interact and come into friction with each other, creating contact zones of exchange (Griem 2022) in which scientists have to prove themselves and defend their expert positions.

Given the complexity of scientific knowledge and the expectation that non-scientists will not seek out scientific information in its entirety, trust in science and its representatives becomes a valuable currency. Building "epistemic trust" (Hendriks, Kienhus, Bromme, 2015) is crucial, requiring scientists to skillfully navigate complex communicative situations and act confidently within them. This means that researchers need to frame and prepare their messages for specific audiences. Adopting a rhetorical approach proves beneficial in this regard.

Rhetoric, understood as strategic and situational communication influenced by factors beyond the speaker or audience (Bitzer, 1968), offers a perspective that helps establish trust and identification (Burke, 1950) between science and the public. It serves as an invitation to understanding (Foss/Griffin, 1995), employing context-adaptive communication to address conflicting interests, information, and motivational factors. Moreover, rhetoric has been central to the training of successful communicators since antiquity, making it a leading discipline for developing and studying the communicative skills required in today's science communication contact zones.

Rhetorical training for researchers interacting with the public at the science-society interface is important especially in light of the rise of personalized social media and the concurrent loss of

influence of traditional science journalism. Skills such as formulating key messages for specific target groups, clearly visualizing scientific knowledge, and competently using social media have become more than "nice to have" for researchers. Ideally, researchers should receive specialized training in core areas of science communication from the graduate level onwards. Through such training, researchers can be empowered to connect with and inspire diverse audiences and take first steps towards a true dialogue with society leveraging their own personalities, emotional engagement, and narrating the processuality of their research.

Even in the absence of specialized training opportunities, researchers can use the following six building blocks of rhetorical science communication as general guidelines to begin tailoring their efforts to their audience and communicative setting.

1. **Recognizing the Distinction:**
   Science Communication versus Scientific Communication

It is important to acknowledge the fundamental difference between science communication and scientific communication. While there may be debates over the precise definition of science communication, one thing is clear: science communication targets a wider range of audiences, including individuals who are not actively engaged in academia. To effectively engage external audiences, the scientific community must shift its focus from merely inviting people into academia towards bringing research directly to the public sphere and discussion. Drawing inspiration from ancient rhetorical theory, successful communication requires the rhetorical concept of 'aptum' (Latin) that encapsulates the multifaceted nature of appropriateness. Considering the 'aptum' of one's communicative actions includes reflecting on: 1) the speaker, 2) the situational context, including the audience, 3) the actions themselves, 4) the judgment of appropriateness, and 5) the flexible system of rules that serve as the standard for judgment. Science communication should strike a balance: avoiding excessive simplification that compromises the speaker as well as the complexity of the subject matter and its underlying rules, while also avoiding excessive complexity and fact-oriented discourse that may not suit audiences with varying levels of topic-specific knowledge and interests.

2. **The Significance of the Target Audience**

Before researchers can begin to successfully communicate their science, they must address a fundamental question: who is the intended audience? It is not only rhetorically advisable but also crucial to select and specifically address a target audience. This calls for the application of a psychological strategy known as perspective taking, which involves evaluating a situation through the eyes of the audience (Batson, 2009). However, adopting the audience's perspective presents challenges for communicators (Hodges, Lieber, Denning 2021). It can be challenging to discern the thoughts and feelings of the target group, especially in contexts like social media. Additionally, maintaining sufficient distance from one's own perspective can be complex. Nonetheless, a central tenet of science communication holds true: there is no universal public. Target audiences in science communication

encompass heterogeneous groups with diverse interests, motivations, and levels of knowledge. The precise factors that define a specific audience and whether they can be fully grasped by a communicator often remain unclear. Nevertheless, adopting a rhetorical approach, perspective taking provides the psychological framework for recontextualization in science communication. Successful science communication necessitates scientists who are willing to shift their perspective, genuinely consider the audience's viewpoint, and see the world through their eyes. In this regard, researchers should pose questions such as: Why would the audience be interested in listening to me? Why should they prioritize my message? What are their interests and motivations? What level of knowledge can I expect from them? How should I present the facts? And what additional information besides the core facts is relevant to the audience?

3. Bridging the Gap: Facts Alone Are Not Enough

While it may be tempting to assume that the primary goal of science communication is to convey accurate facts and make science accessible to the general public, it is important to recognize that the scientific system generally operates in a distinct sphere not intrinsically connected to public discourse and political debates. In science, emphasis is placed on the rigor of method, the exactness as well as falsifiability of results, and an understanding of the provisional nature of incremental progress through research studies. However, for science communication to effectively contribute to societal decision-making, it must establish connections between scientific research and non-specialists, making its insights plausible and highlighting their relevance to people's lives. When scientific content transitions from the realm of science to the public domain, it requires adaptation and framing that suits this specific sphere. From a rhetorical perspective, two key processes play a crucial role in this endeavor:

- Recontextualization: Science communication is not merely a matter of simplifying complex problems or theories; it involves a process of recontextualizing research processes and findings. Good science communication entails highlighting the individual or social significance and potential implications of research, while fostering an understanding of scientific inquiry as a dynamic process. Through recontextualization, experts tailor scientific discourse to suit the specific conditions, audiences, and constraints of particular situations (Gottschling/Kramer 2021). The more distant the audience is from the communicator's scientific discourse and peers, the more challenging the process of adaptation becomes, and the more difficult it is to effectively convey factual information. Moreover, recontextualization may also serve as a creative tool fostering new and fresh perspectives, explanations or metaphors on complex insights.
- Knowledge Design: From a rhetorical standpoint, knowledge design addresses the role of graphic design and visualizations in ensuring information clarity and comprehensibility, as well as employing design strategies to facilitate immediate insight and understanding. How can graphic design effectively communicate scientific findings in a clear and understandable manner? Which visual devices and communication techniques are persuasive to the intended

recipients? Additionally, it is essential to consider the potential susceptibility of graphic design to manipulation and misinformation (Susanka/Kramer 2021).

Incorporating recontextualization and employing effective knowledge design strategies are crucial for science communication to bridge the gap between scientific expertise and the wider public. By going beyond mere facts, science communicators can enhance understanding, foster engagement, and navigate the challenges posed by communicating complex scientific concepts in accessible and meaningful ways.

4. Beyond Results: Communicating the Relevance of Scientific Processes

In science communication, the nature of knowledge being communicated to the public significantly differs depending on whether it focuses solely on conveying results or also encompasses the relational aspects of scientific production. An incomplete form of science communication, often characterized as results communication, tends to prioritize the outcomes of scientific work. It can be encapsulated by the familiar formula that "Scientists have found out...". However, recent mega-topics such as the COVID pandemic have revealed the limitations of relying solely on results communication, particularly when scientific knowledge is still provisional and subject to rapid challenges. Successful science communication thus goes beyond sharing mere factual knowledge; it also encompasses the processes that contribute to knowledge production. This includes shedding light on administrative constraints, the tools utilized, the reliability of methods employed, the conducted experiments, both successful and failed, the extent of uncertainties within the knowledge, the necessary collaborations, and any contentious debates among researchers. By communicating such processes and their contexts, science communication becomes more nuanced and offers an opportunity to cultivate epistemic trust in scientists. Additionally, integrating storytelling into science communication can further enhance the rhetorical process of audience-speaker identification. Science communicator Randy Olson (2013) highlights the significance of crafting engaging narratives that go beyond mere procedural accounts by incorporating contradictions, questions, challenges, or problems. He suggests using the "And-But-Therefore" structure as a foundation for constructing science narratives that captivate audiences, providing them with memorable hooks and opportunities to connect with science themselves.

5. From Monologue to Embracing Engagement and Participation

While the previous building blocks have primarily focused on delivering a message, science communication lacks a vital component if it remains confined to the one-way mode of monologue: feedback and participation from the non-scientific community. After all, those who merely broadcast their message without listening miss out on the valuable insights and perspectives of the audience. Therefore, from a rhetorical standpoint, science communication is not solely about persuading people to take action, despite the term "persuasion" often implying such intent. Instead, science communication should be centered around inviting people to actively participate in the processes of science. Academia, often funded by the public and serving as a public good, needs to recognize the

importance of the public as a significant stakeholder – and should strive to include strategies of reflexivity, transdisciplinarity, and heterogeneity (Gibbons et al. 1994). While other domains of society have long embraced participatory elements, public engagement and participation have only recently gained prominence as important concepts in science. Participation, exchange, and involvement can manifest at various intensities and levels, ranging from passive reception to vocal feedback, active involvement, critical questioning, and confident expression of opinions. Each level of engagement can have different effects and contribute to shaping the discourse. Furthermore, considering the participation of non-scientific interaction groups raises intriguing questions within the scientific community: What knowledge, skills, and perspectives do non-scientists possess? What motivates target groups to invest their time and resources in contributing to scientific endeavors? Of course, caution must be exercised, particularly in project-based participation, and an ethical framework for participation must be established in future support systems. By embracing engagement and participative strategies, science can retain its relevance in a rapidly changing world, including societal transformations. Strengthening participatory elements allows for a dynamic and inclusive dialogue, fostering mutual learning and ensuring that science is not detached from the needs and aspirations of the wider community.

6. Starting Small and Managing Resources: The Labor-Intensive Nature of High-Quality Communication

While transforming scientific research into a concise blog post or a series of tweets may seem manageable in terms of time and effort, it becomes apparent that such approaches overlook the essential considerations outlined in the previous points. If researchers are genuinely committed to effective science communication tailored to specific target audiences, they must acknowledge that going it alone might result in sluggish progress and major challenges. It is no coincidence that professional science communicators have assembled larger teams to facilitate topic identification, text composition, compelling visualization, content production, and multi-channel distribution across various media platforms. Therefore, scientists engaged in communication are advised to start small initially and conduct a rhetorical situation analysis for each piece of content, whether it be a text, podcast, or video. This analysis entails an introspective examination of one's strengths and weaknesses as a communicator, as well as a deliberate consideration of the target audience that one intends to engage. Furthermore, it is essential to allocate sufficient time to implement ideas effectively. Researchers should also explore available assistance from colleagues and utilize technological tools that can support their communication efforts. Moreover, it is crucial to determine the most suitable media platforms for presenting the intended results. Based on the answers to these considerations, researchers can make informed decisions on how and in what framework it can be successfully undertaken. Additionally, seeking help and guidance from available resources within one's own university or other institutions is paramount. These institutions often offer courses aimed at improving communication skills and provide opportunities for regular practice, employing the principle of learning by doing, or ‘exercitatio’ (Latin) in rhetorical terms. Moreover, universities often have

established support systems in areas such as public relations and knowledge transfer, which researchers should actively seek out. By leveraging these support systems, researchers can tap into the expertise of professionals in fields they may be less familiar with or even form collaborative teams dedicated to the shared pursuit of science communication. Recognizing the labour-intensive nature of high-quality communication and engaging in strategic collaboration and skill development, researchers can elevate the standard of science communication and effectively bridge the gap between academia and the wider public.

In summary, science communication is a multifaceted endeavor that demands thoughtful planning, adaptability, and collaboration – all of which is encapsulated in the rhetorical approach. By considering the building blocks of science communication outlined above, researchers can enhance their communication practices and ensure their research reaches and resonates with diverse audiences. Through their efforts, scientists have the power to inspire curiosity, build trust, and contribute to a society that values and appreciates the role of science in our collective well-being.

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Chapter 2

Strategies for Science Communication on social media and networks

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Introduction

During the last years, social networks have become essential channels for disseminating information. These virtual platforms make it possible to publish news, presentations or communications on a peer-to-peer basis, without intermediaries, and make it also possible to obtain immediate and bidirectional feedback. Younger sectors of society, but not only, are informed through them, often exclusively joining the traditional media.

The research, teaching and knowledge transfer fields are also affected by the scope and evolution of social networks, causing a change in the way of relating and interacting with the community and turning these platforms into essential and necessary tools. Science professionals must be increasingly aware of the need to publicize the results of their research and communicate science in general, the proximity and reach of social networks being of particular relevance with respect to highly digitized social layers.

Unlike other more institutional formats, social networks offer more complicity and closeness that invites not only to be interested in science but also to interact in a personal way with the researchers. Among other benefits are its ease of use, as well as its free status, greater visibility and impact before mass audiences and the possibility of establishing collaborations between peers and communication professionals.

In any case, the use of social networks to disseminate the results of scientific research must form part of a broader communication plan that any European research project must take into account. In other words, it should be considered one more tool within a global strategy that includes other dissemination activities and other information supports.

On the other hand, the peculiarities of each of the social networks must be taken into account. On a scientific level, the most widely used social network currently is Twitter, a microblogging network that allows its users to publish and interact through messages known as "tweets", with a maximum length of 280 characters. The use of this and other platforms, whether general (Facebook, Instagram, Tik Tok) or specialized (ResearchGate, Academia), can help improve the visibility of research groups and the work they develop, in addition to facilitating contact with peers, with citizens and with the media.

Through these virtual structures, it is possible to send messages directly and efficiently, and may have a greater impact and visibility of the results of a research project.

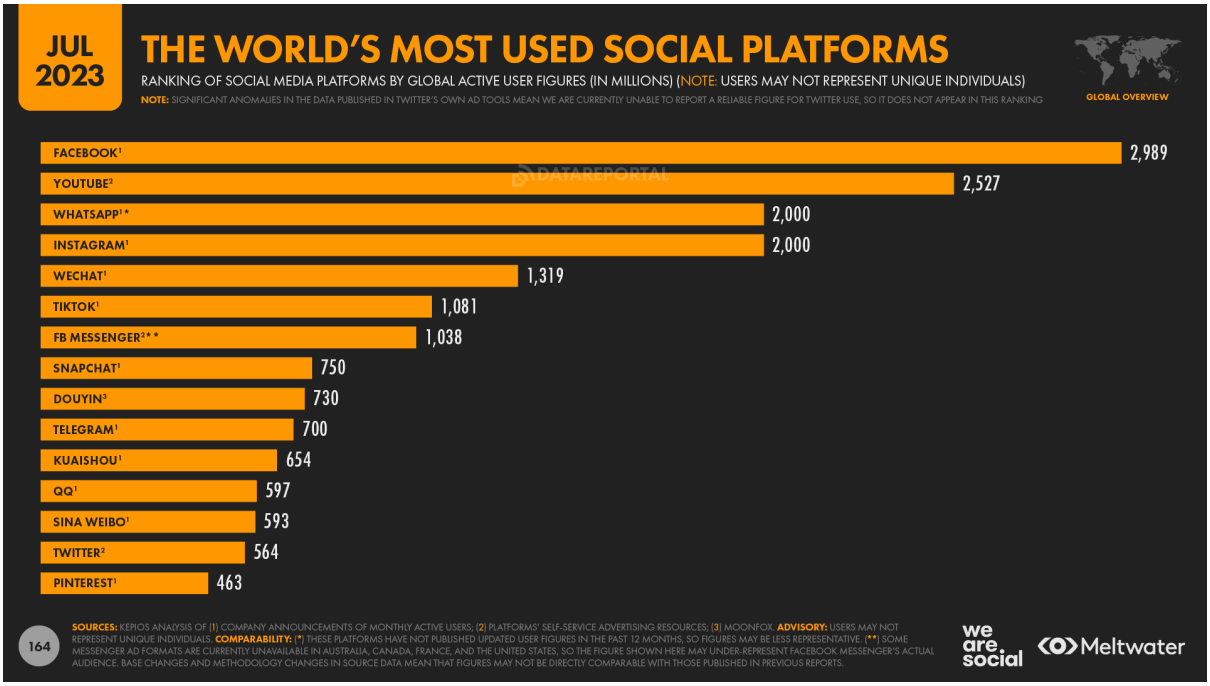

Figure 1.Ranking of Social media Platforms based on on user activity in 2023. (from https://datareportal.com/social-media-users)

Some tips and advice

Consider the convenience of it use. Society has recently changed toward a more considerable digital transformation of our society. Take advantage of this circumstance when you plan a dissemination action.

Set the objectives. It is necessary to define some communication purposes to know where you want to go and how to do it. The establishment of short-term objectives could be based on achieving quantifiable visibility challenges on social networks. A next stage will seek the consolidation of a qualified community or the creation of a recognizable brand for the target audience. The ultimate goal can be set to become a reference for the community, achieving sufficient public impact.

Define the target audience. The choice of the segment of the public to which the content of the publications is going to be directed is of vital importance. One of the purposes of the interaction with the community is to amplify the message, obtain a greater public impact and publicize the research project. To achieve the proposed objectives, choose the most interesting format once the audience you want to reach has been defined. For this reason, it is convenient to investigate at what time this public connects and what designs and social networks attract it the most. If the intention is to create scientific vocations, it will be advisable to have active accounts in more youthful networks such as Tiktok or Instagram, but if you want to reach fathers and mothers, Facebook will probably continue to be the best option. If the purpose is to educate and disseminate content in a striking way, infographics can be prepared, or close-up videos can be made that show the day-to-day life of the research project.

Plan the strategy: It will be of great help to establish temporary planning of the activities in social networks that must be carried out to achieve the purpose that has been designed. This content planning is convenient both internally, for the researcher himself or for the research group, and externally. The specification of which dissemination activities and which communication strategy in social networks will accompany these events will be very useful in order to apply for European projects. For example, it can be specified that each time dissemination activities are carried out, video summaries of these will be published or that information will be shared about the didactic content of the event. All this must be reflected in the strategy and then move on to the schedule through a line of action.

Schedule the content on social networks. Once the planning is established, scheduling the quantity and quality of the performances on the different virtual platforms is effective. It is advisable to decide the rate of interaction with the community, how many weekly posts are going to be made, follow the activity of similar accounts or carry out follow-up analysis from time to time. Progress and day-to-day are essential, and the research process can greatly interest the general public. In the case of social networks, it is important to use them as a newspaper where news about the research process can be updated. It is important to publish on a daily basis for several reasons: 1) It allows science to be disseminated continuously, offering a service to citizens that is essential for society. 2) Highly digitized social strata are reached that consume information and entertainment through social networks. Bringing science closer to these groups through these media can be as important as publishing an article in the media. 3) Expand the positioning on the platforms in which it is present: upload content on a recurring basis, as well as the use of hashtags and key days to post content that has to do with the field of study. If social networks are abandoned and only posters of important events or news are published in a timely manner, surely the projection of the content will not be very wide.

Use of an accessible and close language. Through social networks you can show a closer side of scientific research. Bridging the gap between citizens and research is a challenge and investing time in working on social networks can be of great help. To do this, you can use a multitude of available resources: team selfies, images and videos of the laboratories; videos of routines at work; stories asking followers about the questions or doubts that arise from the investigation and responding with short videos; Twitter threads taking advantage of prominent days to summarize in what the project consists of. In conclusion, the possibilities are endless.

Interact with the community. In addition to showing a human and close side of the author to the public that follows the accounts of the research project, through interaction, debates or explanations are promoted beyond what is published and generate more presence on the social network. In order to broaden the audience, it is recommended to use hashtags, mention users in the same or similar fields of research, and incorporate attractive images in the message, such as photos, gifs, videos, animations, or drawings. Participating in debates will help to place the profile in the focus of interest of the line of research. It also helps to offer credibility to the publication and combat hoaxes. In this direction, leaving questions opens the opportunity to convert readers into the protagonist and encourage their participation.

However, remember that not all are advantages. They can also pose some threats, such as the risk of becoming channels for disseminating hoaxes or false news, loss of quality in pursuit of speed, and uncomfortable situations due to lack of respect due to the lack of moderation. In this last circumstance, we recommend answering in any case, using a combination of comity, humour, and irony.

Chapter 3

One-way or two-way activities and actions to communicate the research

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Introduction: science from institutional structures

The Scientific Dissemination offices or Units were created in different countries in order to promote communication and dissemination of science to society. That is, to make the work of scientists understandable, acting as intermediaries between society and its media and researchers.

Their activity must promote this objective through four channels: information on research results for the media (news, interviews, reports...); organization of events, acts, conferences and workshops to bring science to the public; training in communication and dissemination techniques for research staff, teachers, students, etc.; and finally, development of research lines focused on the study of tools for the promotion of scientific culture and innovation.

The promotion of scientific vocations is another objective of these structures and from them, they try to cover the largest number of knowledge areas. According to a study by the Interuniversity Institute for Advanced Research on the Evaluation of Science and the University (INAECU), 70% of the scientific publications originated in the in originate in the environment of the university system (Web of Science), and in the universities represent half of the country's research staff. This is important to understand the amount of production derived from universities and research centres and the dissemination opportunities that can be channelled through their dissemination units.

The presentation of a European project can include different outreach activities that can be carried out throughout the development of a line of research. For this, it is important to take into account a basic classification within communication, from the point of view of the relationship with the public, by which the activities can be unidirectional or bidirectional.

Unidirectional Activities:

They are those activities or channels of communication that go from the research team to a specific public without the possibility of interaction with it. An example of this type of dissemination would be a newsletter, a brochure or leaflet that is placed in a specific space, or an escape room-type activity in an online format.

Two-Way Activities:

They include activities that imply an interaction with the receiver of the information. The dialogue between the researchers and the public can be deferred (comments to a publication on the web or social networks) or live (establishing a dialogue with the public in some face-to-face activity or answering questions in an online seminar).

Generally, dissemination proposals are directed to non-specialized audiences presented within a European project will generate high interest for people who have to evaluate it. Thus, an optimal planning of communication activities of the results obtained in an investigation will be a good way to make the project stand out. These activities must be focused on various layers of society and have, for example, special attention to sectors such as children or adolescents as the target audience.

On the other hand, taking into account gender and diversity is paramount when designing outreach activities. Actions such as the '**Day of Women and Girls in Science**', which includes several days of workshops and activities, promote the visibility of women scientists throughout history and on day-to-day activities, in order to inspire scientific vocations in the new generations.

Some activities that are held annually under the coordination of European funds the 'European Night of Madrid Researchers', as well as different countries and regional Weeks of Science and/or Innovation, and other group dissemination activities (Pint of Science, Mind the Lab, etc.). Universities and research units can provide lists of events at disposition for researchers to participate.

Below are detailed, various practical ideas to consider when organizing an activity in front of the public, taking into account the steps to follow:

1. **How to build a project**

Preparation of a project: Know or choose where and when the activity will take place. Also what is its format and pedagogical objectives (in the case of a fair format such as the *European Night of Researchers* in each of the positions with the different activities, a research group will develop short practical workshops in which the public will be able to actively participate and carry out experiments together with researchers). In *Science Week*, the format is freer and the same activity can be carried out more than once during the two weeks of the event, or different or similar activities can be proposed for different audiences.

Preparation of an activity:

- Topic selection: Assess what is going to be discussed and what are the basic elements and explanations that need to be clear. If the field of study is very specific, it is interesting to frame it in a broader context. In terms of key ideas, the public will probably only internalize one or two new concepts. Although the activity has a short duration, the attention and the knowledge

acquisition process will filter how much new content is acquired, so the central and secondary messages must be clear.

- Organization of the activity schedule: This exercise is essential to calculate the workshop times. Everything that is going to be developed during the process and the minutes needed for each part must be designed in a document. From the presentation of the papers or the people who give the workshop, going through the minutes necessary to ask the public to form teams or groups, the preparation of the material, transfer from one place to another if it isnecessary, the time that takes to try an experiment, the explanation of that experiment, etc.
- Calculate the budget: For the different outreach events coordinated by the UAM Scientific Culture Unit, there may be a specific budget to obtain the necessary material to carry out an activity. It is important to contact the Unit to find out what amount they can assume.
- Designate the spaces and logistics: Be clear about what is needed to carry out the activity: light points, access to water, chairs and tables, projector and screen, blackboard, microscopes...
- Promotion strategy: Preparing dissemination material for the activity is crucial to encourage participation. To optimize the effectiveness of the diffusion, it can be designed according to the public you want to attend: a post on Facebook if we want families to come or Instagram and Tiktok for younger people. If the activity requires prior registration, it is necessary to provide an email or form to reserve a place.
- Obtain image and recording permissions: These permissions are essential. Many times the photos and videos are necessary to justify the project and when working with minors, families should be asked to sign these documents to disclose the images for promotional or informative purposes. You can request these permits from the Scientific Culture Unit or the Communication Unit.

2. **How to implement the project. Carrying out the project or activity.**

Some interesting tips during the development of the activity are:

- Keep a list of materials and check that nothing is missing.
- Delegate tasks among team members for the preparation, design, assembly and realization of the workshop.
- Have the schedule of the workshop at hand to correct and modify the times that were presumed and that probably change during the realization.
- Transmit science from empathy: It is important to put yourself in the place of the listener and know how to transmit basic information without surpassing the audience. Non-verbal language and closeness also help the message to reach the public.

- Remember the needs of the team: From resting, drinking water, disconnecting for a few minutes...
- Take care of the vocabulary: scientific language is very technical, but in dissemination it is necessary to prioritize the understanding of the public. This may require more explanation time. Technical concepts can be mentioned, but first it is advisable to start with their definition: what it is, what it means and then offer them their name and not the other way around, to avoid that, especially in environments with children, the strange term eclipses the subsequent explanation. .

3. How to evaluate the impact of an activity

During the event, questionnaires, counting of assistance, open boxes to suggestions or event digital platforms to evaluate satisfaction can be used to provide an idea of the result of the actions. There are many ways in which we can evaluate results depending on the audience, and the formats. One interesting example is the case of Childwood in which evaluations can be tested by asking the kids to provide drawings about a particular topic before and after the event. The analysis of the contents of the draws can inform about the success of the information transmission.

Equally, after the events, there is a clear necessity to reflect on the activity process with an analysis of what has worked and what could be improved for future actions. This step is essential within the team that carries out the activity to promote learning through their own experience in the workshop. In addition to evaluating the activity with the team itself, it can be very enriching to meet with the Scientific Culture Unit and analyse the action in the context of the event of which it was a part and listen to feedback and proposals for other activities or formats.

Chapter 4

Science: you do it, I tell it'. Relationship between researchers and the communication media

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Introduction

Scientific dissemination is a team effort. Both the researcher and the journalist have a common objective in this tandem: the transfer of knowledge to society. As scientists interested in disseminating, we will try to work on the keys to be that figure with good communication skills.

As explained in the chapter on Scientific Culture Units, researchers have at their disposal the services of the Dissemination Units, and the communication offices to adapt advances in their work to newsworthy events. It is not necessary to wait for the completion of the project or the presentation of results to make a communication to the public. As specified later in this section, each year there are social events in which the media require scientific personnel who are experts in certain topics. The media can also be allies and act as a speaker in the promotion of activities and events carried out by the research group.

All this means that it is favourable and beneficial to have a fluid relationship with the media through the university. Here are four practical points to take into account if you want to make the leap to communicate the research to the public:

Choose your audience, choose your medium

Perhaps many researchers are so absorbed in their research work that they forget an essential part for the complete success of their work: that it be disseminated to reach colleagues, institutions and society in general. In all cases, the consequences could be very positive as synergies appear, support other work, obtain financing and, as a final objective, transfer knowledge to the general population.

In this first point we already see one of the pillars on which we must base our dissemination: establishing our target audience to select the medium and strategies we want to address and the language we will use in our intervention.

'Open' relationships

In any case, there are different relationships that researchers can establish with a medium. The figure of the usual collaborator can be the most complicated. In this case, it is necessary to have excellent communication skills as well as constant creativity to develop various topics in an attractive way. The reward is high, a greater presence, diffusion and achieving personal recognition by the public.

The media also need occasional experts who, in specific circumstances (such as an economic crisis, the eruption of a volcano or the outbreak of a pandemic) contribute with their knowledge in order to produce quality information about the event and specific topic. In this case, rather than disseminating his own research, the researcher obtains relevance and presence in the public sphere. The symbiosis is created¡

As an interviewee, the scientist must defend his research, making it 'understandable' and interesting by the public he is addressing, and this is the duty of both; the journalist and researcher.

Knock, knock: The first contact

If our objective is to establish first contact with the media, the first way we can use the Scientific Culture Units or offices of each University. Following the procedure they indicate to us; they will be the contact vehicle with the media.

Through the professionals of this unit, it will be possible to prepare the press release that serves as an 'invitation' for the media to take an interest in us. For this reason, it must follow some elaboration guidelines, collecting all the information indicated by the 5W rule of journalism (what, who, when, where and why) and, preferably, in the form of an inverted pyramid according to interest and depth.

In this first contact with the media, two handy tips: the local media can be an extraordinary first step. They are more willing to cover topics due to their proximity to the person in charge of the project, the place of research, or its application.

The second piece of advice is not to disclose everything until everything is finished. The start of an investigation, its first achievements or its application can also be 'newsworthy' facts.

'Eureka! Contact with the public

Once the connection is established, it is important to take maximum care of our message, adapting it to the medium and its audience. A good idea is to previously investigate the medium or program in which we will participate to find out if it is radio, television, written media or what is the tone that is usually used for this content. The possibility of chatting with the journalist beforehand will make us obtain useful information as well as confidence with the interviewer.

In general, the most important thing is to structure our speech correctly: adapt the language to the profile of the public we are addressing, be direct, use images that explain the most important points, take care of the tone and rhythm with which we express ourselves, communication nonverbal etc

And to conclude with the 'useful tips', two more. First, try to find a way for the public to feel attracted. One of the keys may be to explain to them how the result of your research affects them (the public, in general, has that point of selfishness when it comes to only paying interest to something that benefits or harms them).

And the second, and almost more important: smile. Adding humor to your speech will break an invisible barrier with the general public whenever possible.

Chapter 5

Resources and tips for being "creative" in Science Dissemination

Carlos Baena, Javier Baena; Michael Pelzer, Fotini; Markus Gottschling; Fotini Venetsanou; Isabelle Galvez, Alice Novello, Elizabeth Baier, Rafaella Lenoir-Improta, Giulia Antinucci

About the context

We understand that innovation and originality are two key aspects of engaging the public and society with our work. In this sense, we consider that being "creative" as a generalization of both concepts is important (of course not essential) in science communication and dissemination activities.

- Knowing your context: Analyse and know the social and cultural context in which you move and in which your project or idea is framed.
- Consider carefully the public or target to whom your creation is directed; scientific community, childhood, families... Consider the possibility of wildcard audiences with multiple compositions.
- Channel or circuit in which we are going to move, from scientific creation to informative event.
- Take advantage of some of the existing innovations and advances or elements that are fashion.
- Knows the set of rules and procedures related to a topic or specific knowledge (field for Csikszentmibaly, 1998).
- A creative idea is usually nothing more than a reinterpretation of reality, a new idea made up of simpler ideas or concepts, so it is necessary to investigate and know adequately the topic and everything related to it.
- Finding the variables and sub-variables that pivot around a theme or problem.
- Imagine reality as something other than what it is normally expected even using the absurd; you arrive at a lonely bar on a rainy Sunday night… there are only four people having a coffee apparently disconnected…. But it's not a normal situation... it's the introduction to a secret sect that discusses how can you kill with a teddy bear…

About you as a creative person…

- Be very clear about the object and objective of our adventure. The more and better defined, the mind is more focused and less scattered and gets the target better.
- Feeding our mind with accurate and non-accurate information, knowing deeply the topic facilitates the ideas that have to arise. Some ideas lead to others, and along the way a strange process of ideas sieving is produced until reaching a valid creative product, in the worst of cases, and an excellent in the best. Creativity -the good one, the one that arrives, the one that lasts- is never the result of a simple occurrence: I know well that it comes from a feverish neural restlessness in which imagination and knowledge, the random and the meditated, were merged. All are necessary ingredients.
- Give the brain its own time... It usually works without our permission, without our knowing it does over time. It always ends up lighting up a good idea.
- Keep in mind that creating for some topics is not the same as for others. We need to be creative for making an advertisement, to define a thesis topic, design a dissemination work... Each one must create their own strategy.
- A good idea does not imply good creativity; a common idea can become a memorable creativity. Even the lack of ideas can be solved with some infallible resource (good music, a funny/original expression, a persuasive voice, an absurd situation...) There are infallible resources that always connect emotionally with the "target audience": children work, animals, family. Also, even rudeness can generate memory and even choice when it comes to "buying". https://youtu.be/oJfFMoAgbv8

About how to train yourself…

- Try to get out of your routine and start experiencing new things and places. Try new things andf read so much
- Listen to music (preferably classical¡). Many people feel the creative call as they tap into the flow to other senses, and music is a rare resource.
- Keep a journal or sketchbook (doodle) and use it when you are bored or out of ideas. Design short stories of 100-200 words.
- Learn from the children
- Play and enjoy games https://youtu.be/Bg-GEzM7iTk.
- Socialize and network with people.

- Find a space free of distractions and allow your mind to run free. You can do this at home, in a park, or in a library. Any place you feel comfortable in is a great place to brainstorm! Change the usual place where you are supposed to work¡

About how to work in creation…

- Build a good team and work with it. Work in team; It is the best way to build but always surrounded by positive people, but….
- Working in a group works but it is not a guarantee of anything. Brainstorming helps, but intimate work usually is the best way to get a good result. I don't know why but a masterpiece (music, painting...) is NEVER the result of collective work.
- For this reason, we must asume that hierrarchy work inisde creative working groups.
- Avoid discussions and, above all, interference in the group. It is not a public chess game.
- Creativity is exercised. Creating is a practical exercise resulting from perseverance. Do, undo and redo, discard, contrast and rest the ideas. A good idea rarely comes from the first impulse. (It is also rare for it to appear from overload.) However, creativity requires a certain tension: there always (and is positive) a deadline.
- Manage your time well and dedicate enough to it; remember, it's a job not an occurrence.
- Set idea quotas and treat creation as a job
- If you don't make progress, do something different have a cofee or rest.
- Being creative implies in some way to do an exercise in self-deconstruction. What is frequent is that we use the logical and stereotyped thinking that society endows us with. This way of thinking is commonplace to all and therefore it is rare to surprise with a true genius. Parallel thinking without predetermined codes is the best way to be creative. But how is it achieved?
- Use resources similar to those tools used in literatura, particular metaphors, but are not the only ones(metonyms, oxymorons, onomatopoeia, chiasmus, etc.). Parrticularuefull in searching for a headlines.
- Sometimes it is better to destroy to build something good. Escape from the conventional construction and build from surprising breaks of what we see daily.
- For example, I could explain the origin of creativity in a rational way, speaking of neurons of synaptic processes of information flows of stimuli and association of ideas... All very scientific, but little "captivating and memorable"way. If I intend to tell the same thing in a creative way, I could pose it as a game of billiards in which the ideas are the triangulated balls on the table, and the pool cue the determination to seek. The blow to the withe ball is the beginning, the

convulsive and frantic outburst of the mind putting ideas in motion, allowing us to identify those balls that score the most. Our senses of sight, hearing, touch are at the service of searching and choosing the ball that interests us to fall into the pocket. It is the same, but told in a more graphic, accessible and memorable way. In the end everyone would say "yes, finding a creative idea is like playing a game of billiards". In this example, we are using a metaphor, but linked to an specific topic (a game that needs training and thinking).

About the ideas…

- It is very useful to pay close attention to the reality in which one lives and that one always shares with the recipients of creativity. Culture, society, trends, events, celebrities... Everything can be decisive in finding a resource, a route and, of course, the vehicle that takes the address.
- Collect, and archive information and look for creative or innovative examples on the topic that inspire you.
- Take advantage of common social knowledge. If there is a fashion please consider it¡
- Isolates the key factors or elements of a topic that can be connectors to work on them.
- Question existing ideas or assumptions about the topic. Don't dismiss ideas; the absurd is welcome and therefore your critical thinking should decrease in intensity
- Look for the limits and complements of a problem or a topic; have a curious attitude at all times. Don't assume the invalidity of one idea or approach.
- Build on what already exists when finding a good idea.
- Submit your ideas to a public or group opinion as an essential pre-evaluation process.

Apendix. Literary resources used in creativity

- Metaphor is a subtle relationship of analogy or similarity that is established between two ideas or images. Examples: Life is a highway, He is a shining star.
- Simile, establishes a similarity relationship between two elements through an explicit relational element. Examples: "You are cold as ice."
- Hyperbole is done when an aspect or characteristic of a thing is increased or diminished in an exaggerated way. Examples: "I apologized a thousand times."
- Metonymy, consists of designating one thing with the name of another with which it has a relationship. Examples: " Silicon Valley".

- -Synecdoche is a figure in which a thing is called in relation to the whole by the part (or vice versa), the species by the genus (or vice versa) or the material by the name of the thing. Examples: "I am looking for a roof to live in".
- Prosopopoeia or personification consists of attributing qualities of a rational or animated being to another inanimate. Examples: "The clock tells us the time."
- Epithet, is an adjective used to attribute qualities to the noun it accompanies. Examples: "Tender joy", to refer to a feeling of tenderness.
- Oxymoron, consists of generating contradiction, irony or incoherence in a sentence by placing contrary words or ideas. Examples: "There was a deafening silence."
- Irony, one thing is implied by expressing the opposite of what, in reality, is meant or thought. Examples: "I am so intelligent that sometimes I do not understand a word of what I say", Oscar Wilde.
- Paradox, implies the use of expressions, ideas, concepts in which there is a supposed contradiction that, in reality, is intended to give a new meaning to what it is talking about. Examples: "I only know that I know nothing."
- Onomatopoeia, is the written representation of a sound such as: click, crack, plaf, puff, pss, etc. It is a way of vocalizing the sounds that certain objects or animals can generate. Examples: "When squeezing the plastic, a crack sounded, indicating that it had broken."
- Synaesthesia, consists of attributing a sensation (auditory, olfactory...) to an object. Examples: "The bitter past that I do not forget." It refers to a difficult experience.
- Periphrasis, a way of expressing yourself by going around or using more words than would normally have been necessary to communicate an idea or concept. Examples: "He took his last breath this morning", to indicate that someone has passed away.
- Polysyndeton, consists of the repeated use of conjunctions with the aim of increasing the expressive force of the speech. Example: "Oh great and fecund and magnetic slave", Pablo Neruda.
- Antithesis, consists of the opposition that can exist between two ideas or expressions. Example: "I try to forget you and I accidentally remember you".
- The asyndeton is the figure that omits the conjunctions and links of the sentences, phrases or statements, in order to generate greater dynamism and mobility to the expression. Example: "I think of you, in your smile, your look, in the chocolate-flavoured kisses, you ran, you left, we got lost."

- Gradation, consists of organizing the elements of the speech according to their importance, either ascending or descending, the latter also known as anticlimax. Examples: "We both counted the hours, days and weeks to see each other again."
- Commutation, is characterized by the repetition of a sentence or phrase in the opposite direction and by the reorganization of the elements, in order to reinforce an idea or encourage reflection. Examples: Do you always have to feel what is said? / Should you never say what you feel? Francisco de Quevedo.
- Chiasmus, consists of the repetition of ideas but exchanging their order without the sentence or phrase losing its meaning. Examples: "Don't ask yourself what your country can do for you, ask yourself what you can do for your country."

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Chapter 6

Resources to understand and implement Citizen Science

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What is and what means Citizens Science?

Citizen Science is a difficult term to define, partly because of the state of its development and partly because of the unequal understanding of these models. In general, it is based on general ideas with little analytical load (Green Paper, 2013; Kullenberg & Kasperowski, 2016; Lewenstein, 2016). As an essential part of what is known as Open Science, it brings the opportunity to all the individuals of the society to play an active role in research, innovation and policy decisions. This democratization of science implies a change in the current science generation model and the reform of the *Research Assessment*.

The collaborative participation of citizens in actions, decisions, and research projects has differentiated aspects. Firstly, the collaboration in the accompaniment of data collection and, when needed, intermediation with the public. Secondly, its integration into the models for the creation of new scientific knowledge. This differentiation is essential to understanding the change that Citizen Science has established in recent years.

As part of a greater awareness of the role of the different social actors in the generation of knowledge, a concept known as *Civic Engagement* has emerged (Aggett, et al.2012, Haywood, B.K., & Besley, J.C. 2014), which can take many forms including volunteering, community participation activities, participation in government initiatives (municipalities, communities, governments...), marked by a broader objectives than the traditional participation (volunteering) of citizens and that was generally limited to their labour contribution. In any case, this model supposes a new sphere of interaction with citizens, still from a vertical perspective that clearly differs from the horizontal model of Citizen Science.

Models and structures for a better Citizens Science Implementation

We must understand Citizen Science as that model in which society represented by different actors (including the researchers themselves are part of society) normally outside the process of scientific creation, become a level of equality with others, as actors of it (Veeckman, et al. 2019).

Citizen Science implies the active participation of different actors especially citizens in the comprehensive development of the research model. It's based on:

a) There is in-depth knowledge, often geographical, environmental or cultural, in areas that are very difficult to access from the academy, and that citizens, especially those who live in their proximity, have.

b) There is a human collaborative potential capable of carrying out fully integrated tasks in what we understand as Science.

c) There is a real and potential desire to participate in the scientific model on the part of very diverse actors who have seen their access to scientific knowledge limited because they are outside traditional circuits. Your creative capacity can be enormous and deserves to be attended to.

d) There is scientific knowledge that can be directed outside the academy that we must constructively integrate on an equal footing.

e) Citizens' opinions and decisions have a great potentiality in policymakers' decisions. Their contribution to the science models provides an unusual strength to influence Political and administrative decisions.

There are different models and codes of good practice in relation to Citizen Science and, in particular, typologies have been developed that attend to the public or private nature of the environment as well as the theme (Bonney, et al. 2009). Based on the citizen participation model, we can simplify this categorization according to whether citizens are the object of study (behavioral studies) or citizens as third-party data takers (waste collection in specific environments). In turn, depending on the degree of integration we can differentiate:

a) Citizen participation in data collection and generation:

It is the simplest and most limited model of citizen science (hereinafter CC). At least, it implies the integration of citizens in the data collection related to a specific scientific project. The contextualization of the problem and the definition of objectives shared with the citizenry imply a lower degree of integration in the CC model. Within this typology, it is essential to facilitate citizen access to the initiative, minimize learning costs and, above all, facilitate citizen work through platforms, apps or agile registration systems. It is advisable to integrate them into the interpretation of the results.

b) Participation in data collection/generation and interpretation

One more step in the process of scientific co-creation consists of integrating the citizens in charge of data collection in processes of interpretation of the results. As in the previous model, the initial integration in the problems and objectives established in the research project, the citizen integration in the discussion of the results opens a very interesting field to the search for alternative explanations, to the improvement of the model of registration or the creation of new proposals among other aspects. In this case, citizens collaborate based on their experience as information takers but at the same time, as entities capable of interpreting the results.

c) Integration at all levels

One step beyond data collection and its interpretation consists of the smooth integration of citizens in models of science creation. For many, it can be difficult to assume that people from outside the academic field can fully integrate into a research project proposal or a scientific article with a vocation for impact, and in fact, the prevailing science model does not facilitate their inclusion. However, and always depending on the level of integration and contribution of the citizenry, the full integration of this group in the formal and material aspects of science is an act of justice.

At the same time, *citizen labs* are another tool deeply related to the co-creative model of science. These laboratories have the power to identify a particular place, generally related to research infrastructures, as an attractive space for it, and meet the usual conditions of any citizen science project.

Tips for setting up a citizen science project.

1. Analyse the problem in which you are investigating in terms of citizen contribution, critically evaluating the potential of its integration. There could be projects or initiatives in which the role of citizens is secondary. while in others it is possible that it is essential.

2. Inspiring yourself by learning from other projects is a good starting point. Study the organization, orientation, application and resources produced. Learn from others.

3. Define a work team with an adequate division of tasks, which must include experience in contact with people (mediators or facilitators, design of calls, knowledge about the subject, knowledge in dissemination of results, experts finding resources, etc.).

4. Getting access to citizen groups interested in participating in these proposals is quite a challenge (Brouwer, S., & Hessels, L. K. 2019). There are query models that are still restrictive access tools. Social networks, however, can have a much greater echo, but always accessing groups or people focused on the subject that in turn can be participation nodes. Having time

and, above all, a well-connected web space is essential for this. Calling for projects through all possible communication channels is essential.

5. Define the level of engagement: Contributory Project, Collaborative Project, Co-created Project, Crowdsourcing Project, Participatory science Project, Deep Scientific citizen science Project.

6. Select the best platform for that, use creative resources, keep other groups linked (tags, hashtags, etc.), be constantly given content, and pay attention to your statistics.

7. Keep 'feeding' your citizen scientists with information/web/pages. Do this with a regular newsletter, messages on social media, lectures or workshops.

8. Whether you organize a small or large citizen science Project, the way to engage and recruit an audience is often with help from existing networks and communities. Study them (http://eu-citizen.science/ on an International scale and https://www.fecyt.es/es/tematica/citizen-science for our national scope) and return your efforts to them.

9. The training of citizens, through multiple tools (meetings, forums, eMagazine, workshops/webinars, games, scientific publications, etc.) is essential as an initial engine of development and as a tool for involvement. The integration of citizens, when possible, as the protagonist of these training resources, offers numerous advantages (Bowser, et al. 2014).

10. The objectives must be clear and the tasks to be assumed by the citizens must be explicitly transmitted (what should I do, what is expected of me...). Use a regular style and proximity. Do not simplify the information but don't borrow the group.

11. There is a growing interest on the part of the administration (at different levels) in promoting these science creation models. Searching for platforms, actions, financial sources, and citizen laboratories at different administrative scales usually gives rewards (Hecker, et al. 2018). Obtain sufficient financing to carry out the Project by analysing different formulas (crowdfunding, collections, projects, platforms, etc.).

12. Having space for work, either in the form of a laboratory, rooms or even in a virtual format, is essential. Finding a neutral space can help foster this horizontal rapprochement, even delegating the organization of events to the citizens themselves.

13. A citizen science Project should be educational and scientifically productive, but unless it is fun, it will not be successful. Use social activities, competitions, games, prices, or other returns, and give protagonist to people (add different roles to the active people).

14. Arrogance is prohibited in these models of Science. On many occasions, the academic world must be rebuilt by assimilating the value of the apparently heterodox, stripping itself of the academic veneer and assuming that even though we are capable of doing so, the public tends to identify us with these models and generally accept them.

15. Understanding citizen participation as a consideration for citizen work or collaboration is not understanding the CC model. A "sincere" integration assumes the value of each of the pieces that make up the system.

16. Telling stories can improve the messages and create bridges between citizen scientists. Use the storytelling resources for that.

17. Conflicts are assured. An essential task in working with citizens is mediation. Therefore, it is crucial to have sufficient personal resources to prevent these conflicts or limit them to just an interaction between the protagonists.

18. Evaluating the continuity of the work once the initial objectives have been completed is an important aspect part of the expected results.

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