

## Science Communication for Society: Challenges and Opportunities

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**Abstract.** Science communication has an important role in disseminating scientific knowledge to society. However, in the age of fake news and post-truth, science communicators face significant challenges. The proliferation of false and distorted information makes it increasingly difficult for the public to distinguish between established scientific facts and deception, leading to misunderstandings, confusion, and even detrimental decisions for people's health and well-being. In this context, the dissemination of fake news and pseudoscience has become fertile ground for post-truth, whose objective is to establish a situation where false information, laden with strong emotional appeal and based on personal beliefs, outweighs true information in order to influence public opinion. Often, fake news contains a part of the message or public knowledge that can be "verified," but omits another part that is true, distorting the public's understanding of scientific subjects.

Given these challenges, it is crucial for science communicators to be qualified and possess a solid scientific knowledge in their respective fields. Only with a deep understanding of the meaning of science, of scientific concepts and principles can they convey accurate and precise information, providing the public with a proper understanding of scientific subjects. Additionally, it is essential for communicators to develop critical evaluation skills in order to discern the soundness and quality of knowledge received from external sources such as laboratories and reputable institutions, avoiding the dissemination of misleading information and ensuring that only scientifically grounded knowledge is conveyed.

If properly conveyed, science communication may play a crucial role in the process of building scientific knowledge, enabling the sharing,

debate and critical reasoning, leading to the application of scientific discoveries in various areas and dimensions of society. Growing from universities and research centers, scientific communication has evolved and structured itself through formal and informal channels, driving innovation and socio-economic development. Therefore, it is of utmost importance to address the challenges of science communication, combat fake news and pseudoscience, and strengthen trust in science, thus promoting an informed society engaged with scientific knowledge.

**Keywords.** Fake News, Pseudoscience, Qualification of Communicators, Science Communication, Science Knowledge.

### 1. Introduction

Science communication aims to play a major role in disseminating scientific knowledge to society [1]. As we navigate a progressively complex and interconnected world, the importance of an effective communication between the scientific community and the general public becomes increasingly evident. However, this task faces a range of contemporary challenges that require a careful and strategic approach.

One of the main challenges science communicators currently face is the proliferation of fake news and fake science [2]. With the rise of social media and the ease of information sharing, it often becomes difficult for the general public to distinguish between established scientific facts and inaccurate, distorted, or outright false information. Such misleading information can lead to misunderstandings, confusion, and even harmful decisions for people's health and well-being. Fake news provides fertile ground for the post-truth era, where false information, laden with strong emotional appeal and based on personal beliefs, surpasses true information with the aim of influencing public opinion. In general terms, we can state that fake news contains a part of the message or public knowledge that can be "verified," but omits another part that is true. In this sense, science is affected as it deals with information of public interest and holds a position of credibility among the population. Consequently, news about science is widely disseminated and gives rise to groups that not only share these messages, but also make

decisions based on this information.

In this context, the need for qualified science communicators becomes clear. It is crucial that these communicators possess a solid scientific knowledge or are experienced scientists in their respective fields. Only with a deep understanding of the nature and meaning of science, of the scientific method, and scientific concepts and principles can they convey accurate and precise information, providing the public with a proper understanding of scientific subjects.

Furthermore, science communicators must develop critical evaluation and validation skills to discern the quality of information and knowledge received from external sources such as laboratories and institutions regardless of how prestigious they are. This critical discern ability is essential to avoid the dissemination of misleading information and ensure that only scientifically grounded knowledge is conveyed.

Addressing the challenges of science communication, it is important to highlight that the construction of scientific knowledge is a continuous and cumulative process that follows a clear and well-established process, the scientific method. Communication can play an important role in this process as it enables the sharing, debate and critical discussion, and application of scientific discoveries in various areas of society. Since the early days driven from the universities and the growth of open research activities, scientific communication has evolved and structured itself through formal and informal channels, driving innovation and socio-economic development.

Therefore, this article aims to raise some points of discussion and explore the challenges and opportunities of science communication for society. It seeks to emphasize the importance of combating fake news and fake science, underscoring the need for qualified science communicators who are committed to critically conveying accurate and reliable scientific information and knowledge. Through the analysis of these aspects, the goal is to strengthen trust in science and promote an informed society engaged with scientific knowledge.

## **2. The importance of scientific communication**

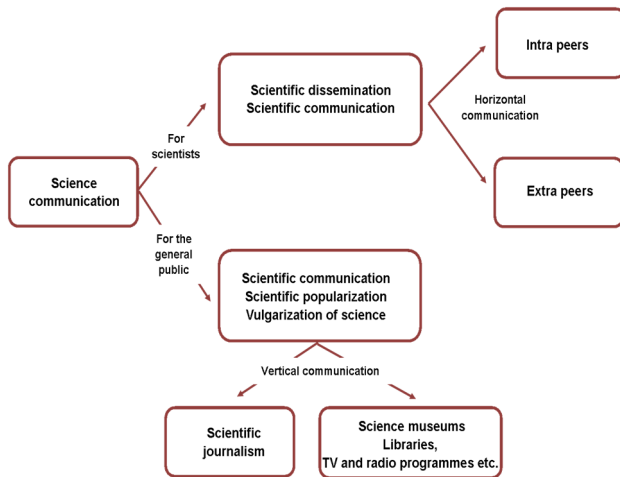
The importance of scientific communication is increasingly significant, being a relevant topic in today's society. Scientific communication can be a way for scientific knowledge to be disseminated in an effective manner, enabling access to accurate, relevant, and up-to-date information for everyone, hopefully. Furthermore, scientific communication is an important tool in building more informed and participatory societies, which is why it is crucial that high rigour and precision are maintained in the production of such content, whether it is science communication or journalistic articles based on scientific topics, thus avoiding the dissemination of incorrect information. In this way, scientific communication can contribute to informed decision-making by citizens and the maintenance of freedom of critical and well-founded thinking [3].

In addition to the mentioned aspects, it is important to highlight that scientific communication can contribute to the development of critical thinking and metacognitive skills. By promoting reflection on the process of producing and disseminating scientific knowledge, scientific communication can help develop the ability to evaluate and question information, identify reliable sources, and consider different perspectives and approaches. Thus, scientific communication can play a fundamental role in shaping more critical and conscious citizens who are capable of making informed decisions and contributing to the construction of a more informed, just, and sustainable society.

In the context at hand, scientific communication, generated from the scientific method, is a generic term that includes other forms of communication such as scientific diffusion, dissemination of science, and popularization of science, with the aim of reaching both the general public and scientific peers [4]. In other words, scientific communication is a way of transmitting knowledge in an accessible and understandable manner to all, regardless of their level of expertise.

Scientific communication is a comprehensive term that encompasses different aspects and specific concepts. Scientific communication can

be divided into horizontal and vertical dimensions. The horizontal dimension is directed towards scientists and consists of scientific dissemination, which can be intra-peer or extra-peer. The vertical dimension, on the other hand, is aimed at the general public and is characterized by science communication, which makes scientific language accessible to non-experts (Figure 1).



**Figure 1. Model of scientific communication [3]**

Scientific communication also encompasses other forms of communication that vary according to the language used or the entity of the communication process. It includes both internal communication directed at the scientific community and external communication aimed at the general public. It is important to highlight that, due to the vast number of specialized fields, scientists can become non-experts in other areas of knowledge. The terms dissemination, popularization, vulgarization, and public communication of science are synonymous and aim to generate public perception of science as a result. On the other hand, terms such as scientific education, public perception of science, public understanding of science, and scientific literacy focus on the recipient and the results and competencies generated from the communication process [4].

Scientific education is a prerequisite for the public perception of science and is essential for public understanding of science. From that point on, individuals can develop the set of skills characteristic of being literate. There are three types of scientific literacy: practical literacy, applying scientific knowledge in everyday life; cultural literacy, appreciating science as a cultural activity; and civic literacy, empowering

citizens to exercise citizenship, being aware of the problems, results, and perspectives that equip them for citizenship.

Scientific communication is crucial for the dissemination of scientific knowledge and its understanding by the general public. Moreover, scientific literacy is essential for individuals to apply scientific knowledge in their daily lives and exercise citizenship consciously and informedly.

### 3. Challenges of Science Communication

Science communication faces a series of challenges that can hinder the effective transmission of scientific knowledge to society. Some of the main challenges faced by science communicators, using as example the current situation in Portugal, are:

#### 3.1. Complexity of scientific topics

One of the main challenges in science communication is dealing with the complexity of scientific subjects. Often, scientific concepts and theories are intricate and require specific technical language. However, in order for scientific information to be understandable to the public, it is necessary to translate this complexity into accessible and clear terms. Science communicators must find ways to simplify complex concepts without compromising the accuracy of scientific data.

#### 3.2. Bias and selective interpretation

Science often deals with uncertainties and results that can be interpreted in different ways. This can lead to different perspectives and interpretations of scientific data. Science communicators must be careful to avoid bias in the selection and presentation of information. It is essential to provide a comprehensive and balanced view of scientific issues, highlighting the available evidence and avoiding hasty or exaggerated conclusions [4].

#### 3.3. Proliferation of misleading information

The dissemination of misleading information, such as fake news and pseudoscience, is a significant challenge for science communicators. In Portugal, as well as in other places, there is a growing proliferation of false news related to science. This false information can confuse the public and undermine trust in

science. Science communicators must be prepared to combat this misleading information by providing reliable and verified sources of scientific knowledge. Promoting scientific literacy and education on how to identify false information are important strategies in this regard [5].

### **3.4. Lack of scientific literacy**

The lack of knowledge and understanding of science in society is an obstacle to effective science communication. Many people struggle to comprehend basic scientific concepts and interpret scientific data. Science communicators must address this gap by promoting scientific literacy through educational strategies. It is important to explain scientific concepts in a clear and accessible manner, using everyday examples and avoiding unnecessary technical jargon [4].

### **3.5. Time and space constraints in dissemination**

In science communication, there are often time and space limitations to convey complex information. Whether in articles, interviews, or presentations, it is necessary to find effective ways to condense and communicate essential scientific information. Science communicators must be able to synthesize complex concepts clearly and concisely while maintaining the accuracy and relevance of the content. The use of visual resources such as graphs, diagrams, and infographics can be an effective strategy to visually convey information in an appealing and understandable way.

### **3.6. Access to scientific information**

Access to up-to-date and reliable information is a challenge faced by science communicators. It is not always easy to access the latest research and scientific discoveries. Obtaining relevant scientific information requires effort and contact with the scientific community. Science communicators must stay updated on scientific advances in their areas of expertise and seek reliable sources to support their communications. Collaboration with scientists and research institutions can be a way to ensure access to reliable and up-to-date information.

### **3.7. Building trust**

Building trust between science communicators and the public is a crucial challenge. In Portugal, as well as in other places, there is a growing distrust towards science and scientific institutions. The dissemination of misleading information and lack of transparency in some areas of science contribute to this mistrust. Science communicators must strive to build trust by being transparent, objective, and presenting solid scientific evidence. It is important to establish two-way communication, listening to the concerns and doubts of the public and responding in a clear and well-founded manner.

By addressing these challenges, science communicators have the opportunity to promote understanding and appreciation of science, as well as to combat misinformation and lack of scientific knowledge. Through effective communication strategies based on scientific evidence, it is possible to strengthen the relationship between science and society, promoting active and informed participation of the population in the scientific process.

## **4. Building Trust in Science and an Informed Society**

Building and strengthening public trust in science is crucial for societal advancement and promoting an informed and engaged population. Trust in science is a fundamental pillar for evidence-based decision-making, both at an individual and collective level.

Effective communication plays a crucial role in building this trust. Science communicators have the responsibility to convey scientific knowledge accurately and precisely, making it accessible and understandable to the public. This involves using clear language and avoiding unnecessary technical terms, using everyday examples to illustrate complex concepts.

Furthermore, it is important for science communicators to be transparent about the sources and methodologies used in obtaining scientific findings. Sharing information about the research process and presenting underlying scientific evidence helps build trust and credibility. This entails sharing information comprehensively, presenting different perspectives, and critically discussing the

limitations and uncertainties related to the establishment and evolution of scientific knowledge.

The accurate and precise dissemination of scientific knowledge can promote an informed and engaged society. When scientific information is communicated clearly and accessibly, people are empowered to understand the challenges and opportunities of science and make informed decisions on issues related to health, the environment, technology, and other relevant areas [3].

An informed and engaged society is capable of actively participating in the scientific process, contributing ideas, questioning, and even conducting investigations. Open science is proving this daily in different fields of science. Moreover, an informed society is less susceptible to the spread of misleading information, such as pseudoscience and scientific misinformation.

Therefore, strengthening public trust in science through effective communication is an essential goal. This requires a collective effort from scientists, academic institutions, media outlets, and science communicators. It is important to invest in communication strategies that promote scientific literacy, stimulate critical thinking, and provide reliable and verified information. In doing so, it will be possible to build a society that recognizes the value of science, makes informed decisions, and actively collaborates in scientific and technological progress.

## **5. Ethics and Responsibility in Science Communication**

Ethics and responsibility play a crucial role in science communication. It is essential for science communicators to follow ethical guidelines when conveying scientific information to the public. This involves ensuring the accuracy and truthfulness of the information, avoiding distortions, exaggerations, or sensationalism. Communicators should be transparent about their sources and conflicts of interest, providing a fair and balanced representation of different scientific perspectives.

Furthermore, science communicators must be aware of the ethical implications of their

communications. This includes considering the social, environmental, and human impact of scientific discoveries and ensuring that the public is fully informed about these issues. Communicators should also respect the privacy and rights of individuals involved in scientific research, obtaining appropriate consent and protecting the confidentiality of data.

Responsibility in science communication also involves promoting scientific literacy, equipping the public with the necessary tools to critically understand and evaluate scientific information. Communicators should encourage scientific thinking by teaching the scientific method, evidence analysis, and critical thinking. They should be willing to answer questions and clarify doubts, facilitating dialogue and active participation of the public in the scientific process.

Science communicators must recognize the importance of diversity and inclusion in scientific communication. This involves the equitable representation of different groups and perspectives, avoiding stereotypes and prejudices. The inclusion of diverse voices enriches the scientific discussion and promotes a more just and equal society.

Ethics and responsibility in science communication are fundamental to establish public trust, promote scientific literacy, and ensure that scientific information is conveyed accurately, transparently, and inclusively. By adhering to ethical and responsible principles, science communicators play an essential role in building an informed and engaged society with science.

## **6. Innovative Strategies for Science Communication**

The production, dissemination, and utilization of information are crucial elements for the development of scientific communities. Throughout the centuries, communication through informal and formal channels has played a fundamental role in building new knowledge [6].

Science communication is constantly evolving, driven by the advancement of new technologies and communication platforms. Innovative strategies that leverage the opportunities offered by these tools to effectively

and engagingly disseminate scientific knowledge include the use of social media, educational videos, podcasts, and other interactive forms of science communication. Network technologies have allowed new modes of organizing scientific literature in all aspects and elements that constitute it [6]. Taking advantage of the opportunities of new technologies, social media plays a significant role in science outreach, enabling the rapid and accessible sharing of scientific information. Platforms such as Facebook, Twitter, Instagram, and LinkedIn promote dialogue and interaction with the public, while also offering targeting features to direct specific content to interested groups [7].

Educational videos have become a powerful tool in science communication. Platforms like YouTube and Vimeo enable the creation and sharing of visually appealing audiovisual content, allowing for the explanation of complex concepts, showcasing experiments, and presenting scientific discoveries in a visually compelling manner. Furthermore, the interactivity of videos allows for audience participation through comments, questions, and shares.

Podcasts have experienced a significant increase in popularity, offering a convenient and flexible way to access scientific content. Produced by scientists, specialized journalists, or science communicators, podcasts delve into discussions, feature interviews with experts, and explore scientific stories in an engaging manner. Listeners can access episodes at their own convenience while engaging in other activities [7].

In addition to these strategies, there are other interactive forms of science communication that explore gamification, virtual and augmented reality, e-learning platforms, among others. The goal is to create immersive and captivating experiences that ignite the audience's interest in science and facilitate the understanding of scientific concepts.

By harnessing the opportunities offered by new technologies and communication platforms, science communicators can reach a broader audience, make science outreach more accessible, and spark people's interest in scientific knowledge. These innovative strategies pave the way for more dynamic,

engaging, and effective communication, contributing to the closer connection between science and society.

## **7. Final considerations**

Challenges of scientific communication, with a special emphasis on the dissemination of false news related to science were briefly addressed in this communication.

It is important to highlight the importance of scientific communicators having a deep and critical knowledge in their respective scientific fields.

Considering that the spread of false news and false science is constantly present in our daily lives, it has become a political, ideological, and economic strategy that is detrimental to society as a whole [8]. The propagation of fake science is a serious problem that affects the credibility and trust in science, and is now identified as a symptom of a broader framework of informational disorders [5]. It is essential for science communicators to be able to transmit their own scientific knowledge that is correct and accurate, or to have the ability to critically evaluate and validate the information they receive from other sources. This implies being scientists themselves or having a deep knowledge, study, and learning in the field of science they operate in.

The role of science communicators goes beyond mere dissemination. They should be able to comprehensively understand scientific concepts, critically analyze evidence and evaluate research methodologies and results, and gather and match information from trustworthy sources, filtering reliable information before disseminating it to the public. This critical and validation capacity is essential to combat the spread of fake science and ensure the dissemination of established scientific knowledge.

Furthermore, it is important to emphasize that science communicators should also be aware of the limitations of their own abilities both in what concerns knowledge and communication, constantly seek updating and deepening. Science is constantly evolving, with new discoveries and perspectives emerging all the time. Therefore, it is crucial for communicators to be open to learning and updating themselves

in order to transmit accurate and updated scientific information [5].

Science communication faces everyday the challenge of dealing, avoiding and dismantling fake science. To do so it is necessary for communicators to act and be scientists in the broadest sense. This indeed helps to enable the transmission of accurate scientific knowledge and the ability to critically evaluate the information received before disseminating it. Well-prepared and critical science communicators play a fundamental role in the dissemination of reliable scientific knowledge and contributing to a more informed society that is aware of the advancements of Science [4].

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