



Article

Research on the Mechanism of Science and Technology Workers Engaging in Science Popularization Work from the Perspective of Communication

Chun Li, Jinlong Xing, Aiqun Zhang, Xuan Li, Xueji Ma*

Hefei General Machinery Research Institute Co., Ltd, Hefei, 230031, China

Academic Editor: Dapeng Zhang <zhangdapeng@gdou.edu.cn>

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Abstract: Popularization of scientific and technological resources is a strategic initiative of the national popularization of science and technology, and the participation of scientific and technological workers close to scientific and technological resources in popularization of science and technology is one of the core contents of this policy. However, most of the scientific and technological workers have not received special training in the communication ability to face the public, and there are barriers to communication when communicating with the public, which leads to the reluctance and fear of participating in the popularization of science and technology. This paper begins by thoroughly exploring the concept of communication and its significance. Utilizing the case study method to analyze representative practical cases and summarizing expert interviews, it presents recommendations and measures for science and technology workers to effectively engage in popularizing science and technology. This paper serves as a valuable resource for enhancing the dissemination of scientific knowledge.

Keywords: Popularization of science and technology resources; science and technology workers; Barriers to communication; Case study method

1. Introduction

The Programme of Action for the Quality of Science for All (2021-2035), issued by the State Council of China, emphasises the importance of science popularisation resources. In order to ensure the implementation of popularization of science and technology resources, we need to establish and improve relevant mechanisms and continuously strengthen the sense of responsibility of scientific and technological innovation subjects in popularization of science and technology. At the same time, we need to explore the popularization potential of scientific and technological facilities and enhance the popularization ability of scientific and technological workers. Under the call of the State, some organizations and units have already carried out active exploration. For example, the "Science Communication Salon - Exploration and Practice of Science and Technology Resources for Popularization of Science and Technology" was held in February 2023, which was co-sponsored by the Beijing Municipal Association of Science and Technology and the Beijing Academy of Science and Technology, with the full support of several associations and research institutes. In addition, the "Science and China" campaign initiated by the Chinese Academy of Sciences (CAS) is also one of the important practices of popularization of science and technology resources in China. Figure 1 depicts the publication trends of articles pertaining to the popularization of science on both the Web of Science and CNKI over the past two decades. While there is an overall upward trajectory, recent years have shown signs of encountering certain bottlenecks in the field's development. Thus, there are still many obstacles and challenges in popularizing science and technology resources in China [1]. For example, the details of popularization of science and technology resources are not clear, the channels of transformation of science and technology resources are not smooth, and the communication barriers faced by scientists and technologists when facing the public. Therefore, we need to further explore and improve the mechanism of scientific and technological resources popularization to provide a solid theoretical foundation for the smooth implementation of scientific and technological resources popularization.

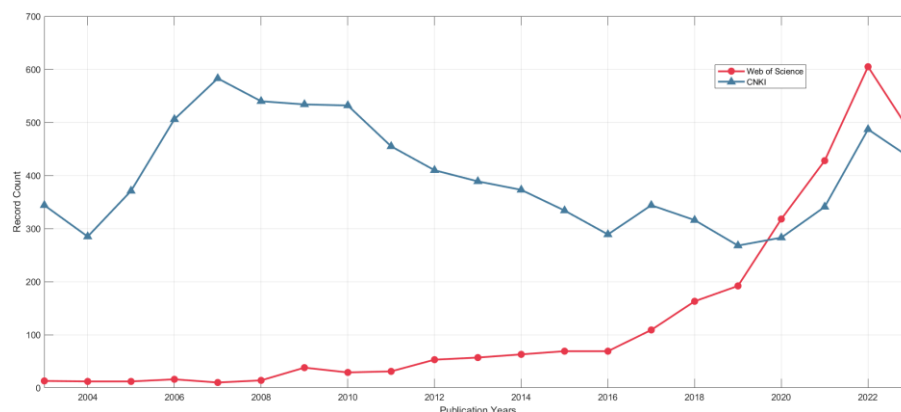


Figure 1. The number of published results about popularization of science from 2003-2023 in the Web of Science and CNKI.

This study focuses on the communication perspective to explore how S&T workers can carry out effective knowledge dissemination in popularization of science and technology and collects and researches domestic and foreign practical experiences and policy guidelines

through case analysis and literature research and puts forward corresponding suggestions on the basis of which, in order to better improve the quality and effect of popularization of science and technology. The line of research in this paper is shown in Figure 2.

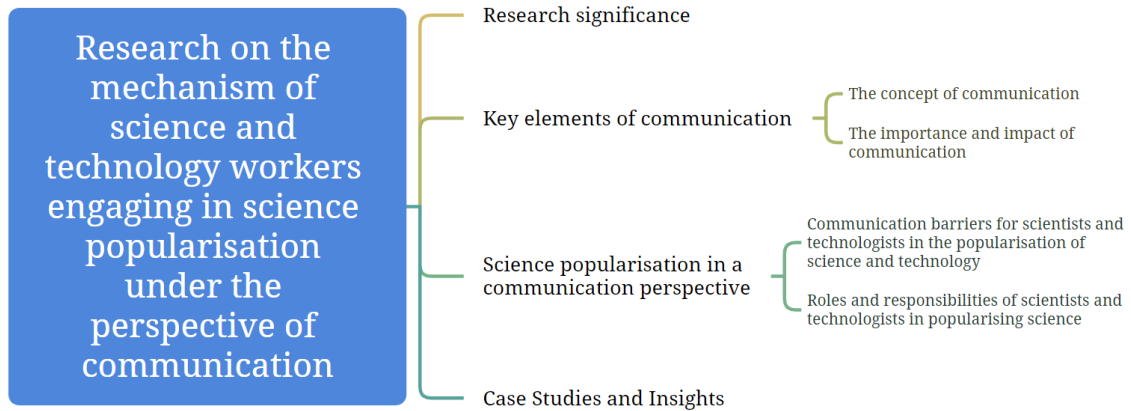


Figure. 2. The line of research in this paper.

2. Key elements of communication

2.1 The concept of communication

Due to the differences in the research perspectives of various disciplines, there is diversity in the understanding of communication. According to incomplete statistics, there are more than 150 disciplinary definitions of communication, which indicates that communication is a complex and multi-dimensional concept, and different disciplines have conducted in-depth discussion and research on it from their own perspectives. As shown in Figure 3. In general, communication mainly includes the following types:

- (1) Sharing, which emphasizes that communication is the sharing of information between people.
- (2) Exchanging, which emphasizes that communication is a two-way activity that has a back and forth.
- (3) Influence theory, which emphasizes that communication is the act of one party exerting influence on another party through persuasion.
- (4) Symbolic theory, which emphasizes that communication is the flow of symbolic information [2].

If these views are combined, the connotation of communication can be more fully understood. In short, communication is the act of conveying thoughts and ideas or exchanging situations and information between actors in a reasonably coordinated way, so that both parties can reach a true understanding or consensus.

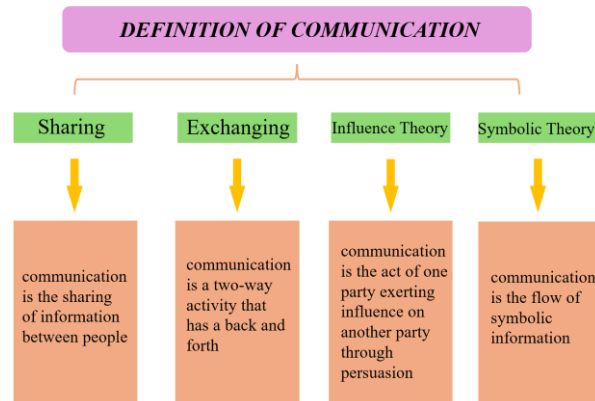


Figure. 3. Different doctrinal definitions of communication.

2.2 The importance and impact of communication

The significance of communication in disseminating information is paramount. Lev Tolstoy famously remarked, "A single conversation with a person often enlightens the mind more than years of labor behind closed doors. Ideas must arise in association with people and proceed in solitude" [3]. This underscores the profound impact of interpersonal exchange in fostering understanding and innovation. Many problems between people are caused by inadequate communication or misunderstanding in communication, and through effective communication, knowledge and information can be spread smoothly to avoid misunderstanding or omission. For science and technology workers, good communication skills is one of the key factors of success, which is not only conducive to mutual trust of people within the organization, improve team cohesion and efficiency, but also help to coordinate the pace and action of organizational members to ensure the successful completion of the organization's plans and goals [4].

Scientific communication, dissemination, and popularization constitute the fundamental pillars of scientific development, forming an interconnected and mutually reinforcing framework that drives progress within society. Scientific communication serves as the bedrock of scientific inquiry, fostering continuous knowledge accumulation and innovation through rigorous discussion and sharing of findings. Science dissemination, on the other hand, extends these discoveries to a broader societal audience, heightening public awareness of and interest in scientific endeavors.

Meanwhile, science popularization plays a pivotal role in realizing the democratization of science. By disseminating scientific knowledge in an accessible manner, it enhances public scientific literacy and facilitates the widespread application and advancement of science within society. These three components synergize to propel scientific progress, injecting a perpetual momentum for the prosperity and advancement of society as a whole.

3. Popularization of science from a communication perspective

3.1 Roles and responsibilities

Scientific and technological workers themselves possess a wealth of scientific knowledge and bear important responsibilities in public perception, such as disseminating scientific knowledge, eliminating scientific superstitions and promoting the transformation of scientific and technological achievements. Their work in popularizing science is not only beneficial to the public and to society, but also promotes the scientific research of the scientists themselves, giving full play to their professional knowledge and skills, and contributing positively to the improvement of the quality of science and the level of scientific development of the whole society.

3.2 Communication barriers

Research shows that the study of scientists' family involvement in science popularization in western countries began around the middle of the 20th century. At that time, the rapid development of science and technology triggered public interest in scientific knowledge, so many scientists recognized that they needed to share scientific knowledge with the public and took the initiative to participate in popularizing science, but in practice, scientists found that there were communication barriers between them and the public, and scientists often cited a lack of training and/or a lack of confidence in their own communication skills as barriers to their participation in public-facing activities [5].

In the research paper "It takes a lot of courage for scientists to communicate with the public - an interview with Philip Cann, Editor-in-Chief of Nature", the problems that scientists may encounter in communicating their scientific knowledge and ideas are explored, with reference to the language and cultural barriers between scientists and the public, and scientists' ability to communicate with the public. The article discusses the problems scientists may encounter in communicating scientific knowledge and ideas, including language and cultural barriers between scientists and the public, and how scientists can cope with the public's misunderstanding of science. Hu, Ao, Cui and Yang concluded that scientists' participation in popularization of science is characterized by the phenomenon of "knowledge-activity contrast", and that there are four dilemmas of "not daring to, not willing to, not caring about and not being good at science" [2]. Gan Xiao, a reporter of China Science News, also mentioned in the research news that "the expression system of scientific researchers is often very academic and professional and cannot resonate with the public". This undoubtedly reveals the importance of mastering communication.

4. Successful communication cases analysis and inspiration

4.1 Effective Communication in Science Popularization

Mr. Wang Pinxian, a Chinese marine geologist and academician of the Chinese Academy of Sciences, is a strong supporter of science popularization. There are more than 100 science videos of Academician Wang Pinxian on the website "Bilibili", in which he introduces Darwin, Newton, the ocean, the earth and even the Pirates of the Caribbean. Throughout his popularization videos, Academician Wang Pinxian always spreads the

knowledge of marine geoscience to the public with his friendly image and interesting way of explanation. Therefore, netizens call him "Netflix Academician". When a reporter asked him how he could translate the profound scientific principles into interesting popularization language that the public could understand, Academician Wang said, "I have found a way to talk to young people - storytelling. If you want to be a good scientist, you have to eat up your own scientific research, and only when you have eaten up the content of knowledge can you apply it freely, and use 'meta-science popularization' to communicate and express it to the general public. In the popularization of science work need to face different audience groups, facing different groups of people, appropriate use of communication skills, such as humor and positive emotions can add interest to the communication. In addition, modern technological tools (e.g., animation, video, etc.) can be utilized to create vivid, three-dimensional science popularization scenarios to achieve the purpose of attracting the public to communicate."

Also in the beep website, there are more than 100 science videos of Liu Jiaqi, researcher at the Institute of Geology and Geophysics of the Chinese Academy of Sciences (IGGP), volcano geology and quaternary geologist, and academician of the Chinese Academy of Sciences (CAS), in which academician Liu always explains volcano geology knowledge in a cordial and amiable way, and so he is known by netizens as the "Volcano Grandpa".

Academician Liu Jiaqi said that "popularization of science should not only be rich in content, but also in form, in a way that young people like." [6]. Whenever he communicates with the public, Academician Liu Jiaqi always interacts and communicates with young people with the concept of equal treatment. Using storytelling, he narrated his scientific research journey. He is also often willing to share his reflections on his life to stimulate young people's interest and enthusiasm in scientific research [7].

Dr. Zhang Dapeng, a promising young scholar in ocean engineering, is embarking on a pioneering endeavor by integrating traditional Chinese ancient poems with the principles of ocean engineering. This innovative approach not only elucidates the intricacies of ocean engineering but also fosters a deeper comprehension among learners. By merging the artistry of ancient poetry with the practicality of engineering, Dr. Zhang aims to achieve optimal learning outcomes with minimal effort. Moreover, this initiative showcases the captivating allure of ocean engineering, enriching learners' knowledge while nurturing their humanistic sensibilities [8].

At the end of 2023, the old scientists of the Chinese Academy of Sciences' Old Scientists' Popularization of Science Lecture Group home twice into the primary and secondary schools in Chenzhou City, where the scientists publicized the scientific knowledge in their own research fields through the form of popular science reports. In the face of questions from the public, the scientists first listened with enthusiasm and patience, and then answered with humor using a staccato accent.

This type of face-to-face communication is very popular with the public and is widely used by scientists. Scientists use visual, verbal, and nonverbal cues to understand the public's thought processes, so that they can more quickly find entry points for communication, and accurately focus on problems and solve them through communication.

4.2 Insights from cases

After analyzing the above case study of scientists' science communication, it is not difficult to draw the following four points of communication experience in science popularization work.

4.2.1 Simple language and illustrations

In his book *Thinking, Fast and Slow*, Nobel Prize-winning economist Daniel Kahneman writes: "If you want to give people the impression that you are trustworthy and intelligent, don't use complex language as much as you can, and keep it simple"[6]. He argues that persuasive speakers and writers do everything they can to minimize the "cognitive stress" they put on people [6]. He argues that persuasive speakers and writers do what they can to minimize the "cognitive stress" of language. In the face of non-professionals to popularize science must be easy to understand the language and text, in this process it is necessary for scientists and technologists to do a good job in advance of the knowledge research, just as academician Wang talked about only after in-depth research can be done to achieve the use of ease of use, the expression of the concise and easy to understand.

4.2.2 Personalizing communications to target audiences

In practice, the audience groups of popularization of science, no matter divided by gender and age, or divided by occupation and work, cannot be precisely unified, but before carrying out popularization of science activities, we still need to be classified according to the main characteristics of the audience groups, and formulate different communication programs for different audience groups, just as the old scientists of the Chinese Academy of Sciences Popularization of Science Lecture Group faced with the middle school students and elementary school students, although we cannot accurately divide the grade, but we also need to have targeted communication programs. It is just like the old scientists' science popularization lecture group of Chinese Academy of Sciences when dealing with middle school students and primary school students, although we can't precisely classify the grades, but we also need to have a targeted communication plan, we can't communicate with middle school students with overly simple language, and at the same time, we shouldn't teach the elementary school students the knowledge of middle school students which is beyond their comprehension [9].

4.2.3 Knowledge of media communication

Science and technology workers should keep abreast of the times, living in today's era of information explosion, popularization of science can not be separated from the media. Network is not developed in the era of science and technology workers usually through thesis presentations or books to promote science, then the number of audiences facing dozens, hundreds, thousands or tens of thousands, but nowadays the network can face more than a million audiences at the same time live, so learning media communication knowledge will help science and technology workers and the audience to communicate.

4.2.4 Establishing two-way interaction model

The two-way interactive participation model enhances the sense of participation and engagement in the communication process, improves communication efficiency, and enhances understanding and trust. During the communication sessions with students in primary and secondary schools in Chenzhou city, students were eager to ask questions and strive for a rare opportunity. After the class, the teachers and students became fanatical "star chasers". When the reporter interviewed the students who participated in the class afterwards, the students all said enthusiastically to the reporter that they had a strong interest in science knowledge through the communication with the scientists and hoped that there would be more such opportunities in the future.

5. Discussion

5.1 Suggestions and perspectives

The aforementioned studies underscore the vital role of science and technology popularization as a conduit between scientific advancements and societal understanding, significantly contributing to the enhancement of public scientific literacy and the advancement of society. Nevertheless, science and technology practitioners currently encounter numerous challenges in effectively disseminating scientific knowledge, including constraints related to time, access to channels, and professional identity, as well as a deficiency in communication skills and methodologies for popularizing science.

As depicted in figure 4, this paper aims to propose suggestions and future perspectives in three key areas: raising awareness among science and technology practitioners regarding the importance of science popularization, providing comprehensive training programs on science communication, and fortifying the evaluation and feedback mechanisms within science popularization initiatives.

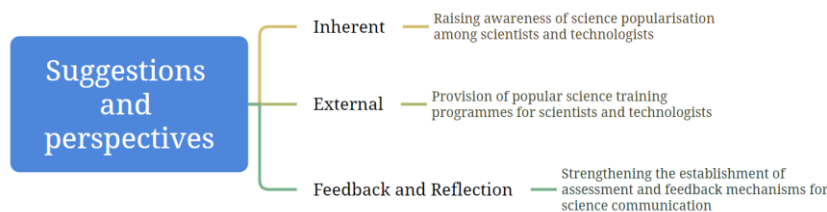


Figure. 4. Framework of recommendations and perspectives.

5.1.1 Increased awareness of science popularization

Scientific and technological personnel from all over the world have encountered the common problems of lack of time, channels and recognition when participating in popularization of science [10]. In China, these problems also exist [10]. In China, these problems also exist, in the research of Song Xian and other researchers, 70% of the interviewed scientific and technological workers proposed that the lack of performance, title, funding and other related mechanisms have an impact on their popularization of science and

technology work. Sun, an academician of the Chinese Academy of Sciences, said in an interview with a reporter that "popularization of science is an important mission that scientists should fulfil. People who know science do not do popularization of science, who do popularization of science? If you ask where is the motivation to do popularization of science? My answer is: a sense of responsibility." Yes, in the scientific and technological resources popularization of science and technology of the regular mechanism is not sound, we should advocate science and technology workers sense of responsibility for popularization of science and technology, learning the old generation of scientists of the family and the country, learning them to forget about their work, learning them to dedicate their lifelong dedication to the motherland's ideals and beliefs, and adhere to the beliefs of the noble feelings to carry out the work to achieve the spirit of the Chinese-style modernization of the dedication of their own strength.

5.1.2 Delivery of relevant training courses

According to research by Sarah and Ruth, PhDs in Immunology at Oklahoma State University, scientists are trained in specialized disciplines but are rarely trained in how to manage and mentor others. The UK Research Councils have published an instructive document, *Engaging the younger generation at the cutting edge of research: a guide for researchers and teachers* [11]. This document is a guide to the way in which scientists and faculty are being trained to manage and mentor others [11]. This document answers the questions of how scientists and technologists can address communication difficulties, activity selection, and thematic direction in science communication activities for primary and secondary school students and can help scientists and technologists to quickly acquire the basic knowledge of communication and dissemination.

In addition, the National Science Foundation's (NSF) Office of Legislative and Public Affairs provides a full range of communication training and communication skills enhancement services for research program directors. The training includes dissemination methods, communication skills, interview considerations, and even how to solve the problem of brain fog caused by nervousness when facing an audience. These services can help researchers learn about public communication and help science and technology workers improve their public awareness.

5.1.3 Establishment of relevant assessment and feedback mechanisms

The assessment and feedback mechanism for popularization of science communication is one of the two-way interaction and participation modes, as well as an evaluation mechanism for the effectiveness of communication between scientific and technological workers and audience groups. Through the evaluation and feedback mechanism, the process of collecting, organizing and analyzing information is established, and through the scientific analysis of the information content, it can provide an important reference basis for the communication barriers between scientific and technological workers and audiences, and adjust and optimize the communication strategy in time according to the information feedback and evaluation results, so as to enhance the influence of science popularization activities and the effect of science popularization. In addition, through the analysis of the

evaluation and feedback, we can also gain an understanding of the actual needs of the audience, which can be used to innovate the communication methods, and also help to establish and maintain the interactive and trusting relationship between science popularization workers and the audience.

5.2 Limitations of the research

Due to the diversity within scientific and technological (S&T) communities and the multitude of methods used to popularize science, our study may not fully capture the experiences of all groups. The limitations of our research methodology fail to account for individual differences and the dynamics among S&T workers involved in science popularization. Moreover, they do not adequately address the varied barriers and challenges faced by different S&T professionals.

In future studies, as resources for science and technology popularization continue to expand, it is imperative to enhance research on effective strategies for overcoming these diverse barriers and challenges. By doing so, we aim to encourage greater participation from S&T workers in science popularization efforts. This will necessitate broadening the scope of our research to delve deeper into the specific hurdles encountered by S&T workers in their efforts to popularize science and technology.

Ultimately, we aspire for our research to provide more targeted support and guidance for those engaged in the practice of science and technology popularization. This will contribute to the enrichment of science communication efforts and foster greater public engagement with S&T topics.

6. Conclusions

Science and technology professionals bear a significant responsibility in driving scientific and technological advancement and promoting the dissemination of scientific knowledge. Their efforts in popularizing science align with the evolving needs of our times and constitute a vital contribution to the long-term development of our nation.

To effectively engage in science popularization, science and technology workers must continuously update their knowledge base and stay informed about the latest developments in their respective fields. Moreover, they should prioritize honing their communication skills and enhancing their abilities to convey complex scientific concepts in accessible ways.

In the realm of science and technology popularization, it is essential for scientists and technicians to identify the appropriate target audience and tailor their communication strategies accordingly. By developing adaptable approaches to popularization, they can effectively bridge the gap between scientific knowledge and public understanding, thereby fostering the advancement and progression of science and technology dissemination through their dedicated efforts.

Conflict of interest: The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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