How Science Communication Can Be Coherent and Effective in the Internet Age: Case Studies of GMO and PX Projects (Postprint)

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Abstract

This article takes recent domestic hot-button events in science communication as case studies, examining from the perspective of issue evolution the fundamental pathways of these events in science communication and the social contexts that gave rise to them. It proposes that it is precisely the closure of major segments in the communication chain, among other reasons, that leads to the public' s "misunderstanding" of science and the current disordered state of science communication. The article also addresses three aspects—building exchange platforms, fostering social trust, and media transformation—offering suggestions and recommendations on how media can innovate and develop in the Internet era and continue to play a leading role in science communication.

Full Text

How to Be Self-Consistent and Effective: Science Communication in the Internet Age—A Case Study on GMO and PX Project Communication

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Abstract

This article examines recent hot-button issues in domestic science communication in China, analyzing the evolution of these topics to trace their basic trajectories in science communication and underlying social contexts. It argues that the isolation of key links in the communication chain has led to public "misunderstanding" of science and the current disorder in science communication. The paper further offers recommendations for media innovation and development in

the internet age, and how media can continue to play a leading role in science communication through three approaches: building communication platforms, fostering social trust, and facilitating media transformation.

Keywords: disorder, closed circles, isolation, trust, media innovation

Introduction

In an era that venerates science, the importance of science in social life is self-evident, making science communication even more significant than general communication studies. Science should not only be disseminated rationally and thoroughly but also gain due understanding and support to become a genuine driver of social progress and civilized living, rather than an obstacle to advancement or a scapegoat for decision-making. Therefore, the primary mission of science communication extends beyond transmitting science to "restoring" science—to returning science to its essence, upholding its rationality while adhering to social ethics, and maintaining a skeptical spirit to prevent science itself from becoming another form of superstition.

In recent years, domestic science communication in China has faced unprecedented challenges on complex scientific issues ranging from genetically modified organisms (GMOs) and PX (paraxylene) projects to nuclear power, PM2.5, food additives, and H5N1. The past decade has been marked by continuous controversy over GMOs, with 2014 even being described as a year of "complete defeat" for GMO science popularization. Regarding PX projects, frequent safety accidents in the chemical industry have provided fertile ground for group psychology that opposes PX and chemical projects in general, making it difficult to curb the repeated occurrence of mass incidents. Meanwhile, on many major issues of public concern, scientific questions remain either unresolved without consensus (even within the scientific community) or unresolved despite decisions being made. The knowledge and conclusions provided by the scientific community, government agencies, and media institutions often fail to convince the public, and even when the public chooses to understand and accept them, they are unwilling to take action. In short, many invisible chasms remain between "being unclear" and "being clear," and between "choosing to understand" and "truly supporting," requiring more targeted and sustained efforts in science communication.

1. The "Disorder" of GMO Science Popularization: Has It Failed?

1.1 The Evolution of Communication Topics GMO issues represent one of the most poorly perceived public topics in contemporary China. This poor perception refers not only to the duration, scope, and intensity of the debate but also to the proliferation of misinformation. Examining major GMO-related events over the past decade reveals that while the overall topics have remained consistent, each stage has featured different focal points that reflect distinct characteristics of science communication.

In 2004, sixteen academicians and experts submitted a proposal to the State Council advocating for the industrialization of genetically modified rice. After being disclosed by *Southern Weekly*, the question of whether GMOs are harmful quickly became a social focus. In April 2005, Greenpeace' s investigation revealing that illegally planted genetically modified rice might have entered the market in Hubei Province triggered widespread panic. In 2009, when China issued its first safety certificates for genetically modified rice, it sparked extensive debate, with new communication focuses emerging on flaws in approval procedures and the "ignoring" of public right-to-know.

In 2012, American scientist Tang Guangwen published a research report on the "Golden Rice" nutritional experiment conducted in Hengyang, Hunan. The study, which began in 2008, involved feeding genetically modified rice to child participants without informing them of the facts. After media exposure, it triggered a protracted debate on experimental ethics. A content analysis of the seven-month dissemination pattern of the "Golden Rice" incident on Sina Weibo found that few netizens concerned themselves with the scientific question itself (such as whether GMOs are safe). Instead, they adopted an "attitude-based alignment" approach to commentary, focusing on rejecting government information, distrusting government management capabilities, and simultaneously resisting scientists as representatives of power.

In March 2014, public figure Cui Yongyuan released an online documentary based on his investigation in the United States, "exposing" the views of some Americans opposing genetically modified foods. Despite numerous scientific "flaws" in the documentary, it nonetheless sparked a new wave of "anti-GMO" sentiment online. That year, the GMO debate finally shifted, with scientists and the scientific community beginning to speak out forcefully and unequivocally. In October 2014, the "International Symposium on the Development Status and Future Prospects of Global Genetically Modified Crops" was held in Wuhan, resulting in the "Wuhan Consensus" based on eight points. The consensus stated that "genetic modification methods for specific improvements have no negative effects on humans or animals" and called for GMO debates to be grounded in science and rationality.

At the beginning of 2015, the GMO debate flared up again. In January, ifeng.com organized a GMO debate, inviting representatives from both "pro-GMO" and "anti-GMO" camps, as well as scholars engaged in science communication research, to engage in open dialogue. The topic shifted from the scientific level to the social level, reflecting basic civil rights. In March, Cui Yongyuan "debated" biologist Lu Daru at Fudan University, sparking a media frenzy. This "heated debate" prompted Cui Yongyuan' s long-considered decision: in an exclusive interview with *China Science Daily*, he stated that he supported GMO scientific research but remained concerned about illegal GMO planting and diffusion, as well as GMO food labeling issues. This represented a complete transformation after years of campaigning as an "anti-GMO" figure. *China Science Daily* characterized the incident as a battle over science

communication.

Today, the mainstream scientific view on GMOs has finally been clarified: the mainstream view in domestic and international scientific communities is that GMO products that have undergone rigorous scientific evaluation and standardized management and have been approved for production or international trade are as safe as non-GMO products. Meanwhile, the importance and necessity of GMO science communication have gained increasing recognition following a series of landmark events. For example, the 2015 Central No. 1 Document first mentioned strengthening GMO science popularization. Additionally, more scientists and scholars have stepped forward to support GMOs. Although participants in GMO rice tasting events still face public pressure, they have made such science popularization stunts known to more people. In August 2015, the Ministry of Agriculture published a response letter to a proposal on "strengthening GMO food safety management," which the media hailed as "China' s Ministry of Agriculture finally speaking up." This seems to place a "comma" on the protracted GMO debate, though questions and controversies surrounding GMOs and other scientific topics directly affecting public life will continue to emerge.

1.2 The Social Background of Topic Formation The GMO controversy did not emerge from a vacuum. Prior media coverage had not triggered such a protracted "tug-of-war." The 2004 "academicians' letter" advocating accelerated GMO development and the 2005 international NGO attention to illegal GMO rice cultivation timely filled the public opinion vacuum at the time, perhaps making GMO topics important issues in science communication thereafter.

In recent years, major and catastrophic chemical accidents have occurred frequently in China, leading to increasingly prominent safety, health, and environmental issues. People have become terrified of PX projects, triggering the rise of domestic NIMBY (Not In My Backyard) movements. In 2010, China' s chemical industry output value reached 5.23 trillion yuan, surpassing the United States to become the world' s largest chemical industry. While becoming a pillar industry of the national economy, the chemical industry' s safety issues have faced unprecedented challenges. From the fire at the Liaoyang Petrochemical PX plant more than a decade ago, the 2009 Fushun Dahua PX fire, the 2011 CNOOC Huizhou refinery PX plant fire, to the successive explosions at the Zhangzhou PX project in 2013 and 2015, safety accidents at PX projects have continued to emerge. The repeated occurrence of "PX incidents" cannot be sufficiently explained by reasons such as increased public rights awareness or insufficient publicity and guidance. Initially, the public may have been unfamiliar with PX technology and felt uneasy about such chemical projects. However, as media science popularization has advanced, public concerns about the science and technology itself have weakened, while distrust in government decision-making transparency, regulatory efficiency, and enterprise operation and management levels has continuously strengthened. Although this strengthening has objective

reasons, scientists, government managers, and media still uniformly emphasize the scientific nature of technology while failing to analyze other causes and propose solutions. The result can only be "each talking their own logic," while the public, as stakeholders, still choose to "not act" or "not accept."

2. Why Doesn' t the Public Understand Science?

2.1 Science from a Communication Perspective The history of human science communication can be traced back to 17th-century England. In the 1960s and 1970s, science' s expanding demand for media triggered a global wave of science popularization, which was also an era of intensified conflict between science and the public. The history of science communication abroad shows that the subsequent "public understanding of science" movement ultimately represented a failed experiment—yet China continues to conduct such experiments.

The disparity between public understanding of scientific facts and their attitudes has always existed. The aforementioned failed Western attempts to make the public understand science are illustrative. Improved public scientific literacy does not necessarily lead to deeper support for science; this non-linear relationship may even develop in the opposite direction. This is exemplified by the current state of science communication in Chinese society: vigorous promotion on one side, active non-cooperation on the other, or verbal agreement without genuine conviction. Traditional top-down communication methods have left the public still lacking necessary understanding of science itself and unable to establish basic resistance to pseudoscience. The emergence and continuation of superstition represent the most obvious example, thriving in large part due to "unscientific" science communication. On the other hand, the existence of anti-scientism is also a factor that cannot be ignored. Anti-scientism emphasizes that overly optimistic views about science—believing it is omnipotent and necessarily promotes social progress—in fact push science toward superstition and even make it a new form of superstition.

2.2 Closed Circles Scientists occupy the discourse power due to their specialized knowledge. The problem of knowledge and information asymmetry between the public and the scientific system and community remains widespread. While modern technological development has greatly expanded people' s horizons, it has also hindered communication between people to some extent, with certain circles growing more tenaciously and their closed nature showing no significant change.

2.2.1 Arrogant "Science" Often, the "science" that scientists are eager to express is not the "science" that the public understands. Scientists are keen to disseminate knowledge in their professional fields or familiar areas while rarely considering the various objective differences among the public receiving this information.

The "heated debate" between Cui Yongyuan and Lu Daru was undoubtedly an unsuccessful dialogue but might be considered a "successful" science communication event. Lu Daru, representing some scientists, displayed a "ruthless" attitude when facing outsiders, which may be one reason why the public finds it difficult to accept their views. Regarding PX, in April 2014, there was an incident where the Baidu Baike entry for PX was tampered with. Tsinghua University students launched a campaign to defend the Baidu entry. Whether PX is toxic or not, and whether it is low-toxicity or highly toxic, is a scientific question. However, previous media reports on this issue were ambiguous and failed to leave a sufficiently deep impression of scientific conclusions on the public. In fact, media discussions on the science of PX have been diverse and random, with pursuing sensational effects being one of their values. Moreover, constrained by limited space and time, traditional media often cannot provide comprehensive coverage of an event (or find it difficult to do so). Media always prefer to "take a part for the whole" and "see the leopard through a tube," starting from a specific issue, grasping one point without covering the rest, and making progressive reports. For example, while PX itself is low-toxicity, this does not mean there are no safety risks in its production and transportation processes. Whether a city should support a PX project is in fact not a simple scientific question but also an economic, political, or social management issue.

The question of why GMO science communication, despite significant investment, remains unacceptable to the public can be partially explained by this "Lu Daru-style" scientist attitude. Lu Daru' s attitude, position, and mode of expression in this confrontation are quite representative. At the same time, from a science communication perspective, why has such extensive investment in GMO science communication still failed to gain public acceptance? Part of the reason lies in this very attitude.

2.2.2 The "Willful" Public The gap between public understanding of scientific facts and their attitudes has always existed. The aforementioned failed Western attempts to make the public understand science are illustrative. Improved public scientific literacy does not necessarily lead to deeper support for science; this non-linear relationship may even develop in the opposite direction. This is exemplified by the current state of science communication in Chinese society: vigorous promotion on one side, active non-cooperation on the other, or verbal agreement without genuine conviction. Traditional top-down communication methods have left the public still lacking necessary understanding of science itself and unable to establish basic resistance to pseudoscience. The emergence and continuation of superstition represent the most obvious example, thriving in large part due to "unscientific" science communication. On the other hand, the existence of anti-scientism is also a factor that cannot be ignored. Anti-scientism emphasizes that overly optimistic views about science—believing it is omnipotent and necessarily promotes social progress—in fact push science toward superstition and even make it a new form of superstition.

"Why can' t the scientific community defeat Xiao Cui (Cui Yongyuan), at least in debate?" When discussing this question, Ji Shisan from Guokr.com calls it "humanity's inexplicable panic about the unknown."The current label for GMOs is that they are an unknown, so regarding their "harm," people would rather believe it exists than not. The public has a need to understand professional knowledge but lacks the ability to express it professionally. They have a need to pay attention to and even participate in public affairs, but this participation right is often not guaranteed. Therefore, in many cases, their opinions are expressed hastily, one-sidedly, or even emotionally. Regardless of whether these expressions ultimately enter the center of public opinion, their appeal to media is undeniable.

2.2.3 Disordered Media In many PX mass incidents, the escalation of PX from an industrial project and technical management issue to an increasingly uncontrollable mass event often involves enterprises and local governments bearing undeniable responsibility. They either communicate negatively beforehand or adopt a "board first, ticket later" approach, launching projects first and then frantically facing challenges from operational safety and environmental risks. On GMO issues, the government and management departments have mostly chosen to remain silent over the years, often asking scientists to speak for them in the face of social debates and mixed communication content. This approach leaves scientists who face irrational debates or even personal attacks feeling resentful. Some scientists even believe that having scientists "rush to the front" suggests the government is shirking responsibility and making scientists take the blame.

It should be recognized that scientists, government and management departments, media, and even the public are all circles, each presenting a semi-open, semi-closed state. Government departments, in particular, though public opinion can influence their decision-making, still maintain closed, hierarchical structures and bureaucratic characteristics that are difficult to break through. The future degree of openness and sharing in these circles will directly affect the process and effectiveness of science communication.

2.2.4 Restrained Managers Whether on GMO issues or PX projects, government departments and managers have always played important roles in communication activities. Because they are important and authoritative, they are cautious to the point of being overcautious, often appearing in communication activities passively, seriously lagging behind and missing from their important position in the communication chain. In the information transmission process, they are also frequently questioned or even resented over issues of transparency and timeliness.

3. Challenges Facing Science Communication

3.1 Increasing Complexity of Communication Content Today, the dissemination of scientific knowledge is no longer as simple as writing a few popular science articles or giving a few lectures. Public access to information channels is becoming increasingly diverse. How to prevent scientific voices from being drowned out by noise or even rumors is a major challenge facing science communication.

In 1976, University of Chicago economist Sam Peltzman published a study showing that new safety technologies such as seat belts and airbags in cars did not improve road safety. While new technologies can significantly reduce fatality rates in accidents, they also increase people' s dependence on technology, breeding negligence and violations, and leading to a substantial increase in the number of accidents within a certain period. Safety issues prevalent in today' s industrial production are also affected by the Peltzman effect based on natural human reactions. Chinese scholars believe that increased investment in chemical safety facilities in China has not significantly improved chemical safety levels because workers make reverse choices depending on continuously improving safety facilities—that is, the Peltzman effect exists.

Currently, almost no media coverage addresses this deeper exploration of the causes of chemical accidents. Consequently, more in-depth research and analysis on how to respond to new challenges in future chemical safety supervision have not attracted attention at the level of science communication. The problem of chemical safety production is similar to many other issues: rather than saying the complexity of social problems is deepening, it is more accurate to say that science communication is weak and lagging in terms of content specificity and methodological flexibility. Therefore, science communication urgently needs to strengthen its ability to analyze and solve new situations, new circumstances, and new problems.

3.2 Diversification of Claims and Interests Taking GMO issues as an example, it is evident that science communication often faces challenges from the diversification of claims and interests. Only by conducting targeted publicity for different problems can better results be achieved. Liu Jinping categorized different types of anti-GMO voices and concluded that current anti-GMO voices come from all directions and industries, with varying degrees and levels of opposition. In contrast, pro-GMO voices mainly come from biologists or related scientific workers.

The main claims of "anti-GMO" individuals vary: some only oppose staple food GMOization, some oppose all crop GMOization, some resist GMO research and development altogether, and many emphasize the right to know and choose when consuming GMO foods. The reasons for opposing GMOs are also diverse. Some fear out of ignorance, while others stem from philosophical reflection or fear of technological power. Additionally, views based on religious or ethical reasons—

that humans should not "create things" and should use "natural" products—are also very common. Of course, opposition based on economic interests is also an undercurrent.

3.3 Increasing Difficulty in Creating Healthy Public Opinion Environments The complexity of the current information environment also stems from the popularization of the internet and the proliferation of opinion leaders. Public expression of opinions has become virtually unobstructed. The internet has given nearly equal communication opportunities to various voices, which inevitably brings about a "noise field"of various opinion expressions and a "powder keg" of various emotional venting.

Concerns about the proliferation of opinion leaders lie in the fact that their views on scientific issues often ignore basic scientific facts themselves. It should be said that regarding specific issues that attract attention, except for researchers in the field, all other participants are laypeople who need to receive communication. The public has a need to understand professional knowledge but lacks the ability to express it professionally. They have a need to pay attention to and even participate in public affairs, but this participation right is often not guaranteed. Therefore, in many cases, their opinions are expressed hastily, one-sidedly, or even emotionally. Regardless of whether these expressions ultimately enter the center of public opinion, their appeal to media is undeniable.

These issues make creating healthy public opinion environments increasingly difficult, warranting deep reflection and research from communicators.

4. How Can Media Be Self-Consistent?

With continuous updates in media technology, communication based on the internet and mobile internet is breaking through the concept of traditional mass media communication. Communication is no longer one-way from news institutions to the public but seamless communication and exchange between any two points in the network composed of communication institutions and all citizens. Communication is no longer limited by whether communicators are professional or how they communicate.

4.1 Building Open and Transparent Communication Platforms How to make the scientific community more actively "step out" of still-closed circles and participate in science communication? The "Information Officer" system established in research institutions in Western countries is worth learning from. Science information officers differ from traditional institutional publicists; they are roles between scientific workers and communicators, with professional backgrounds mainly in science communication and relatively strong organizational skills for external communication and scientific literacy. Because of their existence and various media carriers established based on them, the missing links in modern science communication can be compensated.

Giving full play to the functions of mass communication media is also an undeniable way to break barriers and promote integration. Currently, new media represented by the internet and mobile internet have become important channels for citizens to participate in social life, and voices from the internet have become a force that cannot be ignored. When scientific topics are led astray or scientific controversies fall into irrational abysses, media should assume the role of an authoritative platform for objective information dissemination and positive public opinion guidance. On the one hand, media should further change from passive response to active guidance, actively planning and organizing topics on major scientific issues and social hot topics of public concern, scientifically explaining doubts and eliminating fallacies. On the other hand, they should also uphold the spirit of science, maintain a rational attitude, correctly face social issues entangled in scientific topics, and relieve rather than increase social hostility.

Science communication should transform one-way dissemination into exchange and interaction. It must not only adhere to responding to social needs with authoritative voices but also persist in transmitting social concerns and voices upward. Making information flow convenient, smooth, and reciprocal is one of the necessary conditions for restoring rationality to science communication.

4.2 Jointly Building Social Trust For science communication, focusing on solving the problem of information asymmetry is undoubtedly an important way for scientists and the government to rebuild social trust. Since science communication is still mainly conducted through mass media, scientists should view media as friends rather than merely tools and improve their ability to use media. The scientific community and government must abandon past prejudices that "communicators are only tools of public opinion" and change superficial attention into actual respect, trust, and support. Science communication media and practitioners must also strengthen their cultivation of scientific literacy and insist on establishing a balance between pursuing news value and achieving overall social benefits with an objective and rational spirit.

Simultaneously, communication between scientists and government policymakers during policy formulation must be strengthened, and information must be transmitted timely and accurately through media. One of the signs of rebuilding social trust should be that when trust crises occur, the public can obtain timely and sufficient information from recognized authoritative institutions.

4.3 Media Must Innovate While Holding Firm The rapid rise of new media has cast traditional media like print media into gloom. However, whether traditional or new media, integrated development has become a consensus choice for the future. This integration and transformation must be a comprehensive and innovative transformation, involving systematic innovation in content, form, mechanisms, marketing methods, and many other aspects. The core lies in innovating communication methods according to audience needs and using audience experience and feelings as the criterion for information release and content dis-

semination. Meanwhile, in terms of methodology, using innovation in communication methods to 倒逼 (force) a series of innovations in news product content, reporting models, and expression methods.

In the era of big data, media should also attempt to transform from pure content providers to intelligent information service providers, establishing the concept of "information service is king" and thinking about product production with user thinking to achieve deep processing of information. This mainly depends on media' s emphasis on applying technical means and their ability to obtain various resources.

Finally, it must be emphasized that the current mixed quality of science communication, with "fake news,""rumors,"and "hearsay"being able to spread, is related to media' s own construction and media' s failure to fully play their proper role. However, it should also be recognized that inherent social management thinking patterns are worth reflecting on. Media need survival guarantees and conditions for development and growth. News needs to balance the heavy responsibilities of public opinion guidance and science communication. The degree of external environmental looseness remains an important determining factor for media development and also a key factor determining whether science communication can be effective, in-depth, and sustainable.

Overall, the normal state of public opinion communication lies in swinging left and right. Science communication media have always played an important role in determining communication content and guiding communication direction and will continue to play an even more active and important role in the future.

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Note: Figure translations are in progress. See original paper for figures.