Research on the Science Communication Model of Collaboration between Scientific Journals and Knowledge-based Opinion Leaders (Postprint)

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Abstract

[Objective] To investigate the model construction and specific practical strategies for synergistic collaboration between scientific journals and knowledge-based opinion leaders in science communication.

[Methods] Employing literature analysis and case study methodologies, this study analyzes how scientific journals and opinion leaders can effectively coordinate in science communication activities, revealing the key constituent elements and operational mechanisms of their collaborative model.

[Results] Collaborative science communication between scientific journals and opinion leaders can achieve complementary advantages and mutual benefits. Based on systems theory, a cooperative science communication model is constructed that encompasses an implementation system, a quality assurance and effectiveness evaluation system, and an incentive system.

[Conclusion] Scientific journals should proactively integrate internal and external resources, establish and improve cooperation mechanisms, collaborate to innovate science communication formats, expand dissemination channels, and amplify the social value of research achievements.

Full Text

Research on Science Popularization Propagation Promoted by the Cooperation between Academic Journals and Opinion Leaders

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Abstract

[**Objective**] This study explores the model construction and practical strategies for collaborative science popularization between scientific journals and knowledge-based opinion leaders. [**Methods**] Using literature analysis and case study methods, we examine how scientific journals and opinion leaders can effectively coordinate in science communication activities, revealing the key components and operational mechanisms of their cooperation model. [**Results**] Collaborative science popularization between scientific journals and opinion leaders can achieve complementary advantages and mutual benefits. From a systems theory perspective, we construct a cooperative science popularization model encompassing an implementation system, a quality assurance and effect evaluation system, and an incentive system. [**Conclusion**] Scientific journals should actively integrate internal and external resources, establish and improve cooperation mechanisms, jointly innovate popularization formats, expand communication channels, and enhance the social value of research outcomes.

Keywords: scientific journals; opinion leaders; science popularization; cooperation

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In August 2022, the Ministry of Science and Technology, the Central Publicity Department, and the China Association for Science and Technology jointly issued the *14th Five-Year National Science and Technology Popularization Development Plan*, which explicitly called for strengthening national science popularization capacity and promoting comprehensive development of popularization work to achieve coordinated progress between scientific popularization and technological innovation. As the primary platform for publishing research outcomes and the core venue for academic exchange, scientific journals play a crucial role in enhancing their science popularization function, which facilitates the dissemination and transformation of research results while improving public scientific literacy. Leading international journals such as *Nature* and *Science* have established popular science columns that present complex, cutting-edge research in accessible ways to the public, thereby amplifying the social impact of scientific achievements. *Nature* has even made "making science accessible to the public and promoting the development of science education and culture" one of its editorial missions.

Domestic peers have gradually recognized the importance of science popularization by scientific journals, with related research steadily increasing. These studies have focused on several key areas: First, research on cooperative dissemination with mass media. For instance, Jia Hepeng empirically demonstrated the positive correlation between mass media coverage and journal article impact, while Zhu Qianrong and Yan Bei explored practical pathways for collaborative science news reporting between journals and mass media from different perspectives. Second, research on omnimedia dissemination. He Hongying and Weng Yanqin systematically summarized the methods, channels, and strategies for public science communication by scientific journals. Third, research from more specific practical perspectives, such as Li Mingmin's elaboration on selection principles, writing essentials, and dissemination pathways for popularizing academic papers, and Jin Ling's detailed introduction of popularization methods and approaches based on the case of *Advances in Atmospheric Sciences*. Fourth, theoretical research. Bai Yan constructed a generative logic for knowledge translation by Chinese scientific journals within social ecosystems by combining visibility theory and actor-network theory, while Xu Liping built a knowledge service logic for the "secondary dissemination" of scientific journals. Fifth, research on new technology applications. Qiu Lei summarized four application scenarios for AI large language models in the secondary dissemination of scientific journals. These studies have not only enriched the theoretical system of science popularization by scientific journals but also provided valuable guidance for practice.

However, most research still approaches the issue solely from the perspective of scientific journals, focusing primarily on popularization efforts relying on journals' own resources. Although a few studies have examined cooperation with mass media, research remains relatively scarce on expanding cooperation scope, particularly with broader third-party partners such as knowledge-based opinion leaders. Scientific journals should break away from traditional closed opera-

tional models and actively seek collaboration with external resources to jointly build an open, shared, and interactive science popularization ecosystem. The knowledge-based opinion leaders in this study include paper authors, scholars, science writers, knowledge UP hosts, and other knowledge translators and disseminators who play a crucial bridging role in interpreting and transmitting popular science information, helping to solve the "last mile" problem of public acceptance of research outcomes. This paper systematically constructs a cooperative science popularization model between scientific journals and opinion leaders, and comprehensively explores practical cooperation strategies from the perspectives of implementation systems, quality assurance and effect evaluation systems, and incentive systems. This not only enriches the theoretical system of science popularization but also holds both theoretical and practical value for broadening popularization pathways, enriching content formats, and enhancing communication effectiveness.

1.1 Challenges Facing Autonomous Science Popularization by Chinese Scientific Journals

Science popularization by Chinese scientific journals can be divided into two models: autonomous dissemination and cooperative dissemination. Autonomous dissemination refers to journals relying on their own resources to deeply explore the popular science value of academic content, transform it into forms easily understood by the public through rewriting and recreation, and disseminate it through their own channels. Cooperative dissemination, by contrast, involves journals actively seeking cooperation with other forces to achieve high-quality content creation and broader network dissemination through resource sharing and complementary advantages. The specific differences between the two models are shown in Table 1 .

Several outstanding Chinese scientific journals, such as *Science China*, *Physics*, and *China Journal of Chinese Materia Medica*, have performed exceptionally well in autonomous science popularization. However, most journals still face numerous challenges. The main reasons are as follows: First, the sponsoring institutions of Chinese scientific journals are relatively singular, with 95.49% of publishing units publishing only one journal. This fragmented and independent operational model leads to weak and dispersed editorial resources, making it difficult to integrate resources and achieve large-scale operations. Second, due to limited human, material, and financial resources, most journals focus their primary efforts on quality review and editorial publishing of academic content, leaving little capacity for mass communication work. New media capabilities are particularly weak, with editorial staff predominantly comprising acquisition editors and only 6.47% being new media personnel. Moreover, up to 69.81% of journals have no new media staff at all, resulting in a severe shortage of professional operational skills in science popularization.

1.2 Feasibility Analysis of Cooperative Science Popularization Between Scientific Journals and Opinion Leaders

With the rise of social media and video platforms, science popularization has become increasingly diversified and dynamic. In this context, opinion leaders have become indispensable key nodes in the science popularization ecosystem, leveraging their profound academic expertise, unique insights, and extensive influence. On platforms such as Zhihu, Weibo, Bilibili, and Douyin, they serve as bridges connecting research outcomes with public understanding. For example, the well-known science influencer Yin Ye frequently cites cutting-edge research from *Nature* to create popular science videos such as "Do Cancer Cells Prefer Nighttime Activity?", "Can Eyeballs Be Revived After Death?", and "COVID-19 Myth-Busting: Does It Take 15 Days to Develop Antibodies After Recovery?", which not only expand the dissemination scope of research outcomes but also enhance the visibility of scientific journals. Meanwhile, scientific journals, as authoritative platforms for publishing research results, face numerous dilemmas in science popularization, including insufficient new media operational capabilities, limited content innovation, and single-channel audience interaction. Cooperation between scientific journals and opinion leaders can achieve complementary advantages and mutual benefits.

Table 2 presents the science popularization dissemination statistics of selected knowledge opinion leaders on Bilibili.

For scientific journals, cooperation offers several benefits. First, it enhances content readability and appeal. Opinion leaders excel at transforming profound academic content into accessible, engaging, and interesting popular science works, helping to attract more general readers to journal content. Second, it expands dissemination scope and influence. Opinion leaders possess large fan bases and extensive social media influence, enabling them to transmit academic achievements to broader audiences and increase journal visibility and social impact. Third, it promotes the social application of research outcomes. Through interpretation and promotion by opinion leaders, research results can be more quickly recognized by the public, facilitating the transformation and application of scientific and technological achievements and generating greater economic and social value.

For opinion leaders, cooperation also provides significant benefits. First, they gain access to high-quality content resources. Scientific journals aggregate massive amounts of cutting-edge research, serving as valuable content sources. Cooperation allows opinion leaders to obtain high-level original results firsthand, and these "exclusive resources" help them maintain a competitive edge in the crowded popular science market. Second, it enhances content professionalism and authority. Through rigorous peer review and editorial standards, scientific journals can provide reliable academic support for opinion leaders' popular science works, strengthening their credibility. Third, it facilitates personal growth. Collaborating with scientific journals helps opinion leaders continuously enrich

their knowledge reserves, broaden their academic horizons, increase opportunities for exchange and interaction with academic circles, and subtly elevate their own expertise.

In summary, cooperation between the two parties achieves mutual benefits across multiple stages, including content production, dissemination channels, and audience feedback. To sustain and maximize these cooperative benefits, both sides must further build stable cooperative relationships and continuously explore new operational cooperation models.

1.3 Construction of a Cooperative Science Popularization Model Between Scientific Journals and Opinion Leaders

Science popularization can be viewed as a complex system composed of multiple interacting subsystems. Systems theory posits that complex systems form organic wholes through the interdependence and interaction of subsystems, rather than simple aggregation of components. Based on the principles of holism, relevance, and dynamic balance in systems theory, a cooperative science popularization model between scientific journals and opinion leaders should encompass three core elements: an implementation system, a quality assurance and effect evaluation system, and an incentive system. First, the implementation system serves as the foundation of cooperation, primarily responsible for resource integration and investment. By constructing an institutionalized cooperation framework that clarifies specific objectives, timeframes, cooperation forms, and the rights and obligations of both parties, it ensures the sustainability and standardization of cooperation. Simultaneously, the implementation system must conduct content planning based on precise insights into audience needs and implement differentiated dissemination strategies according to the characteristics of different media platforms to maximize coverage and optimize communication effectiveness. Second, the quality assurance and effect evaluation system plays a role in process control and information feedback. Through rigorous review processes and scientific evaluation mechanisms, it ensures the scientific accuracy of popularization information. Simultaneously, it continuously monitors effects during the dissemination process to provide scientific evidence for strategy adjustment and optimization. Finally, the incentive system serves as an important driving force for maintaining cooperation enthusiasm. Through comprehensive application of material and spiritual incentives, it stimulates both parties' cooperative passion and innovative capacity, jointly promoting the sustainable development and innovation of science popularization work. These three systems mutually support and coordinate with each other, collectively building a virtuous cycle of science popularization communication.

Figure 1 [Figure 1: see original paper] illustrates the cooperative science popularization model between scientific journals and opinion leaders.

2.1 Designing a Standardized Cooperation Framework

First, scientific journal editorial departments should widely solicit and screen suitable opinion leaders through their audience and author communities, actively engage with them to understand mutual needs, and then negotiate specific cooperation matters. To ensure the long-term stability and standardized operation of cooperation projects, a cooperation agreement template should be designed to clarify core content such as basic principles, models, rights, and obligations. This agreement should reflect both academic rigor and professionalism while considering the practical needs and characteristics of science popularization in new media environments, ensuring that both parties can operate freely within legal frameworks to achieve mutual benefits.

(1) **Main clauses of the cooperation agreement.** Cooperation objectives and duration: Clearly define the purpose of accelerating the social dissemination of scientific knowledge and set specific cooperation timeframes. Cooperation model: Determine the cooperation form and clearly define the roles and task allocation of both parties at each stage. Detailed rights and obligations: Clarify the rights enjoyed by both parties, such as publication rights and attribution rights, and define respective obligations, including ensuring the originality of popularization content, delivering high-quality works on schedule, and strictly adhering to academic ethics and industry standards.

(2) **Allocation of responsibilities and intellectual property protection.** Responsibility allocation and resolution mechanisms: Based on relevant laws and regulations such as the *Copyright Law* and actual circumstances, reasonably divide rights and responsibilities in content creation and publication promotion, and establish resolution mechanisms for potential issues. Intellectual property protection measures: Clearly stipulate attribution rights, adaptation licensing scope, and specific conditions for usage rights, including rules for using cooperative popularization content on online media, print media, and other carriers.

(3) **Intellectual property sharing and revenue distribution.** Intellectual property sharing: Establish a mechanism for the reasonable use of each other's works or research results under specific conditions to promote maximum resource utilization. Revenue distribution scheme: Based on principles of fairness and justice, formulate economic benefit distribution plans including advertising revenue, paid reading income, and government project funding to stimulate both parties' enthusiasm and creativity.

The above cooperation agreement represents only a framework text containing core elements. In practice, scientific journals should flexibly adjust agreement content according to different cooperation objects, projects, and methods to better adapt to both parties' needs and enhance cooperation adaptability. When signing publication agreements with authors, scientific journals should include clauses regarding paper adaptation rights to ensure authors fully understand

and agree to their papers being used for science popularization activities. Additionally, journals should attach detailed cooperation agreements to actively encourage paper authors to participate in science popularization activities.

2.2 Precise Planning Based on Audience Needs

Science popularization activities must be closely centered on audience needs through precise planning to ensure that content possesses both scientific value and satisfies public knowledge demands.

(1) **Topic selection should balance scientific value and news value.** Opinion leaders, with their keen insights into research frontiers and communication trends, can provide valuable suggestions for topic selection. Scientific journals should combine their own publication missions to create distinctive popularization content. When selecting topics, they must maintain professional standards while paying attention to current events and public interests to ensure content is both profound and capable of attracting widespread public attention. For example, *Advances in Atmospheric Sciences* astutely identified extreme rainfall as a hot topic and quickly organized relevant experts to write the popular science article "Understanding Radar Maps to Face Rain Without Fear." Within 24 hours of publication, the article achieved over 6,500 total WeChat reads and over 10,000 Weibo reads, fully demonstrating the enormous potential of science popularization.

(2) **Audience segmentation is key to ensuring content relevance and effectiveness.** Different audience groups exhibit significant differences in knowledge background, interests, and information reception habits. Therefore, the difficulty level and presentation format of popularization content should be flexibly adjusted according to audience characteristics. For novice audiences, concise language and vivid, intuitive presentation forms should be used to 普及 basic concepts and principles. For audiences with certain professional foundations, in-depth analysis and case studies can increase content depth and professionalism. Additionally, for different age groups and audiences with different needs, demographic positioning should be refined and different communication strategies adopted, such as using storytelling and interactive methods to attract youth groups, while focusing on concise, clear, and graphic-rich expressions for elderly audiences. *China Journal of Chinese Materia Medica* delivers popularization content with distinct demographic characteristics, providing targeted knowledge for different groups such as those with dry eyes, high blood sugar, or health supplement interests. This precise positioning strategy not only improves popularization effectiveness but also enhances audience trust and dependence on the journal.

2.3 Differentiated Dissemination for Media Platform Characteristics

Reasonable selection and effective utilization of various new media platforms are key considerations for enhancing popularization effectiveness. Based on user knowledge service demand scenarios and leveraging the unique features and advantages of new media platforms, differentiated dissemination strategies should be formulated to scientifically combine various channels and maximize the synergistic effects of multi-platform communication.

(1) **Social platforms focusing on hot topic discussions.** Social media platforms such as Weibo, with their powerful topic-setting functions, can quickly focus public attention on social hot issues and stimulate discussion. Relevant topic tags should be created around specific scientific themes to guide user participation, thereby increasing the exposure and influence of popularization content. For example, on major scientific issues such as "novel coronavirus" and "global climate change," initiating specialized discussions on Weibo can attract broad audience participation, enabling rapid diffusion and in-depth dissemination of scientific information.

(2) **Graphic platforms focusing on in-depth analysis.** WeChat Official Accounts and vertical platforms feature in-depth analysis and personalized push services, which can not only effectively parse and disseminate complex scientific knowledge but also precisely deliver content to target subscribers, fully releasing the educational value of popularization information. In addition to supporting opinion leaders in publishing popularization information on major media platforms, journals should actively encourage them to engage in interactive exchanges on vertical community platforms such as Zhihu, DXY.cn, and GitHub. These professional platforms provide opportunities for deep interaction with users, allowing scientific information to be conveyed closer to social contexts while ensuring both scientific professionalism and continuous communication effectiveness.

(3) **Short video platforms focusing on visual presentation.** Short video platforms such as Douyin, Kuaishou, and Bilibili, with their intuitive, vivid, and easily understandable visual display characteristics, provide new spaces for science popularization. Popular science videos mainly fall into two categories: lecture-style videos featuring opinion leaders on camera, and animation-style videos that transform scientific knowledge into cartoons. Opinion leaders convert abstract scientific knowledge into intuitive and vivid visuals, greatly enhancing audience immersion and comprehension. For example, when the Haihe River basin experienced its largest flood in 60 years in July 2023, "Global Geographic Exploration" released the animated video "Haihe River, North China's Largest Water System: Five Dragons Absorbing Water to Roil Tianjin" on Bilibili, vividly demonstrating the basin's composition and hydrological conditions, thereby en-

hancing public awareness and prevention of flood disasters in the Haihe River basin.

3.1 Full-Process Quality Control

The core of science communication lies in ensuring the absolute accuracy of disseminated content. Quality control of popularization content is a fundamental requirement for ensuring effective transmission of scientific information and preventing public misguidance. Therefore, it is necessary to establish a comprehensive quality control system covering the entire process from planning to production to dissemination.

(1) **Control at the planning stage: Strictly control source quality of popularization information.** Scientific journals should fulfill their responsibilities to ensure information accuracy. All published popularization information must be peer-reviewed research outcomes that have undergone careful verification of original literature, strict confirmation of data sources, and thorough examination of conclusion derivation processes to eliminate factual or knowledge errors. Simultaneously, comprehensive investigation of author qualifications is an important step to avoid dissemination distortion, including verifying whether authors possess long-term research experience in relevant fields and referencing their previously published papers in domestic and international journals. When supplying content to mass media, *Aerospace Knowledge* magazine adheres to high-quality control standards with strict content screening and review, making it the preferred partner for aerospace programs in some mass media outlets.

(2) **Control at the production stage: Strengthen the pre-review system for popularization products.** In the process of transforming academic papers into popularization works, distortion of knowledge connotations due to oversimplification or misinterpretation should be avoided. Experts and scholars from various fields should be invited to participate in reviewing popularization content to help judge its scientific value and accuracy. For example, *Acta Pharmacologica Sinica* consistently maintains scientific rigor in its popularization efforts, ensuring information authenticity and reliability through strict expert review and screening. Particularly for controversial topics, expert opinions can effectively mitigate potential risks.

(3) **Control at the dissemination stage: Establish a robust information error correction mechanism.** Dedicated feedback channels should be established to accept supervision and corrections from peer experts and the public. Once errors are identified, immediate responses should be made to address user questions and suggestions, with prompt corrections and public explanations to maintain the brand image and credibility of both parties.

Additionally, technical-assisted review tools, particularly artificial intelligence technologies, should be actively introduced to verify relevant viewpoints and factual data. This can not only effectively reduce errors but also lower labor costs and improve review efficiency.

3.2 Effect Evaluation and Continuous Optimization

To accurately monitor and measure the real influence and deep value of popularization information in social dissemination, and to provide evidence for adjusting communication strategies, it is necessary to construct a comprehensive and accurate evaluation system for cooperative popularization effects.

(1) **Adopt a combination of quantitative indicators and qualitative evaluation.** In quantitative assessment, network metrics such as read counts and forwarding frequency serve as effective benchmarks for measuring initial dissemination power and public acceptance. However, these hard data only reflect the surface reach of popularization information and fail to reveal the degree of internalization into individual knowledge reserves, audiences' deep understanding of scientific content, or long-term potential social impacts. To overcome the one-sidedness of quantitative evaluation, qualitative assessment must be combined. Through user satisfaction surveys, expert evaluations, and other methods, we can better understand the substantive contributions of popularization information in meeting diverse audience needs and improving public scientific literacy.

(2) **Establish medium- and long-term popularization effect tracking mechanisms.** The impact of popularization activities on public scientific literacy often exhibits lag effects, requiring time to manifest. Therefore, evaluation systems should include medium- and long-term effect monitoring. Combining social network analysis theory, we should comprehensively observe the diffusion paths and life cycles of popularization information in networks. Conducting before-and-after comparison studies at intervals can analyze trends in public scientific literacy changes after participation in popularization activities and assess long-term socio-economic benefits to accurately determine the lasting value of popularization activities.

Constructing and continuously improving the science popularization effect evaluation system is a gradual and iterative process. Based on feedback from dissemination effect evaluation data, communication strategies should be dynamically adjusted and optimized to ensure continuous improvement and innovative upgrading of popularization work, thereby achieving optimal balance among communication efficiency, content quality, and social benefits.

4.1 Multi-Dimensional Incentive Measures for Opinion Leaders

When designing and innovating incentive systems, the multi-dimensional needs of opinion leaders should be fully considered to provide them with both substantive material and spiritual incentives. This not only benefits the personal development of opinion leaders but also stabilizes and deepens cooperative relationships.

(1) **Economic interest incentives.** Economic incentives are crucial means for directly mobilizing the enthusiasm of opinion leaders. Journals can provide economic returns for opinion leaders' participation in creating and promoting popularization information through payment of manuscript fees, royalty sharing, and project funding. For example, reasonable manuscript fee standards can be set to encourage the creation of high-quality original popular science articles. For popularization works with extensive network dissemination and significant social impact, revenue distribution ratios can be flexibly adjusted and increased based on quantitative indicators such as clicks, reads, or downloads.

(2) **Career development incentives.** Integrate opinion leaders' popularization activities with their career development by providing opportunities for academic recognition and enhanced social status. For opinion leaders seeking professional promotion, establish a popularization achievement recognition system that incorporates their popularization contributions into the professional title evaluation system as important assessment indicators. Furthermore, popularization achievements should be included in the performance evaluation system for researchers, giving them due recognition in awards, excellence evaluations, and project applications. For example, in 2017, Zhejiang University issued the *Implementation Measures for the Recognition of Outstanding Online Cultural Achievements of Zhejiang University (Trial)*, which explicitly included outstanding online cultural achievements in the university's scientific research statistics, various promotion and appointment evaluations, and awards and excellence selections.

(3) **Reputation and honor incentives.** For opinion leaders outside the professional title series, journals can jointly establish awards such as "Popular Science Star" or "Outstanding Popular Science Author" with relevant societies and associations to recognize outstanding contributions to popularization work. By widely publicizing their popularization deeds, their public recognition and reputation can be enhanced, which not only stimulates their enthusiasm for popularization but also creates positive word-of-mouth effects and exemplary demonstration roles.

4.2 Internal and External Support Conditions for Scientific Journals

To fully mobilize the enthusiasm of scientific journals in science popularization, favorable internal and external support conditions should be provided at three levels: high-level (policy), medium-level (projects), and low-level (training).

(1) **Policy and institutional guarantees.** The *Law of the People's Republic of China on Science and Technology Progress* has explicitly proposed establishing and improving incentive mechanisms for science and technology popularization, encouraging researchers and journals to actively participate in popularization activities. It is recommended to further adjust policies to incorporate popularization work into the evaluation system for scientific journals. On the basis of existing citation metrics such as impact factor and H-index, new indicators reflecting popularization influence should be introduced, such as popular article reads, forwarding counts, and media citation frequency, or new evaluation indicators such as "popularization contribution" or "public influence" should be established and used as important bases for journal assessment, rating, and funding allocation.

(2) **Establishment of funding projects.** Considering the long-term and continuous nature of popularization work, stable financial support helps scientific journals plan and execute long-term popularization projects. It is recommended to establish a special fund project for "Public Dissemination of Innovative Achievements by Scientific Journals" to specifically support the creation and dissemination of outstanding popularization content, alleviating the economic burden of popularization activities on journals and enabling them to focus more on content innovation and quality improvement.

(3) **Media literacy training.** Scientific journals should attach great importance to and strengthen professional training for their teams in media operations and popularization content creation, enabling editorial staff to master the characteristics and strategies of information dissemination in new media environments and improving their ability to plan popular science topics for the general public. A long-term mechanism for popularization talent cultivation should also be established, including regular professional development training, scientific performance evaluation systems, and recognition of outstanding contributors to ensure continuity in talent team building.

5.1 Discussion on Model Applicability

Through collaborative innovation and knowledge sharing, the cooperation model between scientific journals and opinion leaders plays an important role in promoting the transformation of research outcomes from academia to the public domain. However, due to significant differences among journals in disciplinary

characteristics, knowledge attributes, discourse systems, and audience groups, the applicability of the cooperation model requires careful consideration based on specific circumstances. For instance, for journals specializing in niche disciplines or pure basic research, popularization is more difficult and the audience is narrower, making it challenging to attract high-quality opinion leaders. Consequently, the applicability of such cooperation models is relatively lower for these journals.

Given that popularization needs vary across different disciplines and audiences, scientific journals should select appropriate opinion leaders and design personalized cooperation plans based on specific situations. Simultaneously, journals should continuously summarize cooperation experiences and explore more diversified cooperation methods to adapt to evolving popularization needs. It is worth noting that although this study focuses primarily on scientific journals, the proposed cooperation model also has reference value for academic journals in humanities and social sciences fields such as history, law, economics, and sociology.

5.2 Potential Problems and Coping Strategies

During the cooperation process between scientific journals and opinion leaders, a series of challenges are inevitable, such as interdisciplinary collaboration, balancing popularization depth and breadth, and difficulties in evaluating dissemination effects. While most problems require case-by-case handling, this section discusses important issues that may arise in the three major systems.

(1) **Partner selection and stable cooperation in the implementation system.** Selecting appropriate cooperation partners is the primary difficulty in collaboration between scientific journals and opinion leaders. Journals should comprehensively consider factors such as opinion leaders' professional backgrounds, communication influence, content production capabilities, and value alignment. A strategy of small-scale trial operation followed by gradual expansion should be adopted to continuously optimize the partner pool. Meanwhile, cooperation stability is often constrained by multiple factors, such as shifts in opinion leaders' professional interests, adjustments in both parties' interest demands, and changes in career development directions. To address these challenges, first, exit clauses should be clearly defined in cooperation agreements, including advance notice periods, exit reasons, and compensation measures to provide clear guidance for both parties. Second, a cooperation network comprising multiple opinion leaders should be constructed to avoid excessive dependence on a single leader. Additionally, backup opinion leaders should be continuously identified and cultivated to ensure ready substitutes when necessary. Finally, contingency plans should be formulated to ensure continuity of science popularization under unexpected circumstances.

(2) **Conflicts of interest and ethical issues in the quality assurance**

system. As cooperation deepens, conflicts of interest may arise between scientific journals and opinion leaders. For example, opinion leaders may exaggerate or distort research findings for commercial purposes, damaging the credibility of scientific journals. When dealing with sensitive topics or controversial research outcomes, balancing academic freedom with social responsibility is also an important issue. To address these problems, clear conflict-of-interest management systems and ethical guidelines should be established to define boundaries for both parties in dissemination. Meanwhile, an ethics review committee composed of third-party experts should be established to evaluate and guide controversial content.

(3) **The "diminishing marginal utility" problem in the incentive system.** Over time, existing incentive measures may gradually lose their appeal, resulting in declining incentive effects. To address this issue, incentive forms need continuous innovation. According to opinion leaders' needs at different stages and types, incentive priorities should be timely adjusted to provide personalized incentive schemes. For example, for senior opinion leaders, more opportunities to participate in planning major popularization projects or serving as popularization consultants can be provided. For emerging opinion leaders, more display platforms and resource support should be offered. Additionally, competition mechanisms can be introduced to maintain cooperation vitality through survival of the fittest.

Scientific journals face multiple challenges in science popularization, and cooperation with knowledge-based opinion leaders provides new solutions. However, deepening cooperation and perfecting the model is a dynamic evolutionary process requiring continuous efforts and innovation from all parties. In the future, scientific journals should continue exploring broader cooperative relationships, continuously optimize cooperation strategies, and flexibly address emerging challenges such as deepening interdisciplinary collaboration, personalized customization of popularization content, and application of new communication technologies. Meanwhile, policymakers and all sectors of society should provide more support, ensuring long-term development of popularization work at the institutional level and creating a more open, inclusive, and supportive ecosystem for science popularization.

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Author Contributions Statement

CHENG Fu: Designed the research topic, research plan, and outline; wrote the paper.
LIU Hongxia: Participated in topic design and provided writing suggestions.
LI Xiang, WANG Yajiao: Collected and organized relevant materials and data.
YUAN Genshen: Provided research suggestions and revised the paper.

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