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The Reshaping of Public Engagement with Scientific Knowledge Through AI Dependency in Online Communication

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Abstract

Against the backdrop of online communication profoundly empowering the popularization of scientific knowledge, public reliance on artificial intelligence is fundamentally reshaping the interactive dynamics within the dissemination of scientific knowledge. This paper centers on online communication scenarios, examining the relationship between AI dependency and public engagement with scientific knowledge. It systematically analyzes the specific pathways through which AI dependency reshapes these interactions across four dimensions: participants, forms, content, and logic. The study thoroughly examines practical challenges such as interaction alienation and content bias emerging during this transformation. Finally, it proposes targeted guidance strategies at the individual, technological, and societal levels. These aim to foster a positive developmental relationship between AI dependency and the popularization of scientific knowledge, thereby enabling more efficient and widespread dissemination of scientific knowledge to the public.

Keywords

Online Communication, AI Dependency, Popularization of Scientific Knowledge, Interaction Reshaping, Communication Strategies

1. Introduction

With the deep integration of artificial intelligence technology and online communication, the popularization of scientific knowledge has fully entered a new phase of "AI-empowered" dissemination [1]. Today, nearly every aspect of public engagement with scientific knowledge and participation in science-related discussions is inextricably linked to AI: browsing short videos relies on algorithmic recommendations for tailored science content; scientific queries are swiftly answered through AI question-answering tools; and discussions often involve interactions with AI virtual assistants or virtual science communicators. This reliance on AI has become a defining feature of science popularization interactions within online communication.

The core objective of popularizing scientific knowledge is to bring expertise confined to research domains out of laboratories and into the lives of ordinary citizens. Interaction serves as the pivotal link connecting knowledge disseminators and recipients in this process, directly determining the efficiency and effectiveness of scientific knowledge transfer. Within online communication scenarios, the public's reliance on AI transcends mere "tool usage"; it deeply integrates into every facet of interaction, transforming not only the outward presentation of engagement but also reshaping its underlying operational logic [2]. The AI dependency referenced here specifically denotes the functional and emotional reliance the public develops on artificial intelligence technologies-such as algorithmic recommendations, AI-generated content, and virtual interactions-during the online acquisition, exchange, and dissemination of scientific knowledge. Meanwhile, the popularization of scientific knowledge through interaction refers to the bidirectional or multidirectional communication activities conducted online by stakeholders including the public, researchers, and media organizations, centered around the interpretation, sharing, and discussion of scientific knowledge.

Exploring how AI dependency reshapes public engagement with scientific knowledge in online communication not only clarifies the new patterns and characteristics of science communication in the AI era but also provides practical theoretical and practical references for optimizing communication strategies and enhancing the quality of science communication [3]. Based on this, this paper takes "reshaping" as its core thread. It first delves into the specific ways AI dependency reshapes public engagement with popularized scientific knowledge, then examines the challenges encountered during this process, and finally proposes targeted guidance strategies. This aims to provide robust support for the high-quality development of popular science communication.

2. The Practice of AI Dependency Reshaping Public Engagement with Scientific Knowledge

Within online communication scenarios, public reliance on AI has permeated every facet of public engagement with scientific knowledge. From the participants involved to the presentation formats, from content selection to operational logic, profound and concrete transformations have occurred under the influence of AI dependency, giving rise to entirely new forms of interaction.

2.1 Interactive Participants: Transition from "Binary Opposition" to "Ternary Synergy"

Traditional public science knowledge interactions exhibited a pronounced "binary opposition" between "communicators" and "audiences"-researchers and specialized science media acted as knowledge 'communicators' holding the initiative in knowledge dissemination, while the public served as passive "audiences" with limited interaction within the communicators' defined frameworks [4]. However, as public reliance on AI deepens, this dualistic structure is being dismantled, giving rise to a triadic collaborative model: "communicator - AI - audience." AI is no longer merely an auxiliary tool but has become an independent interactive participant.

On one hand, AI serves as an "intermediary bridge," facilitating efficient connections between disseminators and audiences. When researchers input complex scientific knowledge into AI systems, the AI employs natural language processing to translate obscure academic terminology into accessible everyday language. It then tailors and distributes content based on the cognitive levels of different audience segments. Simultaneously, questions and feedback raised by the public during interactions are filtered, categorized, and organized by AI. This generates clear demand reports transmitted back to communicators, helping them more accurately gauge public needs and adjust communication content and methods. For instance, when a research team promoted knowledge about "quantum entanglement," they first fed specialized research papers into the AI. The AI transformed this into the accessible statement: "No matter how far apart two particles are, their states influence each other." It then designed tailored interpretations for different groups like teenagers and office workers. Simultaneously, it collected public questions such as "Can quantum entanglement achieve instantaneous teleportation?" and other queries from the public, feeding this back to the research team to enable more targeted science communication.

On the other hand, AI can directly participate in interactions as either a "communicator" or an "audience member." As a communicator, AI can autonomously generate science content based on vast scientific data and proactively initiate interactive topics- For instance, AI could generate a science communication piece titled "How to Mitigate Global Warming Through Daily Actions" based on the latest "Global Warming Report," launch a discussion topic on Weibo, and respond to netizens' comments in real time. As an audience member, AI can simulate the cognitive habits and interest preferences of different public segments to engage in "mock interactions" with communicators. This helps communicators anticipate potential public questions in advance and optimize content presentation methods. For instance, before creating a video on "Space Launch Principles," a science blogger engages in simulated interactions with AI. The AI poses questions from the perspectives of space enthusiasts and the general public. Based on these queries, the blogger adjusts the video's depth and presentation style, ensuring the final content better aligns with public needs.

2.2 Interaction Formats: Upgrading from "Unidirectional Passivity" to "Multi-Dimensional Immersion"

Traditional science popularization interactions were limited in format, predominantly following a unidirectional, passive model: "communicator outputs content → audience leaves comments/questions → communicator responds at their discretion." This approach lacked incentives for active public participation, resulting in poor interactive experiences. As public reliance on AI deepens, interaction formats are evolving beyond these limitations toward "multi-dimensional immersion." This shift transforms audiences from passive recipients into active participants, significantly enhancing engagement and enjoyment.

Advancements in AI technology have spawned a series of immersive interactive formats, enabling the public to engage with scientific knowledge in a "firsthand" manner. For instance, leveraging VR-AI integration, online platforms can construct virtual science laboratories. The public can "enter" these labs via mobile devices or computers to personally conduct simulated physics and chemistry experiments. - When conducting an "electrolysis of water experiment," AI displays real-time hydrogen and oxygen volume ratios, explaining the principle that "water is composed of hydrogen and oxygen." If steps are incorrect, AI promptly provides guidance and clarifies errors. In science-popularization livestreaming, AI-generated virtual scientists can interact in real time with hosts and viewers [5]. When an audience member asks via comment stream, "Why do astronauts experience weightlessness in space?" the virtual scientist responds instantly with vivid animated demonstrations and accessible explanations. This creates an immersive experience akin to conversing with a real researcher, greatly enhancing the sense of presence and engagement.

Simultaneously, AI is driving a shift in interaction formats from "one-way responses" to "co-creation and sharing." The public is no longer passive knowledge recipients but can co-create science content with AI, engaging in interactive scientific exchange during the creative process. For instance, using AI painting tools, users can input keywords like "the eight planets of the solar system" to generate personalized planetary illustrations. They can then add their own interpretations of planetary features and share these creations on social platforms. Alternatively, with AI assistance, they can transform complex principles like "gene editing technology" into simple short video scripts. Collaborating with other netizens to film these scripts, they deepen their understanding of scientific knowledge through script revisions and filming discussions, while simultaneously engaging more people in interactive scientific discourse.

2.3 Interactive Content: Shifting from “One-Size-Fits-All” to “Precision Matching”

In traditional science communication, disseminators often deliver content based on “uniform standards,” overlooking differences in public interests, cognitive levels, and knowledge needs. This disconnect between content and actual audience demands typically results in low engagement. Increased reliance on AI has enabled a shift in interactive content from “what communicators want to give” to “what the public wants [6].” By precisely matching public needs, the effectiveness of interactions has been significantly enhanced.

AI recommendation algorithms serve as the core enabler for precise content matching. AI systems on online platforms collect real-time data such as browsing histories, interaction records, and interest tags. Through big data analysis, they accurately capture public preferences and knowledge needs, subsequently pushing tailored science content and guiding interaction directions. For instance, for users frequently browsing astronomy content and participating in “black hole” discussions, AI prioritizes recommendations like “galactic evolution” and “gravitational wave detection” articles/videos, initiating interactions such as “Do you believe humanity will observe black hole mergers in the future?” For users focused on health topics who frequently search for “vaccination” information, AI delivers content like “New Vaccine Development Progress” and “Prevention of Common Infectious Diseases,” with interactive topics centered on health science concerns.

Furthermore, AI dynamically adjusts content depth and complexity based on user feedback to ensure engagement aligns with individual comprehension levels. During science Q&A interactions, if a user asks a foundational question like “Why is the sky blue?”, AI explains using accessible analogies: “Just as tiny water droplets refract sunlight to create rainbows, small particles in the air scatter the blue light within sunlight.” If the public further inquires about “the difference between Rayleigh scattering and Mie scattering,” the AI introduces specialized physics concepts, combining them with concrete experimental data for detailed explanations. This approach ensures that participants of varying cognitive levels gain valuable knowledge through interaction, enhancing the sense of fulfillment from engagement.

2.4 Interactive Logic: Reconstructing from “Communicator-Dominated” to “Algorithm-Driven”

Traditional science communication interactions were entirely communicator-driven, where communicators dictated topics, pace, depth, and direction. The public could only passively follow their guidance, resulting in limited flexibility and autonomy. Under AI influence, interaction logic has gradually restructured into a new “algorithm-driven” model, where algorithms become the “invisible conductors” orchestrating every aspect of the process.

Algorithms first determine the popularity and trajectory of discussion topics. AI algorithms on online platforms continuously monitor metrics like click-through rates, discussion volume, and share counts for various scientific topics. They push trending topics to users' homepages or recommendation feeds, encouraging broader public engagement. During interactions, algorithms prioritize displaying highly-rated comments and quality responses based on metrics like likes and replies. These content pieces often become focal points for subsequent discussions, thereby shaping the overall direction of the conversation. For instance, in discussions about “global warming,” a comment from a research institution containing specific data received numerous likes. The algorithm pinned this comment to the top, and subsequent public participants largely centered their discussions around the data presented in that comment [7]. This kept the interaction grounded in scientific evidence and prevented the topic from veering off course.

Simultaneously, the algorithm flexibly adjusts the pace of interaction to ensure its continuity and efficiency. AI analyzes public engagement patterns-such as online hours, interaction frequency, and peak activity times-to strategically deliver engagement reminders. During high-activity periods (e.g., 7–9 PM), the algorithm pushes new scientific topics, unanswered messages, or friends' updates to encourage participation. When users engage excessively, the algorithm reduces push frequency to prevent information overload. When engagement wanes, the algorithm pushes related extension topics or engaging content to reignite the interactive atmosphere. For instance, as discussion around “AI and Medical Diagnosis” cools, the algorithm might introduce extension topics like “How Accurate is AI in Cancer Diagnosis?” or “Can AI Replace Doctors in the Future?” to sustain public participation.

3. Real-World Challenges of AI Dependency Reshaping Public Engagement with Scientific Knowledge

While AI dependency reshapes public engagement with scientific knowledge by delivering efficiency, precision, and diversity in dissemination, it also brings a series of significant challenges. These challenges not only impact the quality of public engagement but may also hinder the accurate dissemination and popularization of scientific knowledge.

3.1 Alienation of Interaction: Virtual Dependency Replacing Real-World Human Interaction

As public reliance on AI deepens, some individuals increasingly view AI as the “sole option” for scientific knowledge interaction, leading to pronounced alienation-excessive dependence on virtual AI interactions while neglecting or abandoning real-world scientific exchanges with others [8]. For instance, when encountering scientific questions, some instinctively turn to AI for answers, even when friends or teachers engaged in relevant research are present, unwilling to initiate discussions; When participating in scientific discussions, they focus solely on AI-generated content and perspectives, ignoring contributions and comments from other individuals. Some even block real users' science-related posts on social platforms, retaining only AI science accounts' feeds.

This "prioritizing AI over human interaction" not only confines scientific knowledge exchange to virtual cyberspace but also weakens emotional bonds and real-world communication skills among the public. The dissemination of scientific knowledge is not merely a process of information transfer but also one of emotional exchange and intellectual collision. AI cannot replace genuine human emotional interaction and the spark of thought between individuals. Prolonged reliance on virtual interactions with AI gradually disconnects the public from real-world scientific exchange scenarios, making it difficult to share scientific knowledge or discuss scientific topics with others in daily life. This ultimately impedes the dissemination and popularization of scientific knowledge in society, contradicting the very purpose of making science accessible to the masses.

3.2 Content Bias: Algorithmic Echo Chambers Narrow Public Knowledge Horizons

While AI recommendation algorithms achieve precise content matching, they also readily form "algorithmic echo chambers," gradually narrowing the public's scientific knowledge horizons. The core logic of algorithms is "catering to preferences," continuously pushing science content aligned with users' interests while neglecting knowledge from other fields or differing viewpoints. This traps the public in an "interest loop." For instance, individuals interested in physics may receive only physics-related science content and discussion topics over time, limiting exposure to knowledge from biology, chemistry, astronomy, and other disciplines, resulting in a narrow knowledge structure. Even within the same discipline, algorithms may exclusively promote content from a single viewpoint. For instance, in discussions about "the safety of genetically modified foods," if a user initially likes content supporting GMOs, the algorithm will persistently push pro-GMO perspectives [9]. This prevents exposure to reasonable counterarguments and scientific debates from opposing sides, gradually fostering one-sided knowledge.

Long-term confinement within algorithmic echo chambers gradually deprives the public of opportunities to engage with diverse scientific knowledge, hindering the development of a comprehensive and systematic scientific understanding. Scientific knowledge forms an interconnected, interpenetrating whole, with knowledge across disciplines and viewpoints closely interrelated. Only by engaging with diverse scientific knowledge can one develop a complete understanding of the world. Algorithmic echo chambers confine the public within their own spheres of interest, preventing them from exploring the broader scientific landscape. This not only hinders the improvement of individual scientific literacy but may also lead to misunderstandings of scientific knowledge and even the formation of erroneous scientific beliefs.

3.3 Trust Risks: Knowledge Misinformation from AI Content Accuracy

The accuracy of AI-generated content poses significant trust risks for public science engagement. Since AI relies on training data and algorithmic models, inaccuracies or flaws in either can lead to the production of misleading or erroneous science content. For instance, when generating content about the "human digestive system," one AI erroneously described the appendix as "an organ with no physiological function" due to outdated anatomical knowledge in its training data-despite modern medicine identifying its immune function [10]. When addressing queries about "COVID-19 vaccination contraindications," some AI systems provided incorrect answers such as "hypertensive patients cannot receive the vaccine" because their algorithms could not update in real-time with the latest medical guidelines.

More alarmingly, some members of the public exhibit "blind trust" in AI, treating its outputs as "authoritative conclusions" and actively disseminating this content during interactions. This blind trust and the spread of erroneous information not only lead to the miscommunication of scientific knowledge but may also negatively impact public health-for instance, individuals refusing vaccinations based on AI's incorrect advice, thereby increasing infection risks; or developing unhealthy dietary habits due to misinterpreting AI's analysis of "nutritional balance." Simultaneously, the spread of misinformation erodes public trust in scientific communication, undermining the long-term development of science popularization.

3.4 Weakened Capabilities: Overreliance Erodes Public Critical Thinking

Excessive reliance on AI in science communication interactions gradually diminishes the public's capacity for independent thinking and scientific judgment. When accessing scientific knowledge, individuals grow accustomed to waiting for AI to organize and interpret complex information, ceasing to actively consult specialized science books or research papers and neglecting to ponder the underlying logic and principles. During interactive discussions, reliance on AI-generated viewpoints, arguments, or even comment content leads to a lack of independent thinking and innovative expression, resulting in formulaic interactions devoid of intellectual depth. When confronting controversial scientific topics, blindly following AI judgments prevents individuals from independently evaluating the validity of differing perspectives, ultimately eroding their capacity for independent scientific judgment.

For instance, when debating whether "artificial intelligence will replace human jobs," many directly copy AI-generated viewpoints without analyzing them through personal experience or critically evaluating the AI's perspectives. When learning about relativity, they settle for AI's simplified explanations rather than deeply contemplating the core principle of "the relativity of time and space." This weakening of critical thinking gradually transforms the public into passive knowledge recipients, preventing genuine understanding and mastery of scientific knowledge. It further hinders the application of scientific knowledge to solve real-world problems, running counter to the core objective of science popularization: enhancing public scientific literacy.

4. Guiding Strategies for Positive Interaction in Science Popularization Amid AI Dependency

To foster a constructive relationship between AI dependency and science popularization while mitigating practical challenges during this transformation, coordinated efforts are needed across three levels: individual, technological, and societal. This approach must leverage AI's positive enabling role in interaction while effectively mitigating potential risks, thereby supporting high-quality development in science popularization.

4.1 Individual Level: Enhancing Dual Literacy and Cultivating Rational Dependency

As core participants in science popularization interactions, the public must proactively enhance their media literacy and scientific literacy while cultivating a rational approach to AI dependency. This fundamentally mitigates risks stemming from overreliance.

Regarding media literacy, individuals should actively learn about AI technologies and online communication mechanisms [11]. Understanding how AI recommendation algorithms and AI-generated content operate enables recognition of issues like algorithmic echo chambers and AI content biases. Through such learning, the public can recognize that AI-recommended content represents “partial information” filtered by interests, not “complete knowledge.” This enables them to consciously step outside their interest comfort zones, actively seeking out and engaging with interdisciplinary scientific knowledge and diverse viewpoints to prevent narrowing their intellectual horizons. Simultaneously, the public must learn to evaluate the accuracy of AI-generated content, understand its potential limitations, and avoid blindly trusting all information produced by AI.

To enhance scientific literacy, the public should obtain scientific knowledge through authoritative channels-such as following official accounts of research institutions and professional science media, reading reputable popular science books and journals-to continuously build their scientific knowledge base and critical thinking skills. When encountering AI-generated scientific content, individuals should evaluate it against their existing knowledge. If doubts arise, they can verify the information by consulting authoritative sources or experts to prevent the spread of misinformation. Additionally, the public should consciously balance interactions with AI and real-world human engagement. Actively participate in offline science salons, lectures, and community outreach activities to deepen understanding of scientific knowledge through peer discussions and enhance real-world scientific communication skills.

4.2 Technical Level: Optimizing Technical Design to Fortify Quality Control

As technology providers, AI developers and online platforms must fulfill their social responsibilities by enhancing technical design and refining functional settings to establish robust quality control for positive public engagement with scientific knowledge.

First, refine AI recommendation algorithms to break algorithmic echo chambers. Companies and platforms should incorporate “diverse knowledge recommendation mechanisms” into their algorithms. While delivering science content aligned with users' interests, they should also strategically include interdisciplinary and multi-perspective content to ensure the public accesses comprehensive scientific knowledge. For instance, when recommending physics content to enthusiasts, pair it with interdisciplinary topics like “Cross-application of Physics and Biology” or “Breakthroughs in Physics for Medical Applications.” When promoting supporting viewpoints on a scientific topic, simultaneously present reasonable opposing arguments and neutral analyses to guide the public toward a balanced perspective.

Second, strengthen the review of AI-generated content to guarantee accuracy. Establish a dual-review mechanism combining “AI generation + human verification.” For AI-generated science content, first conduct preliminary scientific screening via AI systems, then invite researchers and professional science communicators for manual verification to ensure accuracy and scientific rigor. For content concerning critical areas like public health and safety, elevate review standards and, when necessary, involve authoritative experts in relevant fields to prevent the dissemination of erroneous information. Simultaneously, prominently label AI-generated content with “AI-generated content, for reference only” to remind the public to approach it rationally.

Finally, implement an “AI Dependency Alert Feature” to guide the public toward reasonable AI usage. Platforms should analyze user interaction data. When users engage with AI excessively frequently, for prolonged periods, or consistently interact only with AI while lacking human interaction, automated alerts should pop up. These alerts should suggest actions like “Moderate your AI interactions and try discussing scientific knowledge with others” or “Strive for a balance between online and offline scientific engagement.” This helps cultivate reasonable AI usage habits and prevents overreliance.

4.3 Societal Level: Building Collaborative Mechanisms to Foster a Healthy Communication Environment

Government, research institutions, media, and other societal entities must establish collaborative mechanisms to jointly foster a favorable communication environment for public science engagement under AI dependency, promoting positive interaction development.

Governments should take a leading role by enacting relevant policies and regulations to standardize AI applications in science communication. This includes defining quality standards, review processes, and accountability for AI-generated science content, while penalizing AI developers and platforms that intentionally disseminate erroneous scientific information. Increase support for the creation and dissemination of high-quality science content, encouraging research institutions and media to develop innovative “AI + Science Communication” projects to enhance the quality and impact of public science communication. Simultaneously, strengthen public science education by integrating media literacy and scientific literacy into the national education system, cultivating the public's ability to rationally view AI and engage appropriately in scientific interactions from the foundational education stage.

Research institutions should proactively participate in online communication, leveraging their professional expertise to guide interaction directions. By establishing official accounts, publishing authoritative science content, and engaging in online discussions, they should convey accurate, professional scientific knowledge to counteract the impact of erroneous AI content [12]. Regularly organize researchers to participate in “AI + Science Communication” activities, such as co-hosting science livestreams with AI or collaborating on science content creation. Through such interactions, demonstrate scientific research processes and methodologies to the public, thereby enhancing trust in scientific knowledge. Simultaneously, research institutions can collaborate with AI enterprises to provide high-quality training data, thereby optimizing the accuracy of AI-generated science content.

Media should serve as a bridge by establishing quality interactive platforms. By integrating the professional resources of research institutions with public demand, they can create “AI + Science Communication” platforms offering authoritative and diverse channels for scientific knowledge interaction. Media should organize events like “AI Science Communication Creation Competitions” and " Science Knowledge Interactive Q&A" events to encourage public-AI collaboration in creating science content and participating in scientific discussions, thereby enhancing scientific literacy through engagement. Concurrently, media must strengthen oversight and critique of AI-generated science content, promptly identifying inaccuracies to guide the public toward rational interpretation of AI outputs and foster a healthy environment for scientific knowledge dissemination.

5. Conclusion

The AI-driven reshaping of public engagement with science communication is an inevitable outcome of technological and communicative imperatives. While enabling efficient knowledge dissemination through greater participation, richer formats, and targeted content, this transformation introduces challenges-including distorted interactions, algorithmic biases, and eroded trust-demanding critical assessment.

As AI and digital communication evolve, coordinated efforts across individual, technological, and societal dimensions will be essential to maximize AI’s benefits while minimizing risks. This ensures AI remains an enabler-not a dominant force-in science engagement, fostering constructive integration of scientific knowledge into public discourse. Ultimately, such an approach will advance science communication and strengthen societal scientific literacy.

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