Strengthening National Science Popularization Capacity Building to Serve National Strategic Needs in the New Era (Postprint)

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Abstract

In the new era, national science popularization capability is manifested as the comprehensive strength of a nation to continuously provide effective science popularization products and services to the public, enhance the scientific literacy of the entire populace, foster a scientific culture, promote the transformation of scientific and technological achievements, and thereby underpin innovation-driven development. Grounded in theoretical research and practical construction of China's science popularization capability, this paper examines the existing deficiencies in China's science popularization capability building and the developmental orientation of science popularization capability in service of the national development strategy for the new era, endeavoring to propose constructive recommendations for strengthening national science popularization capability construction, serving innovation-driven development, and contributing to the realization of Chinese-style modernization.

Full Text

Strengthening National Science Popularization Capacity to Serve New Era National Strategic Needs

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Abstract

The national science popularization capacity of the New Era is reflected in the comprehensive strength of a country to continuously provide effective science popularization products and services to the public, improve the scientific literacy of all citizens, cultivate a scientific culture, promote the transformation of

scientific and technological achievements, and thereby support innovative development. Based on theoretical research and practical construction of China's science popularization capacity, this study analyzes current deficiencies in China's science popularization capacity building and identifies development directions for serving national strategic needs in the new era. It attempts to propose beneficial recommendations for strengthening national science popularization capacity, serving innovation-driven development, and facilitating the realization of Chinese modernization.

Keywords: national science popularization capacity, construction of science popularization capacity, science popularization, Chinese path to modernization

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The Concept, Connotation, and Constituent Elements of National Science Popularization Capacity

Origins of the Concept In February 2006, the State Council promulgated the *National Medium- and Long-Term Plan for Science and Technology Development (2006–2020)*, which first introduced the phrase "strengthening national science popularization capacity" in a national-level policy document [3]. In March of the same year, the General Office of the State Council issued the *Implementation Plan for the Outline of the National Action Plan for Scientific Literacy (2016–2020)* [4]. These two programmatic documents established medium- and long-term plans for China's scientific and technological development and citizen scientific literacy construction, integrating science popularization with technological innovation at the national policy level and placing science popularization capacity building on the national socioeconomic development agenda. That same year, strengthening science popularization capacity building was written into the *Eleventh Five-Year Plan for National Economic and Social Development of the People's Republic of China*: "Strengthen science popularization capacity building and implement the national action plan for scientific literacy" [5], thus forming the top-level design for national science popularization capacity building. In January 2007, the Ministry of Science and Technology, the Publicity Department of the CPC Central Committee, and six other departments jointly issued the *Several Opinions on Strengthening National Science Popularization Capacity Building* (hereinafter referred to as the *Opinions on Science Popularization Capacity Building*), marking the beginning of concerted national efforts to advance science popularization capacity building [1]. The *Opinions* stated that "strengthening national science popularization capacity building and improving citizens' scientific literacy is an important foundation for enhancing independent innovation capability and an important guarantee for building an

innovative country" [1].

Following the release of the *Opinions*, relevant academic research gradually unfolded. Some scholars, focusing on the concept and practical issues of national science popularization capacity, proposed numerous suggestions regarding mechanisms, funding, venues, and industries, arguing that a broad science popularization coordination mechanism and diversified investment mechanisms were important levers for promoting capacity building [2]. The 2009 Nanning Forum and 2010 Beijing Forum on National Science Popularization Capacity Building further identified, from a policy research perspective, the importance of special science popularization plans, improved leadership and coordination mechanisms, and the advancement of science-for-people projects and major science popularization demonstration activities for enhancing national science popularization capacity [3]. In 2017, the China Research Institute for Science Popularization published the *Report on Development of National Science Popularization Capacity in China (2006–2016)*, which systematically studied the development of China's science popularization capacity and constructed an evaluation index system [4]. Since then, annual blue papers on national science popularization capacity research have been released [5-8], providing a theoretical foundation for practice.

Main Connotation and Constituent Elements The academic community generally agrees with the definition of science popularization capacity in the *Opinions on Science Popularization Capacity Building* and explains the connotation and constituent elements of national science popularization capacity by reference to its six elements. These elements include science popularization creation, science communication channels, science education systems, social organization networks for science popularization work, science popularization talent teams, and macro-management of government science popularization work [1]. The constituent elements of science popularization capacity are derived from the long-term practice of China's science popularization work.

Facing new opportunities and challenges in the internet era, some scholars have proposed future directions for science popularization capacity building from perspectives including subjects, content, methods, space, concepts, processes, and timing [9]. Others have elaborated on development trends such as informatized, precision, and crowdsourced science popularization [10]. Empirical research based on the six-element framework has found that science popularization personnel, funding, infrastructure, and science education environment have relatively significant impacts on national science popularization capacity [11]. In addition to systematic evaluation of national capacity, research on regional science popularization capacity assessment has also advanced [12].

As economic and social development enters a new era, newly formulated national policies on science popularization and scientific literacy provide references for interpreting the connotation of national science popularization capacity in the new era. In June 2021, the State Council issued the *Outline of the National*

Action Plan for Scientific Literacy (2021–2035) (hereinafter referred to as the *Scientific Literacy Outline*), which emphasizes value guidance in its guiding principles, implying that national science popularization capacity in the new period should focus on deepening connotation [6]. The two editions of the scientific literacy outline issued in 2006 and 2021 both emphasize establishing long-term mechanisms and "improving coordination mechanisms" in their implementation, which requires attention from the perspective of national science popularization capacity building.

In August 2022, the Ministry of Science and Technology, the Publicity Department of the CPC Central Committee, and the China Association for Science and Technology issued the *National Science and Technology Popularization Development Plan for the 14th Five-Year Plan Period* (hereinafter referred to as the *14th Five-Year Science Popularization Plan*), which further clarified the content of national science popularization capacity building in the new era, including six aspects: strengthening theoretical research, enhancing creation capacity, improving facility layout, building an all-media science communication matrix, advancing informatization, and promoting market-oriented development [7]. In September 2022, the General Office of the CPC Central Committee and the General Office of the State Council issued the *Opinions on Further Strengthening Science and Technology Popularization Work in the New Era* (hereinafter referred to as the *Opinions*), which proposed seven tasks for strengthening national science popularization capacity building: strengthening grassroots services, improving infrastructure layout, enhancing creation, improving activity effectiveness, expanding talent teams, promoting industry development, and strengthening exchanges and cooperation [8].

Based on the above, this paper defines national science popularization capacity in the new era as the comprehensive strength of a country to continuously provide effective science popularization products and services to the public, improve scientific literacy of all citizens, foster a scientific culture, promote transformation of scientific and technological achievements, and thereby support innovative development. Strengthening national science popularization capacity is mainly reflected in giving play to the value-leading role of science popularization, strengthening overall coordination, advancing integration of science popularization and education, ensuring supply, promoting standardization and evaluation, strengthening science communication, expanding talent teams, increasing investment and infrastructure, and promoting international exchanges.

Systemic Characteristics of National Science Popularization Capacity For a long time, China has explored a systematic development model in science popularization capacity building practice, with gradual improvement of systems and mechanisms and continuously enhanced service capabilities, contributing foundational strength to China's entry into the ranks of innovative countries and building a moderately prosperous society in all respects. Science popularization work adheres to the guidance of Xi Jinping Thought on

Socialism with Chinese Characteristics for a New Era, applying its worldview and methodology, particularly its positions, viewpoints, and methods. Since the 20th CPC National Congress, the "six must-adheres" have been implemented as grasping the "six characteristics" of science popularization: insisting on people-centeredness, highlighting guidance, emphasizing scientificity, endowing with timeliness, grasping integration, and expanding openness [13].

Meanwhile, national science popularization capacity in the new era pays greater attention to systematic characteristics. Connotation building guided by the scientific spirit continues to strengthen. The combination of "coordinated advancement" and "deepening supply-side reform" promotes comprehensive transformation and upgrading of science popularization concepts, mechanisms, and methods, continuously improving the breadth, depth, precision, speed, and intensity of science popularization work.

Current Achievements and Deficiencies in China's Science Popularization Capacity Building

Achievements in China's Science Popularization Capacity Building Under the strong leadership of the CPC, the science popularization policy system has been continuously improved, driving significant progress in China's science popularization work and substantial rapid growth in citizens' scientific literacy. Since the 18th CPC National Congress, the country's overall science popularization capacity has continued to improve. According to calculations by the National Science Popularization Capacity Research Group, China's comprehensive national science popularization capacity development index increased from 1.88 in 2012 to 2.84 in 2020 [7]. While remarkable achievements have been made in capacity building, new challenges posed by the new era and new situations must be recognized.

China's science popularization capacity building demonstrates strong momentum, with continuous optimization of the science popularization ecosystem, mainly reflected in: (1) The organizational management system for science popularization work has gradually improved, with increasingly perfected policy systems and work institutions to ensure capacity building, exploring an effective implementation mechanism of "Party leadership, government promotion, public participation, social coordination, and open cooperation." (2) Science popularization funding has grown steadily, talent teams have expanded and become more professionalized, infrastructure has improved in both quantity and quality, and a modern science and technology museum system has been initially established, providing strong support for national capacity enhancement. (3) The supply of science popularization products and services has continuously increased, with flourishing creation, influential platforms for creation and transformation, and an endless stream of excellent popular science books and films. (4) Science popularization informatization has continuously improved, with widespread implementation of "Internet + Science Popularization." Diversified online media has become the most relied-upon channel for public science

learning, and online science communication has become normalized [14]. Aggregated internet platforms such as "Science Popularization China" have become the most influential science popularization media. (5) Science popularization for public benefit has deepened and expanded, with grassroots systems improving and highlighting the original mission of "people-centeredness" [15]. (6) Internationalization of science popularization has taken new steps, with preliminary establishment of international exchange and cooperation platforms for scientific literacy and rich international exchanges of venues and activities, expanding international influence.

Deficiencies in Current Science Popularization Capacity Building

With the rapid development of domestic and international situations placing higher demands on capacity building, and with the implementation of innovation-driven development strategies and the goal of achieving high-level scientific and technological self-reliance, science popularization capacity building faces problems that are not adapted to new era development requirements: (1) Science popularization needs further integration with scientific and technological innovation, lacking systems and measures to implement the principle that "science popularization is as important as technological innovation" [16]. The phenomenon of emphasizing research over popularization and disconnecting research from popularization is widespread, which is not conducive to improving overall national capacity. (2) Science popularization service effectiveness and guarantee capacity need enhancement. Issues such as insufficient grassroots science popularization venues and low service efficiency are prominent. In talent team building, there are problems including low participation of scientific and technical workers and incomplete incentive and reward mechanisms. (3) Original science popularization works and product innovation are insufficient and of low quality, with weak public appeal. The informatized, all-media, multi-channel science popularization communication matrix needs further improvement. (4) The degree of marketization and socialization is insufficient. Some industries, enterprises, media, and scientific and technical workers lack awareness of science popularization, their initiative and enthusiasm for participation need improvement, and the degree of social coordination is low, which is not conducive to overall capacity enhancement. (5) There is a lack of systematic monitoring and evaluation of national science popularization capacity. Existing monitoring and evaluation research cannot fully reflect the panorama of science popularization development in the new era, and no comprehensive supervision and evaluation system has been established that covers multiple elements such as implementation and policy execution, while accommodating different subjects, activities, and levels.

The Situation Facing National Science Popularization Capacity Building to Serve New Era National Strategic Needs

Since the 18th CPC National Congress, General Secretary Xi Jinping has creatively proposed that scientific and technological innovation and science popu-

larization are both important components of China's innovative development, elevating the strategic status of science popularization to an unprecedented height. The implementation of new era national strategies has also placed higher demands on national science popularization capacity building.

High-Level Scientific and Technological Self-Reliance and Strength's Requirements for National Science Popularization Capacity Building In May 2016, at the National Conference on Science and Technology Innovation, the Academicians' Conference, and the Ninth National Congress of the China Association for Science and Technology, General Secretary Xi Jinping pointed out: "Scientific and technological innovation and science popularization are the two wings of innovative development. Science popularization should be placed in the same important position as technological innovation. Without the universal improvement of scientific literacy among all citizens, it is difficult to establish a large high-quality innovation army and to achieve rapid transformation of scientific and technological achievements" [17]. This statement profoundly clarifies the relationship between science popularization and technological innovation, between science popularization and scientific literacy, and between scientific literacy and economic and social development, pointing out the direction and providing fundamental guidance for science popularization work in the new era.

High-level scientific and technological self-reliance and strength are strategic supports for comprehensively building a modern socialist country. As one "wing" of innovative development, science popularization will also provide high-level collaborative support for improving the scientific and technological innovation system. Science popularization is also a powerful tool for "building a high-quality innovation army." Only by improving the quality of all workers in society and laying a solid foundation for a high-level innovative scientific and technical talent team can we cultivate more pioneers and leaders for scientific and technological self-innovation. The rapid transformation of scientific and technological achievements also cannot be separated from the foundational support of science popularization. Timely and effective science popularization around new knowledge, new technologies, and new trends in global scientific and technological development enhances public recognition and understanding of scientific frontiers, promoting a public opinion orientation and social atmosphere conducive to scientific and technological innovation. For new demands in economic and social development, cross-industry and cross-field technology popularization for professional scientific researchers is conducive to promoting integration of science and industry. Science popularization for the public helps facilitate rapid application and transformation of high-tech achievements, creating a path of "innovation breakthrough + timely popularization" and forming a positive interaction between science and technology and society [13].

High-Quality Development's Requirements for National Science Popularization Capacity Building General Secretary Xi Jinping has pointed out that innovation has become the primary driving force for economic and

social development, and that building a modern economic system should be supported by high-quality scientific and technological supply [18]. With socialism with Chinese characteristics entering a new era, the vitality, innovation, and competitiveness of the economy in the high-quality development stage need further improvement. As previously mentioned, vigorously strengthening the wing of science popularization and accelerating technology popularization and achievement transformation in the process of emerging and developing industries can contribute strong momentum for innovation-driven development. Developing a green economy, promoting low-carbon transformation and technological upgrading in key industries and important fields, and building an ecological civilization with everyone's participation and responsibility cannot be achieved without the dissemination and influence of science popularization. "Human modernization is the logical starting point and ultimate goal of modernization; what development ultimately requires is change in human quality" [19]. Building a new development pattern and leveraging the important roles of innovation and talent are essential to solving high-quality development problems. Therefore, it is necessary to further strengthen science popularization capacity building, give full play to China's institutional advantages, enhance the value-leading role of science popularization, win the "people's war" of innovative development, and lay a solid foundation for achieving high-quality development and building a highland of scientific and technological self-reliance and strength.

Chinese Modernization's Requirements for National Science Popularization Capacity Building The report of the 20th CPC National Congress emphasizes that education, science and technology, and talent are foundational and strategic supports for comprehensively building a modern socialist country, and that science and technology are the primary productive forces, talent is the primary resource, and innovation is the primary driving force. Science popularization, as an important variable, runs through science and technology, education, and talent work, connecting the three into an organic whole with its foundational and strategic characteristics. On the one hand, science popularization integrated with education promotes high-quality education development and helps cultivate high-quality talent. On the other hand, science popularization integrated with scientific and technological innovation promotes transformation of innovative achievements and building of a high-quality innovation army, which in turn further promotes high-level scientific and technological development. The results of high-level scientific and technological development, transformed through science popularization, will comprehensively benefit the entire society, create more favorable economic conditions, and better support the development of science and technology, education, and talent work. These elements interact and promote each other, ultimately providing foundational support for comprehensively building a modern socialist country.

The 20th CPC National Congress proposed to "develop a socialist culture that is oriented toward modernization, the world, and the future, and that is national, scientific, and popular." Science popularization plays an irreplaceable role in im-

proving people's scientific and cultural quality, health quality, ideological and moral quality, and enriching people's spiritual world, comprehensively integrating into the advancement of the "five-sphere integrated plan" and becoming a powerful support for promoting the great rejuvenation of the Chinese nation.

Basic Paths for Strengthening National Science Popularization Capacity

Strengthening national science popularization capacity to empower Chinese modernization is the fundamental goal of science popularization work in the new era. To further serve national strategic needs, consolidate the foundation for high-level self-reliance and strength, improve citizens' scientific literacy, and enhance social civilization, the construction of national science popularization capacity should adhere to a people-centered approach, uphold the leadership of the CPC, promote coordinated progress between science popularization and scientific and technological innovation, make science benefit all people, and promote comprehensive human development and human modernization [13]. From the strategic height of further implementing the coordinated development and deep integration of scientific and technological innovation and science popularization, and thoroughly implementing the requirements of the *Scientific Literacy Outline*, the *Opinions*, and the *14th Five-Year Science Popularization Plan*, we propose focusing on six aspects to advance national science popularization capacity building around the ecosystem construction of socialized coordination, intelligent communication, standardized construction, and international cooperation.

(1) **Comprehensively strengthen the national science popularization capacity building system through a broad science popularization strategy.** Under the leadership of the CPC, give full play to the advantages of the new national system, integrate science popularization into the implementation of new development concepts, promote profound changes in science popularization concepts, strengthen the overall mobilization, resource convergence, service demonstration, and decision-making consultation effectiveness of the science popularization capacity system, promote international exchanges and cooperation, and form a grand synergy and cooperation that drives and radiates the whole society to jointly advance science popularization. Connect all aspects of science education, talent cultivation, spirit promotion, and cultural cultivation to achieve systematic improvement of science popularization capacity [13].

(2) **Create an innovation culture to empower innovative development.** Establish and improve institutional arrangements that place science popularization and scientific and technological innovation in equally important positions, give play to the value-leading role of science popularization in scientific culture and innovation culture construction, and explore the role of science popularization in advancing the "five-sphere integrated plan." Through popularizing scientific knowledge, promoting

the scientific spirit, disseminating scientific thought, and advocating scientific methods, create a social atmosphere that loves science and advocates innovation, forming a strong driving force for scientific and technological innovation.

(3) **Deepen supply-side reform to comprehensively upgrade science popularization products and services.** Science popularization forms in the new era have shifted beyond "flood irrigation" to "precision drip irrigation" [20]. Through deepening supply-side structural reform, innovating and upgrading science popularization means, mechanisms, and methods, based on big data analysis and guided by public demand, upgrade science popularization creation technology, improve product quality, perfect the standard system, establish a universal science popularization service system, and provide precise, timely, ubiquitous, and three-dimensional science popularization services.

(4) **Deepen the advancement of science popularization informatization and improve the layout of science popularization infrastructure.** Strengthen the construction of science popularization positions, continuously expand the openness of research platforms in scientific research institutions and universities, and promote the transformation of scientific and technological resources for science popularization. Rely on new-generation technological applications to achieve all-time, all-area, and all-scenario development of the science popularization infrastructure system, and build comprehensive immersive experience learning places that integrate online and offline. Use cutting-edge technologies to strengthen all-media science popularization content dissemination, forming a scientific communication matrix that integrates the scientificity of innovation sources, the authority of mainstream media, the diversity of self-media, and the broadness of public communication, and build a science popularization resource platform that gathers massive high-quality content from home and abroad.

(5) **Advance high-quality development of science popularization through theoretical research and evaluation practice.** Mobilize universities and research institutes to collaborate on theoretical research on major science popularization issues to provide support for national capacity building. Oriented by the needs of science popularization service development, improve the quality of the science popularization standard system and further perfect the standardization working mechanism. Improve the science popularization evaluation system, strengthen theoretical research on science popularization evaluation, explore innovations in monitoring and evaluating science popularization work effectiveness, comprehensively refine evaluation mechanisms and measures [21], and establish a scientific and normalized science popularization capacity evaluation system.

(6) **Strengthen international scientific and technological and cul-**

tural exchanges to serve the building of a community with a shared future for mankind. Improving world citizens' scientific literacy and promoting international exchange and popularization of scientific and technological achievements are beneficial themes for exchanges and mutual learning among world civilizations. Science popularization capacity building in the new era should adhere to being oriented toward the world and the future, tell Chinese science and technology stories and innovation stories with Chinese discourse, strengthen exchanges of works, products, and activities, and actively build international organizations for science popularization and scientific literacy exchanges to make beneficial contributions to promoting the building of a community with a shared future for mankind.

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