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# Science Education in Post-COVID-19 Era

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## Abstract

It is a consensus worldwide that COVID-19 has made far-reaching impact on education. As one of the essential topics of discussion for Education 4.0, science education has been paid lots of attention focusing on its further development especially under the background of the fourth industrial revolution and Post-COVID-19 era. This research proposes developing strategies of science education in the Post-COVID-19 era with a globalized vision. The strategies, proposed on the basis of worldwide research outcome of science education and the analysis of China's actual conditions, include developing the top layer design for science education from national security perspectives, establishing a training system of science and technology talent reserve, building-up a systematic competency evaluation standard, enhancing the professionalism of science teachers, and promoting the socialization of science education supply. They aim to ensure the firm and effective development of science education in the Post-COVID-19 era in China.



## Keywords

science education; Post-COVID-19 era; the fourth industrial revolution; science and technology



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**Abstract:** It is a consensus worldwide that COVID-19 has made a far-reaching impact on education. As one of the essential topics of discussion for Education 4.0, science education has been paid lots of attention focusing on its further development, especially under the background of the fourth industrial revolution and post-COVID-19 era. This research proposes developing strategies of science education in the post-COVID-19 era with a globalized vision. The strategies, proposed on the basis of worldwide research outcome of science education and the analysis of China's actual conditions, include developing the top-level design for science education from national security perspectives, establishing a training system of science and technology talent reserve, building-up a systematic competency evaluation standard, enhancing the professionalism of science teachers, and promoting the socialization of science education supply. They aim to ensure the firm and effective development of science education in the post-COVID-19 era in China. **DOI:** 10.16418/j.issn.1000-3045.20210310002-en

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In 2020, the world was caught by the sudden attack of COVID-19, which exerts enormous pressure on mankind. Thus, the fourth industrial revolution is sped up, and people further realize the importance of emerging technologies such as artificial intelligence (AI), Internet of Things (IoT), and blockchain for the future world. Technology fusion, as the core feature of the fourth industrial revolution, will gradually remove the boundaries between the physical world, the digital world, and the biological world [1] and bring about great changes in the production mode and productivity. Further, it will change and even subvert the industrial structure and skill structure of workforce. To meet the new demand for talents in the future, educational reform will be indispensable. Science education shoulders the important tasks of cultivating innovative talents in the field of science and technology and improving people's scientific literacy [2]. Especially under the background of COVID-19, science education is found to play an increasingly prominent role in improving people's scientific literacy [3]. In recent years, it has enjoyed rapid development in China, which has explored the establishment of a science education ecosystem and the promotion of science disciplines integration so as to meet the development demand in the intelligent era. Depending on the current situation of science education in China and its new situation in the post-COVID-19 era, this paper provides an outlook on the strategies for science education in the post-COVID-19 era in China.

## 1 Background and current situation of China's science education

### 1.1 Current situation of China's science and technology competitiveness

The World Competitiveness Center, International Institute for Management Development (IMD) released the IMD World Digital Competitiveness Ranking 2020. It aims to analyze the capacity and maturity of 63 economies in exploring and using digital technologies to promote social and economic changes and also forecast the way of their economic rehabilitation in the post-COVID-19 era. China rose from the 22nd in 2019 to 16th in 2020. The country witnesses great improvement in terms of talent, scientific concentration, and adaptive attitudes and takes the lead in some segmentation indexes. In addition, Global Innovation Index (GII) 2020 established an analysis index "innovation quality" based on the level of universities/colleges, scientific publications, and international patent applications and also ranked 131 economies by the innovation capability. China ranked the 14th in GII 2020. As for the number of science and technology clusters, 17 clusters in China ranked top 100 in the world, which is second only to the United States.

However, Science and Technology Daily reported 35 key technologies whose lagging behind will hinder the development of China in the first half of 2018, which indicates the

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great gap between China and developed countries regarding the competitiveness of cutting-edge technologies.

### 1.2 Current competitiveness of science and technology talents in China

In the intelligent era, it is a consensus of all countries in the world to improve the comprehensive national power through knowledge innovation and scientific and technological progress. Essentially, the competition in science and technology innovation is the competition in talents. In The Global Talent Competitiveness Index 2020 (GTCI) [4], China ranked the 42nd, ahead of the other four BRICS countries, including Russia (48th), South Africa (70th), India (72nd), and Brazil (80th). China performed excellently in the aspects of growth (22nd) and global knowledge and skills (29th) due to the world-class education system (8th in formal education) and global innovation force (15th in talent impact). However, there were still great gaps between China and developed countries in terms of talent attraction & retention and vocational and technical skills. The report also shows a huge talent gap in high-tech fields in China. With the AI field as an example, the demand for talents was soaring. In 2017, there were 1.9 million AI talents in the world, including over 850,000 in the United States and only 50,000 in China [5].

### 1.3 Current cultivation of science and technology talent reserve in China

Although China's students ranked top in science in Programme for International Student Assessment (PISA) in recent years, their occupational expectation in the field of science is lower than the average level of the member countries of the Organization for Economic Co-operation and Development (OECD). Around 80% of China's students told that they were interested in science, but only about 17% expected to engage in occupations related to science and technology after the age of 30, which was far lower than the average level of OECD member countries (24%); however, the average result about the willingness exceeded 35% in the United States [6]. To effectively cultivate science and technology talent reserve, China should attach more importance to science education, making the students truly love science and be willing to engage in science careers in the future.

### 1.4 Implementation status of science education in China

Science education consists of the education in four interrelated levels, namely scientific knowledge, scientific method, scientific attitude, and scientific spirit [7]. In a broad sense, the content of science education can be divided into two aspects, namely scientific content and scientific process. Scientific content focuses on what the students should know (knowledge and understanding); and scientific process involves what the students should be able to do (abilities and skills), mainly including the methods, skills, attitudes, and concepts related to research [8]. In a narrow sense, science education refers to natural science education in schools only (mainly the subject education of physics, chemistry, biology, etc.). Its research content involves theoretical and practical issues in curriculum, teaching, learning, and evaluation regarding natural science in schools of all levels and types [9].

Science education is an important part of fostering virtue and a basis for improving the scientific literacy of the public and constructing a country of innovators ①. Since the implementation of basic education curriculum reform in 2001, the science curriculum in primary schools has played an important role in cultivating students' scientific literacy. In practice, however, there are still some aspects to be improved, such as course suitability, operability, contemporaneity, and integrality. To further deepen science education, the Ministry of Education of China issued *Science Curriculum Standard for Primary Schools during Compulsory Education* in 2017, which stipulated that all primary and secondary schools in China should provide science courses. However, China Science Writers Association finds through investigation that many problems need to be solved in science education at the stage of compulsory education. Most schools do not employ full-time science teachers, and the proportion of full-time science teachers in primary schools is only 16.1% at the level below county. Science education lacks top-level design, and the compilation of science textbooks and the formulation of curriculum standards should be strengthened. In addition, from the perspective of the implementation of science education, China's science education also faces some challenges, such as insufficient interdisciplinary integration, a lack of science education resources, and poor teaching quality.

## 2 Challenges to science education in the post-COVID-19 era

COVID-19 is assessed as a global pandemic by World Health Organization (WHO), which greatly affects human development and the changes in the world pattern. Friedman [10], a famous writer in the United States, believes that this outbreak is a dividing point between B.C. (Before Corona) and A.C. (After Corona). With the basic control of the pandemic, human beings have comprehensively promoted the

① Ministry of Education of the People's Republic of China. Notice of the Ministry of Education on the Release of *Science Curriculum Standard for Primary Schools during Compulsory Education*. (2017–02–06) [2021–07–06]. http://www.moe.gov.cn/srcsite/A26/s8001/201702/t20170215_296305.html.

 

social, political, economic, and educational recovery during regular pandemic prevention and control. Therefore, it can be considered that human beings have entered the post-COVID-19 era.

The post-COVID-19 era consists of two major elements, namely COVID-19 and science and technology, both of which create a huge impact on human society. COVID-19, due to the high infectivity and concealment, cannot be effectively controlled worldwide in a short period of time. Thus, most countries would be continuously affected. Under the overlapping of post-COVID-19 era and intelligent era, science and technology become a key driving force to promote the orderly development of human society. Before designing strategies for science education development in the post-COVID-19 era, we need to clarify the challenges and opportunities brought by COVID-19 and science and technology to science education development in the post-COVID-19 era.

## 2.1 Challenges brought by COVID-19 to science education

The outbreak of COVID-19 has resulted in class suspension in more than 180 countries around the world, making students fail to engage in normal learning. Many organizations and research institutions in China and other countries have provided timely feedback on the impact of COVID-19 on education. United Nations Educational, Scientific and Cultural Organization (UNESCO) issued Education in a Post-COVID World: Nine Ideas for Public Action. The nine ideas for the development of education in the post-COVID-19 era include committing to strengthen education as a common good, expanding the definition of the right to education so that it addresses the importance of connectivity and access to knowledge and information, valuing the teaching profession and teacher collaboration, promoting student, youth, and children's participation and rights, protecting the social spaces provided by schools as we transform education, making free and open source technologies available to teachers and students, ensuring scientific literacy within the curriculum, protecting domestic and international financing of public education, and advancing global solidarity to end current levels of inequality [11].

The impact of COVID-19 on science education is mainly reflected in the changes of teaching objectives and teaching methods. ① In terms of teaching objectives, UNESCO clarifies that in the post-COVID-19 era, all countries should strengthen scientific literacy education, and science education would not be limited to scientific knowledge and understanding but extend to capabilities and skills. During the spread of COVID-19, Academician Zhong Nanshan once pointed out that the improvement of the public scientific literacy was an important lesson learned from this pandemic and also a basis for eliminating panic, implementing mass prevention and control, and making the public effectively respond to the pandemic [①]. UNESCO also stressed that scientific literacy should be ensured within the curriculum. "This is the right time for deep reflection on curriculum, particularly as we struggle against the denial of scientific knowledge and actively fight misinformation" [11]. Therefore, it is particularly urgent to promote the scientific literacy of students in the post-COVID-19 era, which requires the education systems in all countries to adopt opportune curricula and methods for teaching and assessment. Furthermore, it is also especially important to establish an education ecosystem that can systematically improve the scientific literacy of students. To this end, informal learning environments, such as families, museums, and other institutions of social networking, should be able to provide learning opportunities for students in appropriate ways [12]. ② In terms of teaching methods, the combination of online and offline teaching in the post-COVID-19 era would greatly impact and change the traditional teaching methods and also have a significant influence on teaching methods of science education. Mature augmented reality (AR) and virtual reality (VR) technologies can provide technical support for the mixed teaching of science education. It is of great importance to explore a mixed science education pattern with the improvement of online teaching resources, for it can help realize individualized education and increase learning time and opportunities [13].

## 2.2 Challenges brought by new science and technology to science education

With the arrival of the fourth industrial revolution, new science and technology continue to emerge, which would replace plenty of traditional technologies and occupations [14]. China is in urgent need of a large number of innovative talents in the field of science and technology for economic transformation, upgrading, and sustainable development. In other words, new science and technology pose new challenges to science education in China.

Science education should attach more importance to capacity building of students. The emergence of new science and technology would make some industries disappear and create a large number of new unforeseeable industries. Traditional science education focuses on knowledge teaching. However, in the intelligent era, the accelerated knowledge update renders knowledge acquisition less important than knowledge application and ability cultivation. In 2017, LinkedIn issued a research report "The Digital Workforce of the Future," which points out that AI-induced talent movement is prone to start, and 65% of the jobs done by Generation Z candidates do not even exist yet [5]. The World

[①] Zhong Nanshan: Improving public scientific literacy, and promoting future medical development with cutting-edge technology. (2020–11–08) [2021–07–06]. https: //finance.sina.com.cn/tech/2020–11–08/doc-iiznezxs0688970.shtml.

Economic Forum states in The Future of Jobs Report 2020 [15] that COVID-19 accelerated the coming of future work; in 2025, about 85 million positions will undergo the division of labor between man and machine, and there will be 97 million new positions. A number of important skills, such as critical thinking, problem solving, and self-management, will be more important in the future. Therefore, it is not feasible to cultivate future talents with traditional methods. As a new link of science and technology with education, science education should pay more attention to capacity building of students, so as to make them better acclimatize themselves to future work.

Science education should focus on the cultivation of learning interests and guide more adolescents to engage in science and technology in the future. The cultivation of science and technology talent reserve in China remains to be further improved. While cultivating students' interest in learning, China's science education should make the students have a more in-depth understanding of the science and technology industry and enhance their willingness to engage in relevant careers. For example, it is necessary to establish the curricula for science education based on the learning ecosystem. Enterprises and institutions with rich scientific education resources and experts and professionals in the field of science and technology should cooperate with families, communities, and schools to form a learning ecosystem so that they can provide educational resources and opportunities for students [16]. Science education should make students have access to opportunities to know of science and technology and relevant practitioners in the real world, develop their interest in learning, and eliminate their occupational prejudice.

## 3 New achievements in science education in the post-COVID-19 era

### 3.1 Increasing the importance of science education to the level of national security

With the arrival of Industry 4.0 era, science and technology innovation will have an increasing influence on national strategy and even national security. Industry is the lifeblood of economy in each country, and science education is capable of cultivating talents meeting the needs of science and technology innovation in the Industry 4.0 era, improving the scale of human capital, and promoting the steady growth of national macro-economy. Croak [17] believed that the degree of science education is a form of enhancing human capital. By collecting data of 87 countries from 2010 to 2018, Croak studied the relationship between the level of science education and elements such as gross domestic product (GDP). The results show that science education has a significant and positive impact on productivity. Science and technology are an important support for national security, and science education can promote sustainable development in the field of science and technology innovation in China, thus ensuring the independence of technologies required in the field of national security. Therefore, to maintain a leading position in the fourth industrial revolution, realize economic transformation, upgrading, and sustainable development, and ensure national security, China should increase the importance of science education to the level of national strategy and even national security.

### 3.2 Establishing a systematic competency evaluation standard

China issued the Master Plan for Deepening the Reform of Education Evaluation in the New Era (hereinafter referred to as the Master Plan) in October 2020. The Master Plan proposes the abolishment of the previous education evaluation mode only based on five aspects. It aims to reform the evaluation of schools, teachers, and students, accelerate education modernization, construct an education power, and develop a strong education system that the people are satisfied with. It also points out that the evaluation of primary and secondary schools should focus on the followings: implementing the comprehensive quality evaluation of students, providing development guidance for students, optimizing the allocation of teaching resources, promoting the orderly selection of courses and classes, and standardizing the enrollment and school running. Guided by evaluation reform, science education in the post-COVID-19 era will gradually turn the objective to the cultivation of students' scientific literacy. Science education should promote the reform of teaching and learning based on evaluation reform and cultivate students' scientific literacy, especially higher-order thinking, through more flexible teaching methods, such as project-based, large-unit, and large-concept learning. Meanwhile, science education in the post-COVID-19 era will pay more attention to the cultivation of ability and interest of students, which will greatly promote the implementation of comprehensive quality evaluation and development guidance for students. Therefore, science education will be an important means to resolve the disconnection between teaching objectives and ability standards in higher education and basic education in China. With the coming of the Education 4.0 era, it will be a new pattern of science education in the post-COVID-19 era to establish a systematic competency evaluation standard and decompose the cultivation objectives (especially those for cultivating literacy and ability) of innovative talents proposed by colleges and universities into multi-step objectives in primary and secondary schools.

### 3.3 Setting up an ability improvement project for science teachers

The professionalism of teachers, the implementers of science education, determines the quality of science education. To ensure the high-quality implementation of science education, China should set up an ability improvement project for science teachers, establish an effective training system for them, and strengthen the training of teachers with interdisciplinary backgrounds especially in economically backward areas and groups. In addition, teachers should be encouraged to integrate science education into classroom teaching. The above measures can contribute to the scientific literacy improvement of teachers. The following measures should be taken by education departments: integrating the teachers' cultivation and development system, and ensuring their long-term development and potential exploitation; releasing the corresponding evaluation and incentive mechanisms, motivating and mobilizing all the teachers to promote science education; establishing professional teacher training platforms, arranging high-level experts and scholars to serve as tutors and lecturers, and attracting national universities/colleges and regional teacher training institutions to join the ability improvement project for science teachers.

### 3.4 Strengthening the construction and management of the socialization of science education supply

China should strengthen the construction and management of socialization of science education supply and turn science education into an action guided by the government, led by the schools, and promoted by the society. China can break through the limitations set by policies, teachers, and funds by means of online education and artificial intelligence, so as to meet the needs of schools to develop high-quality science education. In addition, China should establish and improve a long-term cooperation mechanism, integrate teaching, research, and practice, and encourage the cooperation among schools, families, and society through mobilizing the active participation, exchange and cooperation, and diversified input of the whole society based on a consensus. It should prepare a stable, clear, operable program for the socialization of science education supply through promoting top-level policy design, understanding the development trend of science education in the world, and analyzing the development status of science education of itself, so as to provide guidance and direction for classroom teaching. Meanwhile, China should also strengthen the standard governance of the off-campus training industry by referring to international experience, form a public governance decision-making mechanism participated by multiple subjects, and create a good policy environment to ensure the sustained and effective implementation of science education.

### 3.5 Establishing a training system for science and technology reserve talents

At present, China has initiated multiple reform measures including "creating first-rate universities and disciplines" to cultivate science and technology reserve talents, especially top-level innovative talents. Some achievements have been made, but these measures remain to be further explored in the field of basic education. To establish a systematic training system for science and technology reserve talents from higher education to basic education, China has successively launched some education reform measures, such as "new college entrance examination," "plan for strengthening basic academic disciplines," and "education evaluation reform," which emphasize the cultivation of students' core competence at the stage of basic education. With the core connotation of cultivating the scientific literacy of students, science education naturally fits the ongoing establishment of the training system for science and technology reserve talents in the basic education stage in China. Meanwhile, multiple regions, schools, and institutions in China have explored localized research and practice regarding science education and preliminarily formed a Chinese model of science education. Therefore, science education will be the core module and an important basis for China to establish a training system for science and technology reserve talents.

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