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Domestic and International Research on Science and Technology Education: Review and Prospects

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Abstract: Competition in science and technology is the core of the national game in the new era. The construction of science and technology education, as an important force to promote national strategic scientific and technological power, is highly valued by all countries. Three developed countries in science and technology, the United States, Japan, and the United Kingdom, are the main research objects for analyzing their science and technology education. Domestic research on science and technology education mainly focuses on the theoretical and practical research of science and technology education activities. In the future, it is necessary to learn from the experience of foreign countries in the development of science and technology education, explore the localization of science and technology education activities, strengthen the top-level design of science and technology education, and highlight the strategic transformation of the trinity of "education, science and technology, and talents."

Keywords: Science and technology education; Review; Reflection and prospects

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1. Introduction

The Chinese President pointed out that: "building a strong education, science and technology, and talent is inherently consistent and mutually supportive, and we should organically combine the three, promote them as a whole, and form a multiplier effect to promote high-quality development. We need to smooth the virtuous circle of education, science and technology, and talent in accordance with the requirements of developing new quality productivity." In view of this, in-depth study of science and technology education is not only a key path to promote the strategic layout of "education, science and technology, talent" trinity, but also a core engine to drive the development of new quality productivity. Therefore, using the China National Knowledge Infrastructure (CNKI) database, we searched the literature of "science and technology education," and analyzed and summarized the domestic literature on science and technology education after reading the literature. In addition, the English literature is mainly collected through "Baidu Academic," "Sci-Hub," and other channels with the keyword "technology education" to understand the current situation of foreign research on technology education. It is of great practical significance to analyze and reflect on the domestic and foreign research on science and technology education, and to look forward to the future direction of research on science and technology education, in order to promote the implementation of science and technology education.

2. Review and reflection on domestic and international research on science and technology education

2.1. Research on science and technology education abroad

Science and technology education is an important part of basic education in many countries. Developed countries attach particular importance to the development of science and technology education both in and out of school. In recent years, developed countries such as the United States, Japan, and the United Kingdom have increased their investment in science and technology education, vigorously developing science and technology education for young people, and have gradually formed their own styles of science and technology education models for young people.

2.1.1. Research on science and technology education in the United States

In October 1957, as the U.S.-Soviet rivalry became more and more intense, some U.S. educators believed that the Soviet Union's leadership was mainly due to the success of science education, and therefore believed that U.S. basic education had to be reformed and the construction and change of "science and technology education" had to be strengthened. Therefore, in 1983, the U.S. Federal Department of Education published the *Report of the National Commission on Gifted Education: A Nation in Crisis*, which suggested that science classes must be modified and modernized to benefit those who were not prepared to enter college and those who were prepared to take college entrance exams. In 1985, the United States began a program of science and technology education with the main goal of improving the scientific and technological literacy of all Americans, and put forward the slogan of "science for all Americans" in the education sector, and formulated the famous "2061 program" [1]. In the 80s of the 20th century, the United States proposed Science, Technology, Engineering, and Math, referred to as STEM, to train mathematicians, scientists, engineers, and technicians with scientific literacy [2]. Over the past 40 years, the U.S. government and a number of scientific research institutions, colleges and universities, and foundations have promoted the deepening of STEM education through a variety of ways.

2.1.2. Research on science and technology education in Japan

The structure of the Japanese elementary and secondary school curriculum includes "Science and Technology Study Time" in addition to "Compulsory Subjects" [3]. The Japan Science and Technology Agency (JST), a national research and development corporation, has been creating Science Koshien since the 23rd year of the Heisei era, and is aiming to create a place where high school students can gather for hands-on science activities, and by creating such a place, it is aiming to expand the students' enjoyment of science and to improve their high-level abilities [4].

In addition, the Government of Japan has formulated science and technology policies to support the implementation of science and technology education. In the 7th year of the Heisei era, the Japanese government implemented a systematic and consistent science and technology policy from a long-term perspective, and formulated the Basic Law for Science and Technology, or the "Science and Technology Basic Plan," which has been formulated in five phases so far, has promoted the implementation and development of science and technology policies. Afterwards, the Basic Law for Science and Technology was amended to "Basic Law for Science, Technology and Innovation" due to the amendment of the law in June of the second year of the Order, and the Basic Plan for the Third Year of the Order was formulated [5]. The Ministry of Education, Culture, Sports, Science and Technology (MEXT) has been promoting "science for policy" in science, technology, and innovation policy since the 23rd year of the Heisei era, with the goal of realizing "policy formation based on objective evidence." With the cooperation of related organizations and bases for basic research and human resources development, a Promotion Program (SciREX Program) was established [6].

2.1.3. Research on science and technology education in the United Kingdom

Science and technology (S&T) education is an important part of the innovation ecosystem in the U.K. In 2004, the U.K. government formally promulgated for the first time a medium- and long-term S&T development plan: the Science and Innovation Investment Framework (2004–2014), which aims to promote the development of innovation in S&T education and strengthen the mutual synergy between higher education institutions and enterprises [7]. The Royal Society (RS), the Royal Society of Chemistry (RSC), the Institute of Physics (IOP), the British Standards Institution (BSI), etc., are generally the venues for students to carry out S&T education. Research funding for students in the UK to undertake science and technology education mainly comes from the government, corporations, universities, and private funding.

To summarize, the development of science and technology education in the West has been made possible by the support of the government, schools, and communities. The government provides policy guarantees for the implementation of science and technology education activities, and schools and communities provide support in terms of personnel and venues for the development of science and technology education activities. At the same time, museums, libraries, university research institutes, and even personal studios of scientists in many Western countries are open to students. Students are less burdened with schoolwork, so they have plenty of time after school to participate in science and technology activities of their own interest.

2.2. Domestic research on science and technology education

2.2.1. Theoretical research focusing on STE activities

Qi has studied the theory of science and technology education in primary and secondary schools, i.e., he has made a more comprehensive overview of the six aspects of science and technology education, namely, the proposal, meaning, goal, content, implementation, and methods [8]. Wang has sorted out the results of research and exploration of science and technology education in China from four aspects, namely, the meaning, objectives and contents of science and technology education, the principles, ways and methods of implementing science and technology education, and the practice mode of science and technology education, so as to provide theoretical references for the study of science and technology education. Wang's research ideas have commonalities with Qi's in terms of meanings, objectives, ways, and methods. The differences lie in the principles of implementing science and technology education and the mode of practical exploration. Among them, Wang summarized some models with certain characteristics and representativeness: "science practice class," "integrated science," "science and technology high school," and "resource gifted class." Qi summarized "Resource Gifted Classes," "Junior Science Academy," "Creative Science and Technology Education," "Industrial Science and Technology Education," "S.T.S (Science, Technology and Society)," "Multi-channel Progress," "Science Clubs," and "Curriculum Advancement and Breakthrough." The action models in the ten major areas provide reference for frontline schools to carry out science and technology education [9].

It can be seen that in the research of science and technology education theory, scholars have given full theoretical guidance to “how teachers should teach” and “how students should learn” science and technology education. After the emergence of STEM education (Science, Technology, Engineering, and Mathematics) in foreign countries, scholars have introduced and thought about the theory of STEM education, combined with the development of science education in their own countries, and carried out localized research on STEM education, which has greatly enriched the theoretical system of scientific and technological education activities in China.

2.2.2. Practical exploration of science and technology education activities based on core literacy

Some scholars take Beijing Jingshan School as the experimental position, actively seek the talent cultivation path compatible with the current primary and secondary education, and solidly push forward the reform of science and technology education from the perspective of core literacy, and gradually form a long-chain characteristic science and technology education model linking primary, junior, and senior high schools [10]. Under the perspective of core literacy, some scholars analyze the basic concepts of youth science and technology innovation education, explore the problems of youth science and technology innovation localization practice, and put forward specific practical measures: guiding students to carry out extracurricular science and technology practice activities based on classroom teaching content, and carrying out diversified extracurricular science and technology practice activities in the second classroom to cultivate students’ scientific innovation ability and quality [11].

3. Prospects of science and technology education research

3.1. Exploring the construction of localization of science and technology education activities by drawing on overseas experience in the development of science and technology education

The key to the localization of science and technology education activities lies in the organic unity of systematic reference to foreign experience in science and technology education and in-depth integration of regional cultural resources. In order to achieve this goal, educators need to build a science and technology education system with an international vision and local characteristics, with the fundamental orientation of “what kind of people to cultivate, how to cultivate people, and for whom to cultivate people.” Firstly, teachers need to systematically study the curriculum design and evaluation system of science and technology education in foreign countries; secondly, on this basis, they should dig deep into the traditional cultural elements in school-based resources, and transform the scientific wisdom contained in local non-heritage skills and traditional crafts into educational materials. For example, we can creatively combine the mechanics of traditional construction techniques and the astronomical knowledge of the festival culture with the theme of modern science and technology education, and design special programs such as “mortise and tenon structure creation workshop” and “intelligent festival observatory.” Finally, through the logical theory of “introduction-deconstruction-reconstruction,” the experience of foreign science and technology education is deeply integrated with the local culture, and a localized curriculum system is explored, so that a science and technology education paradigm with the cultural genes of our country can be formed, and support is provided for the cultivation of talents with global competitiveness and cultural roots in the new era.

3.2. Strengthening the top-level design of science and technology education and emphasizing the strategic transformation of the trinity of “education, science and technology, and talents”

To strengthen the top-level design of science and technology education, it is necessary to take the trinity development of "education, science and technology, and talents" as the strategic fulcrum, and build a systematic and sustainable strategic implementation system. Therefore, the school should be based on the national strategic needs—the education system innovation, scientific and technological resources integration, talent mechanism innovation—a strategic combination of the three, to build education, science and technology, talent synergistic development mechanism, systematic planning from the target positioning to the implementation of the path of the full cycle of design. First, the school development orientation should be deeply integrated with the goal of cultivating scientific and technological innovation talents; second, the school should break through the disciplinary barriers, design interdisciplinary integration of scientific and technological education curriculum clusters, and develop project-based learning resources reflecting the concepts of STEM education; third, the school should build a scientific and technological innovation literacy development-oriented evaluation system, and use this as a basis for the establishment of dynamic optimization of the cultivation of talents. Based on this, it is not only conducive to enhancing the effectiveness of science and technology education, but also continuously promote the emergence of high-level science and technology innovation talents, and ultimately realize the benign cycle of education empowering scientific and technological innovation, scientific and technological feedback on the growth of talents, and talents supporting the upgrading of education.

4. Conclusion

At present, China is in the process of moving from a "scientific and technological power" to a stronger "scientific and technological power." There is a serious shortage of top-notch innovative talents in China, which has slowed down the progress of some high-end scientific research projects and bottlenecks in key core technologies, and severely limited the in-depth layout and rapid development of China's strategic emerging industries, such as artificial intelligence and chip manufacturing. Therefore, it is of practical significance to study the domestic and foreign science and technology education for our country to cope with the science and technology competition strategy of the developed countries led by the United States against China in the new period.

Disclosure statement

The authors declare no conflict of interest.

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