Application and Popularization of Science and Technology in Education: Development and Policy Management in China

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Abstract. This paper examines the application and popularization of science and technology across primary, secondary, and tertiary education stages in China. It analyzes the current scenario, challenges, and government policies. Technological integration has progressed substantially but gaps remain in resource equity and ethical usage. Formal guidelines promote science and technology education, yet implementation inconsistencies persist. However, technology remains invaluable if managed effectively. Recommendations include public-private partnerships for resources, competitive science events, and improved academic oversight. The analysis forecasts future developments in utilizing technology to benefit Chinese education.

Keywords: Science Education, Technology Integration, Policy Recommendations.

1 Introduction

The objective of “advancing the nation through science and education” is to fully embrace the principle that science and technology serve as the primary productive forces, thereby assigning substantial importance to science, technology, and education in socioeconomic development. The influence of the application and popularization of science and technology on education manifests in numerous aspects. Science and technology not only act as the primary drivers for educational development but also profoundly impact thinking processes. The content, methodologies, and tools of teaching naturally evolve in response to technological advancements. Since the adoption of the strategy of revitalizing the nation through science and education in 1995, China’s science and technology education has progressed tremendously, demonstrating different features and outcomes at varying educational stages. At different stages of education, they have different manifestations and development results. The education system bears responsibility for fostering students’ scientific literacy [1].

In today’s world, science, and technology education is deeply integrated into nearly all aspects of learning and life. The government has introduced numerous guidelines and management policies to strategically maximize the benefits of science and tech-

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nology education. From the government's perspective, fostering basic scientific literacy and developing scientific thinking abilities should start from an early age for every child. The aim is to create a new classroom teaching model that centers on student development and cultivates innovative spirit and practical skills. This approach underscores the importance of information technology in quality education and positions science and technology as tools that empower students to understand and explore their world. At each educational stage, suitable forms of technology are employed to fully exercise students' thinking and abilities.

This article categorizes Chinese education into three distinct stages: primary education (elementary school), secondary education (middle and high school), and tertiary education (university/college and above). The paper employs literature analysis, archival research on published policies and regulations, and interviews to examine the present state and policy management of science and technology education.

The remainder of the article is organized as follows: Section 2 presents the literature analysis; Section 3 investigates the status quo (reason analysis) of the application and popularization of science and technology at various educational stages; Section 4 offers corresponding policy management suggestions and city examples for further analysis; and Section 5 summarizes the research and puts forward expectations for the future.

2 Literature Review

The literature on science and technology's role in education, particularly in China, is varied and insightful. These works provide diverse and valuable insights into the field. For instance, Wang (2014) emphasized the importance of modern information technology in science and technology education. He advocated for aligning the tutoring process with the evolving trends in science and technology development, the shifting needs and expectations of teenagers, and accelerating the modernization of science popularization among this demographic. In addition, he underscored the Internet as a pivotal means of information acquisition, with multimedia technology as a potent teaching tool [2].

Li (1996) highlighted the significance of science and technology education in middle school. He provided an extensive overview of the content of science and technology education in middle schools and concluded with four recommendations regarding middle school science and technology education measures, encompassing curriculum system, resource planning, academic construction, and the educational process [3].

In "Several Opinions of Beijing on Further Promoting the Development of University Science and Technology Parks", a government notice, a strategy to promote the development of university science and technology parks in the Beijing area was outlined. It detailed plans to amalgamate different resources to enhance the superior resources of science and technology education in the Beijing area and expedite the construction of a market-oriented, industry-university-research-combined innovation system in the capital region [4]. The Beijing Municipal Committee, along with relevant departments, formulated guidelines and recommendations detailed in the notice, emphasizing the encouragement of scientific research projects and financial support.

Li and Wang (2019) posited that refining the academic norms system of universities is a vital step in managing graduate students' academic misconduct [5]. They analyzed the academic misconduct governance texts of 38 universities, identifying common issues and substantiating the shortcomings with extensive data. The authors concluded their article with numerous improvement suggestions.

In a comparative analysis, Deng et al. (2020) examined the handling methods of academic misconduct in 42 colleges and universities [6]. They argued that proactive responsibility in aspects such as prevention, investigation, and identification contributes to mitigating academic misconduct.

3 Current Integration of Technology in Education

3.1 Primary Education Stage

Modern information science and technology become deeply integrated into learning and daily life [2]. The most direct application of science and technology in elementary schools is the introduction of computer courses. Although the information technology curriculum in China's primary education was initiated in 1981, for the subsequent decade, computer courses remained flexible general subjects, present only in adequately equipped schools, primarily located in key cities like Beijing and Shanghai.

However, post-2008, the use and popularization of technology began to proliferate in China's primary education stage. More schools acquired the equipment and faculty resources for computer classes, though these were restricted to less than an hour per week for students in the third grade and above. Simultaneously, the information technology teaching materials and curriculum system was incomplete and lacked relevance and resources suitable for primary schools.

The government and relevant departments have emphasized that enabling students to understand and master basic information technology knowledge and skills can stimulate their interest in learning, fostering their ability to collect, process, and apply information, thus laying a robust foundation for future stages. In recent years, numerous guidance notices and ordinance requirements issued by the government and the Ministry of Education have led to wider coverage of computer courses in Chinese primary schools, accompanied by a steady flow of course materials.

Since 2015, China has developed a variety of science curricula for enlightenment education, with course types spanning several forms, such as computer programming, robot assembly, and electronic building blocks. A growing number of societal enterprises are venturing into primary technology courses, aiming to foster children's curiosity from an early age and integrate technology education through exploration and play. These courses are both engaging and impactful. Currently, there are numerous training institutions, and the average cost of a one-hour class in first-tier cities is approximately 150 RMB.

Starting in 2020, the Chinese government began a comprehensive rectification of the training class industry, which had become a significant sector in China, encompassing hundreds of entrepreneurs starting businesses, applications, educational technology platforms, test subject score training, hobbies, and special skills. The expenditure on off-campus programs created a high stress and financial burden for many families. Although the science and technology enlightenment courses were introduced with good intentions, the acceptance ability of elementary school children is limited, and the quality and duration of the entire training class require improvement.

3.2 Secondary Education Stage

The power of science and technology is deeply intertwined with the learning process, particularly in middle school and high school, where laboratories and experimental tools are commonplace. However, the utilization rate of these resources by students is questionable. In one semester, most students have no more than three lectures in the laboratory, spending the rest of their time in the classroom. Strengthening science and technology education for middle school students holds significant practical importance for the development of productivity [3].

Secondary education science and technology education primarily manifest in students' interest in science and technology experiments and their participation in school associations. Unfortunately, many schools do not prioritize the development of clubs, and school leaders often overlook non-examination subjects, resulting in a limited scope for club activities. Furthermore, many students engage in examination courses outside of class or on weekends, which limits their time to interact with and experience science and technology. Laboratory access is often reserved for teachers and competing students, making it a rare opportunity for average students. Insufficient funding in some schools can result in a lack of science equipment, materials, or tools, and in some impoverished areas, the concept of a laboratory is virtually unknown.

A variety of science and technology competitions are available for secondary education students in China, organized at the national, city, and district levels. These extracurricular competitions, approved by the Ministry of Education and coordinated by national associations of related organizations and departments, provide a platform for students to showcase their scientific literacy. The competitions span a wide range of topics, including radio testing, computer programming, robot comprehensive skills competition, robot creativity competition, artificial intelligence innovation challenge, and others. In recent years, science and technology competitions have served as an additional benefit for some students seeking admission to colleges and universities. The most renowned projects include the "China Adolescents Science & Technology Innovation Contest (CASTIC)", "The Awarding Program for Future Science Prize", "China Adolescent Robotics Competition (CARC)", and "International Olympiad".

Currently, the science and technology competition for secondary education students has reached a significant stage, with the most notable change being the continuous increase in the number of participants. However, various issues have emerged, such as whether the competition delays test results and whether the resources and environment for preparing for science and technology competitions are unfairly distributed.

3.3 Tertiary Education Stage

In tertiary education, students already possess fundamental scientific literacy and knowledge and exhibit greater autonomy in the application of technology. However, this autonomy can sometimes lead to misuse of technology. Recently, new technologies like AI chatbots are introducing ethical concerns around academic misconduct at the tertiary level. In November 2022, "Chat Generative Pre-trained Transformer (ChatGPT)", an AI chat robot program, entered the market. ChatGPT can generate academic papers and complete assignments, leading some educators to prohibit its use over academic integrity concerns [7]. They argue it could enable student cheating and educational inequity.

However, banning new technologies entirely may not be the solution. While research relying solely on AI has limitations in accuracy and context, no single educational method can replace another. Human development remains inseparable from technological application. Rather than blanket bans, academic misconduct requires better regulations as emerging technologies are adopted. As this is a new area, rules governing appropriate use are still being developed and perfected [5].

Moving beyond ethical issues, the application and popularization of science and technology are otherwise flourishing at the tertiary education stage in China. Back in January 1956, the government issued a call and a development plan to expand technology education. That same year, Harbin Institute of Technology became the first to enroll computer science students, with Tsinghua University establishing its first computer major shortly after in July. In the subsequent decades, the government and relevant departments have continued expanded science and technology majors. They have also increased the master's and doctoral research projects in these fields.

Despite China's huge market size and abundant labor resources in scientific and technological research, it still faces some challenges. These include a lack of high-technology talent, the need for strengthened management in the cultivation and attraction of talent, and uneven and inadequate performance in the allocation and management of scientific research funds. In addition, many institutions grapple with issues such as insufficient funds, less convincing results, and outdated equipment. Indeed, the application and popularization of science and technology, while flourishing at the tertiary education stage in China, present a unique set of challenges. These need to be understood and considered in the context of the evolving educational landscape.

4 Recommendations to Improve Technological Integration

4.1 Advancing Technological Integration in Primary Education

To enhance science and technology education at the primary level, it is suggested that society should foster a stronger cooperative relationship between enterprises and schools. This could involve utilizing existing resources in the social environment to provide science and technology educational materials for primary school students. For instance, course activity plans could be established, blending school standard requirements with external teaching at science education bases and technology museums, and other similar venues in an extracurricular context.

In addition, the organization of science popularization activities might develop the scientific understanding and hands-on skills of primary school students. In Beijing, the "Blue Sky Project" provides additional educational methods, encouraging children to seek knowledge beyond their classrooms. These students can visit museums and engage with modern facilities.

Practical projects, which can stimulate children's curiosity, can lead to more effective learning than traditional lectures. The government might also consider integrating off-campus training institution resources into school curriculums, offering elective classes and interest-based courses.

The transformation of science and technology enlightenment classes into a new type of popular science teaching tool could intersperse scientific knowledge into primary school education in an interesting, informative, innovative, and interactive manner through various forms of expression [8]. This method could lead to the continuous use of technological education resources and might reduce the financial strain of extracurricular tuition fees on families.

4.2 Improving Technological Application in Secondary Education

The opinions and reform guidelines issued by the Chinese government and the Ministry of Education have deeply influenced educators, promoting technological innovation and educational reform. The science and technology competition for secondary education students serves as an important driving force for technology application. In terms of the competition's reach, the government should actively support its generalization, aiding more students to understand the competition and affording them the opportunity to engage with technology.

The government and financial departments should enhance publicity and invest funds in school laboratories and competitions. Given the significant educational gap between urban and rural areas in China, the government might consider forming cooperative school groups to implement one-on-one learning assistance programs, ensuring that students have equal opportunities to access educational resources. Participation in competitions requires not only scientific knowledge but also fundamental opportunities and resources.

In addition, schools should pay more attention to the activities of science and technology clubs for middle and high school students, utilize existing school resources effectively, and prioritize student development. Through these activities, students can gain a deeper understanding of concepts not found in textbooks [9]. School leaders should also manage funds appropriately to fully guarantee the allocation of basic scientific and technological research in secondary education schools.

4.3 Enhancing Technological Use in Tertiary Education

Regarding academic misconduct, tertiary education in China needs to assess the merits and drawbacks of the current teaching model, evaluate objectively the developments and challenges that science and technology bring to education, and manage to adopt beneficial aspects and discard unhelpful elements. Enhancing regulations and rules can assist schools in raising awareness, placing greater importance, and taking appropriate measures to address academic integrity issues. For instance, Order No. 40 of the Ministry of Education stipulates that schools should formulate rules and measures for investigating and handling academic misconduct based on their actual content [6].

All universities should also reinforce students' training and learning on scientific and technological research patents and academic ethics, aiming to form a long-term publicity and education model. When resolving academic misconduct incidents, the faculty and department should adhere strictly to relevant process steps to ensure fairness. Simultaneously, the school must safeguard appropriate information privacy, protecting the identities of the involved personnel to uphold their rights and interests.

Moreover, research funding is a crucial enabler of technological innovation. The government must increase its investment in scientific research, bolstering the management and oversight of research funds. Education funding is a key financial consideration in China [10]. The government can augment financial support through various channels and resources and encourage private enterprises and all sectors of society to back and invest in technological innovation.

Finally, it's necessary to avoid issues such as insufficient scientific research funding, dispersed efforts, short research cycles, lack of focus, and a decline in the level of scientific and technological achievements. When allocating funds or assistance, the government should also prepare planning and process supervision to ensure that all funds flow into scientific research projects. In regional allocation support, it is necessary to provide effective and orderly support, following the management system according to the scope and process. As for focus, the relevant departments should distinguish between primary and secondary and strengthen overall planning and coordination to avoid division and repeated use of funds.

5 Conclusion

The rapid advancement of science education aims to fuel educational innovation and the development of Chinese education, ushering in novel requirements and challenges across different stages. The knowledge level and structure of educators, influenced by the degree of scientific development, directly impact their decision-making in the selection of educational content and methods and affect the government's understanding of educational development and the setting of the capacity of the educational mechanism. Presently, the application and popularization of technology touch every school and every child's learning environment. Students, whether in or out of school, can engage with various forms of technology that accompany their learning and growth. In essence, the application of science and technology has brought a new dimension to the Chinese educational structure.

The government must establish a more robust structural system and guidelines for the development of science and technology education. Both government and schools should strengthen basic theoretical research in science education. They must also enhance the relevant science education curriculum system and manage resources both inside and outside the school to maximize educational use across all stages. Furthermore, the government should ensure technological access and fairness for every student in China. It should also provide students with diverse channels and opportunities to utilize technology correctly. Transitioning the application and popularization of science and technology to tangible scientific and technological achievements should be the upcoming goal for the Chinese government and education system.

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