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REFLECTIONS AND EXPLORATIONS ON THE ADDITIVE STRATEGIES IN SCIENCE EDUCATION IN GUANGDONG PROVINCE UNDER THE "DOUBLE REDUCTION" POLICY

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ABSTRACT
Under the framework of the "Double Reduction" policy, additive strategies in science education have become a vital pathway to enhance educational quality. This paper examines the current state of science education in Guangdong Province and explores the challenges and opportunities in policy guidance, teacher training, and curriculum reform. We propose a personalized teaching approach based on the theory of multiple intelligences, emphasizing the importance of interdisciplinary integration and practical activities. The study reveals that Guangdong has made preliminary progress in science popularization and teacher development; however, it still faces issues such as a shortage of science teachers and insufficient research. To advance high-quality development in science education, it is essential to strengthen policy support and integrate educational resources, enhancing teachers' professional competencies and research capabilities to achieve a comprehensive improvement in scientific literacy.

KEYWORDS: *Science Education; New Curriculum Standards; Teaching Practice*

1. INTRODUCTION
Science education serves not only as a core mechanism for cultivating innovative and practical talent essential for national development but also as a critical safeguard for enhancing the country's future innovation capabilities and international competitiveness. Against the backdrop of rapid globalization, the significance of science education has become increasingly prominent, emerging as a key driver of social progress and economic development. In recent years, China has significantly strengthened policy support and financial investment in the field of science education, aiming to effectively nurture and guide future talent. Notably, in September 2020, President Xi Jinping emphasized at a symposium with scientists that "guiding and fostering scientific interest should begin from an early age, enabling youth to better understand scientific knowledge, master scientific methods, and form a large cohort of young people with the potential to become scientists" (China Association for Science and Technology, 2020). This critical statement provides both a theoretical foundation and practical direction for the comprehensive development of science education. In this context, President Xi further proposed in 2023, amid the implementation of the "Double Reduction" policy, an "additive" approach to science education, advocating for resource integration and optimized teaching to enhance the quality and efficiency of science education (Ministry of Education of the People's Republic of China, 2021). This series of policies underscores the importance of science education within the modern educational system, aiming to cultivate highly skilled talent with innovative and practical capabilities. Therefore, this paper aims to reflect on and explore the current state of science education in Guangdong Province, analyzing the present challenges and opportunities, and proposing feasible recommendations for science education practices to offer valuable insights and guidance for advancing this field (Sun, 2010).

Through an analysis of the current situation in Guangdong's science education, we will explore specific issues and solutions in the areas of policy implementation, teacher professional development, and curriculum reform. Moreover, aligning with the principles of the new curriculum standards, we will propose how innovative practices such as scientific inquiry and interdisciplinary integration can be effectively incorporated into teaching to enhance students' scientific literacy and practical skills. We believe that such efforts can provide valuable insights for the science education reforms in Guangdong and throughout China, ultimately contributing to the high-quality development of science education nationwide (Yue, 2024).

2. SCIENCE EDUCATION ADDITIONS UNDER THE "DOUBLE REDUCTION" POLICY
In February 2023, President Xi Jinping explicitly stated during the third collective study session of the Politburo of the Communist Party of China Central Committee that "science education additions should be effectively implemented within the context of the 'Double Reduction' policy" (Communist Party Member Network, 2023). This critical directive indicates that,

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within the implementation of the "Double Reduction" policy, science education additions are not only a proactive response to educational policies but also a strategic measure to enhance educational quality and equity. The primary aim of the "Double Reduction" policy is to effectively alleviate the excessive academic burden on students and work toward reducing inequalities in educational resource allocation. However, in the context of rapid global technological development, China's pursuit of goals such as building a strong nation in education, science, and talent still faces significant challenges in science education. Specifically, the current foundation of science education in China is relatively weak, with regional disparities, unintegrated resources, limited teaching staff, and insufficient practical instruction. Moreover, mechanisms for the early identification and cultivation of high-caliber, innovative talent remain underdeveloped, and these issues urgently require attention and improvement. To support the nation's high-quality development, science education additions within the "Double Reduction" policy framework are crucial. International experience suggests that a technologically advanced nation must proactively promote science education from the elementary level to cultivate students' scientific literacy and innovative thinking, strengthening their practical abilities and enhancing their interest in scientific experiments. Science education is not only a driving force for national technological innovation and sustainable development; it also serves as a critical foundation for enhancing national technological competitiveness, cultivating innovative talent, and improving the scientific literacy of the general population. This series of initiatives will provide a solid foundation for China's future technological competitiveness and create favorable conditions for the comprehensive improvement of scientific literacy and innovation capabilities (Ren, 2023).

2.1 Policy-Guided Educational Direction

At the national policy level, several significant policy documents, such as *The Action Plan for Improving National Scientific Literacy (2021-2035)*, *Notice on Strengthening Primary School Science Teacher Training*, and *Opinions on Enhancing Science Education in Primary and Secondary Schools in the New Era*, have been released, laying a solid foundation for the development of science education and providing robust policy support. These documents underscore the government's emphasis and investment in science education, reflecting its determination and strategic clarity in promoting the improvement of scientific literacy and the cultivation of innovative talent. Among them, *Opinions on Enhancing Science Education in Primary and Secondary Schools in the New Era* (referred to as the *Opinions*) was jointly issued by the Ministry of Education and eighteen other departments, aiming to comprehensively implement President Xi Jinping's significant speech during the third collective study session of the 20th Politburo. This document provides systematic guidance on effectively implementing science education additions within the "Double Reduction" policy, supporting and promoting the high-quality, integrated development of education, science, and talent (Ministry of Education of the People's Republic of China, 2023). The goal of this comprehensive deployment document specifically tailored for primary and secondary science education in the new era is to address the needs of current technological development and industrial transformation.

The *Opinions* document seeks to strengthen and optimize various aspects, including curriculum materials, experimental teaching, teacher training, practical activities, and resource provision, aiming to integrate resources within and beyond the school to facilitate the organic connection between the school's primary educational space and the broader societal learning environment. The core objective of this policy is to elevate students' scientific literacy and nurture a cohort of young people with scientific potential who are committed to scientific research careers. The language of the policy indicates that it primarily targets primary and secondary education, emphasizing the importance of top-level planning to optimize the design and structure of the science education system. The policy advocates for strengthening science education research to achieve the goal of cultivating innovative talent, while also emphasizing multi-stakeholder collaboration and diversified development. However, it is noteworthy that science education in China is still in its early stages; although many policies embody commendable visions and goals, they face numerous challenges in practical implementation. Thus, the effective implementation of science education additions requires practical exploration and validation to ensure that policy measures are genuinely effective and impactful. To this end, educational administrative bodies, schools, and relevant research institutions should strengthen collaboration to advance systematic research and practice in science education, thus realizing the practical conversion of policy objectives and laying a solid foundation for the sustainable development of science education in China.

2. 2 Theoretical Foundation of Science Education Additions in Multiple Intelligences Theory

Within the framework of the "Double Reduction" policy, the concept of science education additions is not merely a positive response to existing educational policies but also a profound application of Howard Gardner's theory of multiple intelligences. This theory highlights the multidimensional nature of human intelligence, encompassing areas such as linguistic intelligence, logical-mathematical intelligence, spatial intelligence, bodily-kinesthetic intelligence, interpersonal intelligence, intrapersonal intelligence, musical intelligence, and naturalistic intelligence (Gardner, 1983). Therefore, science education should focus on each student's unique combination of intelligences, facilitating personalized teaching to meet diverse learning needs. This student-centered educational approach not only helps to stimulate students' learning interest but also promotes their comprehensive development, thereby establishing a solid foundation for cultivating innovative talent (Xu, 2023).

In practical teaching, teachers can effectively apply the core ideas of multiple intelligences theory by implementing personalized

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instruction and interdisciplinary integration. For example, after assessing students' intelligence types, teachers can design a variety of learning activities. Students with strong logical-mathematical intelligence may benefit from additional components like experiment design and data analysis to enhance their logical thinking skills, while students with prominent bodily-kinesthetic intelligence might engage more in hands-on activities and practical experiments to boost their learning engagement. This approach of teaching according to individual aptitudes allows each student to achieve optimal learning experiences in environments that match their intelligence profiles. Additionally, integrating subjects such as arts, music, and physical education through comprehensive projects can not only enrich students' learning experiences but also foster their creativity and aesthetic skills. Such interdisciplinary integration aims to inject new vitality into science education, enhancing students' overall competencies and cultivating their multifaceted abilities (Ran, 2024).

It is worth noting that multiple intelligences theory also emphasizes the importance of experiential learning and cooperative interaction. In science education, particular attention should be given to hands-on practice and experimental exploration, encouraging students to solve problems in real-world contexts. This approach not only enhances students' naturalistic intelligence and bodily-kinesthetic intelligence but also strengthens their scientific inquiry skills (Lave & Wenger, 1991). Through collaborative group learning, students share perspectives and experiences in an interactive setting, cultivating teamwork and communication skills. This cooperative learning model not only deepens students' understanding of scientific knowledge but also instills a sense of social responsibility and engagement, creating favorable conditions for the future implementation of science education.

Therefore, multiple intelligences theory provides a solid theoretical basis and practical framework for the "additions" in science education, fostering comprehensive development and innovation among students. As Gardner stated, "The purpose of education is not merely to convey knowledge but to cultivate individuals who can adapt to the demands of a future society" (Gardner, 1993). This concept supports the nation's mission to cultivate future scientists and innovative talent, thereby contributing to China's long-term goals in technological innovation and educational modernization (Gao, 2024).

3. INITIAL FORMATION OF A COMPREHENSIVE SCIENCE POPULARIZATION FRAMEWORK IN GUANGDONG PROVINCE

As a leader in China's educational reforms, Guangdong Province has continuously implemented relevant national policies, aiming to explore feasible ways to enhance science education additions within the "Double Reduction" framework, while promoting the integrated development of high-quality education, science, and talent cultivation.

3.1 Nationwide Science Popularization Showing Initial Results

The advancement of science education in Guangdong Province has benefited significantly from supportive policies, particularly the implementation of the *Guangdong Science and Technology Popularization Regulations*. The introduction of these regulations marks a substantial step forward for Guangdong in science popularization. According to the 2020 Chinese Public Scientific Literacy Survey, the proportion of Guangdong citizens with scientific literacy reached 12.79%, surpassing the national average of 10.56% and ranking sixth nationwide, though still trailing economically developed regions such as Shanghai, Beijing, Tianjin, Jiangsu, and Zhejiang (China Association for Science and Technology, 2021). To close the gap with these leading regions, Guangdong issued the *Guangdong Science and Technology Popularization Regulations* in 2021 (People's Government of Guangdong Province, 2021), outlining future directions and goals for science popularization, with a particular emphasis on strengthening foundational infrastructure. The regulations aim to achieve full coverage of science and technology facilities in all 21 prefecture-level cities and to establish campus science museums (or rooms) across eastern, western, and northern Guangdong. These initiatives provide richer science education resources for young students, enabling more children to access high-quality science education close to home, thereby enhancing their scientific literacy.

Beyond infrastructure, Guangdong also plans to establish a provincial science popularization group and gradually develop a provincial science popularization joint conference system led by the provincial government to more effectively coordinate and advance various science popularization activities. Additionally, the provincial government will invest in building the "Yue Science Popularization" digital public service platform and introduce a series of policies to encourage the development of the science popularization industry, aiming to create a win-win situation for both public-interest science popularization and market-driven science popularization industries (Guangdong Provincial Department of Science and Technology, 2023). These measures provide a solid foundation for the development of science education in Guangdong, creating more and better resources and opportunities for science education for young people. Leveraging its strong economic base, Guangdong strives to close the gap with other advanced regions domestically, seeking further breakthroughs in science education and cultivating future technology talents with innovative skills and scientific literacy. Since the implementation of the regulations, as of 2023, information from the Guangdong Provincial Department of Science and Technology indicates that a comprehensive science popularization framework in Guangdong has largely taken shape. By integrating resources and adopting innovative approaches, Guangdong has diversified its science popularization efforts and enhanced public scientific literacy, with initial results seen in its nationwide scientific literacy campaign. Statistical data show that in 2022, the proportion of citizens in Guangdong with

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scientific literacy rose to 14.8% (Guangdong Provincial Department of Science and Technology, 2023), demonstrating the effectiveness of policy implementation and laying a solid foundation for the future development of science education.

3.2 Urgent Need to Address the Shortage of Science Education Teachers

A key to strengthening science education lies in having a qualified teaching workforce. However, there remains a significant gap in both the quantity and quality of science teachers in China. According to statistics from the Ministry of Education, the total number of dedicated science teachers in primary schools nationwide grew by 35.3% from 2012 to 2022. Nevertheless, by 2022, there were only 240,000 science teachers nationwide, with an average of 1.61 science teachers per school, which is clearly insufficient. Many regions in China still face a shortage of dedicated science teachers in primary and secondary schools. For instance, a survey conducted at the 2023 "National Science Education Summer School" hosted by South China Normal University (SCNU) across Guangdong, Hainan, and Guangxi revealed a phenomenon among primary science teachers described as "two lows, one high, and three confusions": a low proportion of specialized science teachers, low professional teaching proficiency, high demand for professional training, and confusion about effectively implementing science education. The survey results showed that only 15.14% of surveyed primary science teachers were dedicated science teachers, with the majority serving as part-time teachers from other disciplines, and over two-thirds of them having a humanities background. Approximately 60% of respondents indicated that science classes lacked necessary scientific knowledge and experimental materials, and nearly 80% expressed an urgent need for training in scientific and interdisciplinary knowledge (Southern Plus, 2023). This shortage of professional science teachers and the lack of relevant expertise and training severely restrict the effective implementation of science education, especially in (1) effective pathways for delivering science education; (2) science class design; and (3) methods for interdisciplinary teaching (Yang, 2024).

The shortage of science teachers is a result of multiple factors. Firstly, the lack of adequate recognition of the importance of science education in current educational policies and society directly affects the recruitment and training of science teachers, with insufficient supporting measures in place. Many higher education institutions have weak science education programs within teacher training, lacking systematic training and practical opportunities to meet the demand for high-quality science teachers. Secondly, the attractiveness of science teaching as a profession is generally low, especially in rural and remote areas. Issues such as salary levels, career development prospects, and living conditions fail to attract top talent, leading many potential science teachers to shift to other industries, exacerbating the shortage. Additionally, the professional competence of existing teachers needs improvement; many long-serving teachers from other subjects lack the scientific expertise and practical experience necessary to teach science effectively, impacting their ability to deliver quality science education. Finally, the absence of a comprehensive teacher training system also contributes to this issue (Zhu, 2022). Although some science teacher training programs are currently available, they often lack specificity and systematic design, failing to address the actual issues teachers encounter in their teaching practice. Therefore, to effectively alleviate the shortage of science teachers, a multifaceted approach is required, including strengthening policy support, enhancing the profession's attractiveness, improving teacher training mechanisms, and establishing a scientific training system to ensure the sustainable development of science education (Chen, 2021).

4. ADDRESSING THE RELATIVE DEFICIENCY OF RESEARCH IN THE FIELD OF SCIENCE EDUCATION

On the other hand, Guangdong Province's research in science education remains relatively underdeveloped, underscoring a pressing need for increased focus and emphasis in this field. To gain an in-depth understanding of the state of science education in Guangdong, this study selected “Guangdong” and “science education” as search keywords for journal articles in CNKI. Based on the search results, a total of 45 articles were identified. The study employs bibliometric analysis on these articles to reveal the extent to which educators and researchers have previously examined issues related to science education in Guangdong, thereby providing new perspectives and references for the future development of science education.

Figure 1 illustrates that research on science education in Guangdong has shown an upward trend since 2002, but the overall volume remains limited, with the highest annual publication count being only four articles, a number that has stagnated. This indicates that the research conducted by educators and researchers in Guangdong on science education is insufficient in both quantity and focus. Therefore, more robust attention and efforts are needed in this area. Specifically, although there have been some research outputs in recent years, Guangdong’s academic production still lags behind other provinces in the national context, which could potentially impact the formulation and implementation of science education policies and, to some extent, limit improvements in the quality of science education. Conducting more systematic, in-depth research on science education, particularly in areas like teacher training, curriculum reform, and academic exchange, will establish a solid foundation for the long-term development of science education in Guangdong. Enhancing the quality and quantity of research will also help establish an academic voice in Guangdong’s science education, allowing a more effective response to the educational reform requirements under the "Double Reduction" policy.

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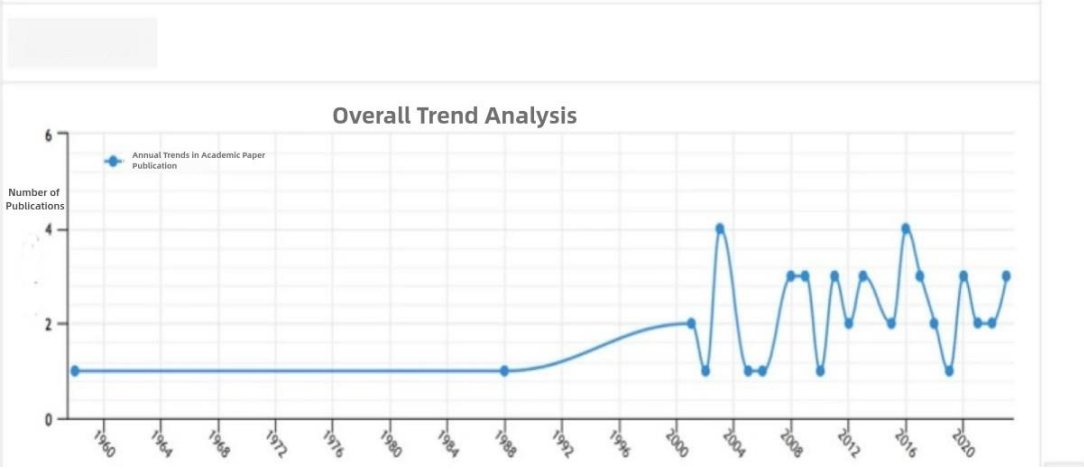


Figure 1. Annual Trend in Journal Publications on Science Education in Guangdong

Through thematic analysis of the 45 identified articles (as shown in Figure 2), it was found that 25.93% of the research focuses on science education itself. Additionally, 11.11% of the studies explicitly set “Guangdong Province” as the research context. This data shows that although science education research in Guangdong is gaining attention, the overall research focus is still limited. Notably, themes like "school-museum collaboration", "science centers", "scientific literacy", and "primary science education" have emerged, highlighting the province’s emphasis on promoting science education through school programs, science museum education, and public science centers. This trend suggests that science education extends beyond classroom instruction, encompassing diverse forms of education aimed at comprehensively enhancing students' scientific literacy. School education is widely regarded as the primary means by which students gain systematic and comprehensive science education; thus, exploring ways to leverage primary and secondary science curricula, combined with integrated practice activities and social resources, to enhance students’ scientific literacy and innovation skills has become a critical topic. Integrated practice activities not only effectively promote students' practical skills but also stimulate their inquiry and creativity, which is essential for cultivating future scientific talent. The school-museum collaboration model provides abundant resources and a broader perspective for science education, allowing students to experience the joy of science and foster an interest in it through hands-on exploration. For this reason, science education researchers and practitioners should actively explore diverse teaching models and strategies to drive innovation and development in science education, addressing current educational reform challenges while supporting the comprehensive development of students and nurturing scientific thinking (Ma, 2024).

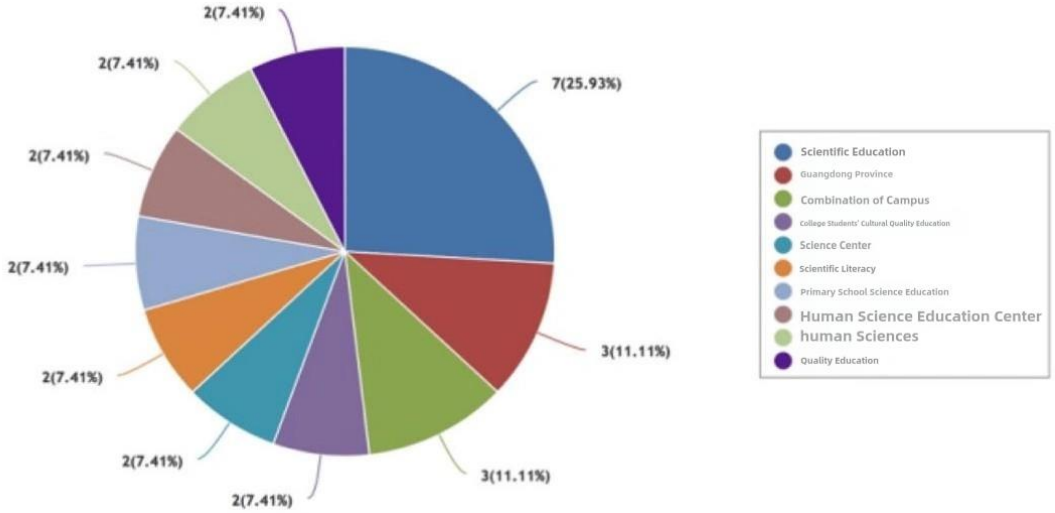


Figure 2. Major Themes in Journal Publications on Science Education in Guangdong

To preliminarily understand the research focus within Guangdong's science education field, this study conducted a word frequency analysis of the titles, keywords, and abstracts of relevant literature. Figure 3 shows that the two primary research emphases in Guangdong's science education are "science popularization" and "technology". This finding highlights the importance of science popularization (science outreach) and technology education in enhancing students' scientific literacy, reflecting educators’ and researchers’ concern with the effectiveness of science education. The primary subjects of

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research are students (mainly adolescents) and teachers, indicating an emphasis on improving students' scientific abilities and enhancing teachers' instructional competencies. The research primarily revolves around two key areas: (1) How to enhance students' scientific literacy, fostering their innovation and practical skills. Improving scientific literacy is regarded as a crucial goal of modern education, not only involving students' understanding of scientific knowledge but also equipping them with the ability to apply scientific knowledge to solve real-life problems. Researchers are dedicated to exploring various teaching methods and practice activities to spark students' interest, encourage initiative in scientific inquiry, and cultivate creativity. (2) Exploring models and resource coordination (e.g., school-museum partnerships) to support students' high-quality development, meeting the demands of a quality-oriented education in the modern era. This research direction emphasizes the integrated use of educational resources, especially the collaboration between schools and science museums, to enrich students' practical experiences and create diverse learning environments that promote holistic student development. These research priorities reflect the current research trends in science education in Guangdong and provide valuable theoretical foundations and practical guidance for future reforms and practices in science education in the context of the new era.



Figure 3. Word Frequency Analysis of Themes in Journal Publications on Science Education in Guangdong

Currently, Guangdong has seen initial success in advancing science education additions within the framework of the "Double Reduction" policy. However, the lack of systemic guidance and unified standards remains, especially in terms of research on school-level science education. Specifically, the training of science teachers and related educational research require strengthening, as this gap could potentially impact the overall quality and developmental potential of science education. Practical policies and measures will positively influence the quality development of science education additions in Guangdong. To effectively guide frontline teachers in advancing science curriculum reforms at the primary and secondary levels, the Ministry of Education released the new *Compulsory Education Science Curriculum Standards (2022 Edition)* in March 2022 (referred to as the "New Curriculum Standards") (Ministry of Education of the People's Republic of China, 2022). These standards not only provide clear directions and guidelines for science education but also include teaching philosophies and practical suggestions, offering theoretical and practical support for teachers in their teaching processes. Considering the current state of science education research in Guangdong, studying and understanding the principles and recommendations of the New Curriculum Standards will help align with the trends in science education during the compulsory education phase. For example, the New Curriculum Standards emphasize student-centered teaching approaches, advocating for inquiry-based learning to inspire students' interest and creativity, which aligns closely with Guangdong's current education reform objectives. An in-depth

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analysis and understanding of the characteristics and changes in the New Curriculum Standards will provide practical insights for educators, enabling them to address various teaching challenges more effectively. Therefore, the following sections will further explore specific methods of implementing science education additions, taking into account Guangdong's current state of science education and the New Curriculum Standards. These discussions aim to offer practical teaching strategies for frontline teachers and establish a solid foundation for the sustainable development of science education in Guangdong (Xie, 2014).

5. REFLECTIONS ON TEACHING PRACTICES IN LIGHT OF THE NEW SCIENCE CURRICULUM STANDARDS

From a literature analysis perspective, previous research in Guangdong's science education has primarily focused on science popularization, with limited studies addressing school-level science education. However, the new curriculum standards explicitly establish the goal of science education as cultivating students' core competencies. Through curriculum learning, students are expected to understand fundamental scientific concepts, principles, and methods, thereby helping them form scientific perspectives. In problem-solving and practical applications, the curriculum should develop students' hands-on and scientific research skills, stimulating their curiosity and scientific thinking. Additionally, the new standards emphasize problem-based and interdisciplinary approaches, aiming to closely link scientific knowledge with real-world issues to foster students' scientific attitudes and sense of responsibility. In this context, school-based science education becomes an essential pathway for students to form systematic and comprehensive scientific perspectives, thought processes, and attitudes (Sang, 2024).

Thus, the following section offers recommendations for teaching practices in primary and secondary education, addressing an area that has been relatively lacking in Guangdong's science education research. The cultivation of core competencies as emphasized in the new standards centers on scientific perspectives, scientific thinking, inquiry and practice, and a sense of responsibility. Learning these competencies can help students develop interdisciplinary concepts while enhancing their inquiry and practical skills. Students must engage both mentally and physically, combining learning with reflection, and effectively integrating theory and practice through hands-on tasks. In daily science education, we can adhere to the following principles to cultivate students' core competencies (Yi, 2024).

The principle of combining hands-on and intellectual engagement promotes inquiry-based teaching, a significant aspect of the new curriculum standards, emphasizing that students should engage in observational, experimental, and inquiry activities to develop their scientific thinking and spirit of exploration. Teachers' roles shift from traditional knowledge transmitters to guides and facilitators, encouraging students to think critically and solve problems. Scientific inquiry skills are foundational to scientific understanding and attitudes; students can effectively undertake scientific inquiries, test hypotheses, and, in doing so, form appropriate scientific attitudes and perspectives only when they comprehend the underlying concepts (ASE Education Group, 2018).

The integration of knowledge and action through social practice is another critical component emphasized by the new standards. These standards encourage students to explore and address real-world issues through social practice activities. Through this process, students learn how to apply scientific knowledge and methods holistically and to focus on societal issues, thereby developing a sense of social responsibility and innovation. Social practice, grounded in real-life contexts, not only improves students' problem-solving abilities but also provides opportunities for cross-disciplinary learning and interdisciplinary thinking (Ministry of Education of the People's Republic of China, 2022).

The new standards also advocate for conceptual transformation and diverse assessment methods. The standards encourage the use of a variety of assessment forms, such as lab reports, group projects and presentations, and scientific papers, stressing formative and performance-based assessments. Through diversified assessments, students' scientific literacy, practical abilities, and innovation skills can be thoroughly evaluated, with a specific emphasis on assessing inquiry skills in science. Teachers can evaluate learning and student performance across multiple dimensions, including learning outcomes, student engagement, interpretation, exploration, creation, assessment, and planning (Mang et al., 2023).

Keeping pace with the times by strengthening teaching in technology and engineering is also a major direction of the new curriculum standards. These standards encourage students to utilize information technology and engineering knowledge in scientific practice and research, including using simulation software, lab instruments, online resources, and model design. By employing these technologies, students gain easier access to scientific knowledge and come to understand the impact of digital and engineering technologies on individuals and society, equipping them with related technical skills, scientific thinking, and improved practical and innovative abilities (Department for Education, 2015). Thus, future science education should focus on comprehensive scientific capabilities, incorporating technology and engineering practices into learning tasks.

Another essential aspect emphasized by the new standards is developing sustainable perspectives through environmental education. Activities in ecological studies, ecological practices, and ecological projects aim to enhance students' understanding of environmental protection. Environmental education should begin from students' everyday life contexts, exploring environmental issues and their solutions to develop students' problem-solving

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skills and foster their civic responsibility and global outlook (Fraser et al., 2013).

In the context of the "Double Reduction" policy and considering the current state of science education in Guangdong, this paper reflects deeply on teaching practices in science education. From the perspective of the new curriculum standards, Guangdong's science education teaching practices can be enhanced through various forms of scientific inquiry and hands-on activities to cultivate students' scientific thinking, practical skills, and innovative spirit. Such practices enable students to apply scientific knowledge and methods to solve real-world problems and engage with social development and environmental protection (Zhang, 2018).

FUNDING PROJECTS

2024 Zhaoqing Philosophy and Social Sciences Planning Project: "Research on Collaborative Mechanisms for Science Popularization in Rural Primary Schools from the Perspective of New Productive Forces—A Case Study of the Zhaoqing Region". [14th Five-Year Plan for Zhaoqing Philosophy and Social Sciences, Project Approval Number: 24GJ-37].

2024 Key Education Research Project of the Zhaoqing Institute of Educational Development: "Research on the Current Status of Science Popularization Education in Rural Primary Schools in the Zhaoqing Region". [Project Approval Number: ZQJYY2024023].

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