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The Exploration and Practice of Science-education Integration Between Local Research Institutes and Provincial Universities in China

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Abstract: Science-education integration has become a vital strategy in higher education and a core principle for the high-quality development of world-class universities. The integration between local research institutes and provincial universities not only enhances the training quality of application-oriented talents but also serves the economic and social development of local regions. However, significant differences in functional positioning, funding channels, evaluation criteria, and cultural atmosphere among them pose practical challenges to their integration. To advance this integration, efforts could be put on establishing an integrated management and operation system, implementing a segmented talent cultivation model, introducing the "PI system" in research team organization, and developing a "full-chain" system for translating research outcomes. These gradual reforms will improve institutional mechanisms, unlock development potential, and foster a united force for development.

Keywords: Science-Education Integration; PI System; Full-Chain

With the deep implementation of the national innovation-driven development strategy, the construction of the science and technology innovation system has been improved continuously, unleashing the enthusiasm and creativity of various innovation entities. A variety of new research and invention institutions have emerged rapidly. As two major pillars of regional scientific and technological innovation, local research institutes and provincial universities play an immeasurable role in promoting regional economic and social development. However, due to the influence of the Soviet model, universities and research institutes in China have been set up separately in a long time, which has hindered the construction of the innovation system and the full exertion of innovation synergy to some extent.

The "13th Five-Year Plan for National Economic and Social Development" proposed that "promote the integration of science and education, encourage comprehensive participation of universities, vocational colleges, and research institutes in the national innovation system, and support a group of high-level universities and research institutes in forming interdisciplinary and cross-sector research teams" explicitly in the section of "Optimizing the Innovation Organization System" . Some provinces have taken the lead in exploring science-education integration between local research institutes and provincial universities actively, paving the way for coordinated development and integrated advancement.

1. The Importance of Science-Education Integration Between Local Research Institutes and Provincial Universities

"Science-education integration" is a fundamental aspect of modern universities, and "higher education supported and driven by scientific research" is its core characteristic[1]. The concept of science-education integration was first introduced in the early 19th century at the University of Berlin in Germany, where scientific research was integrated into university education, revitalizing the classical university and transforming it into the modern university we know today. In recent years, both domestic and international scholars have engaged in theoretical discussions and practical explorations of science-education integration, and it has become a reform trend in global higher education systems.

For example, Northwest A&F University established at the end of the 20th century, was

formed through the merger of two universities and five research institutes. Similarly, Paris-Saclay University, founded in 2015, is a union of nine grandes écoles, two public universities, and seven research institutes[2]. These reforms in science-education integration have broadened the development perspective and expanded the reform pathways, providing new avenues for enhancing the innovation capacity of local research institutes and improving the academic standards of provincial universities.

1.1 Science-Education Integration as a Strong Support for Regional High-Quality Development

Local research institutes serve as regional scientific research hubs, while provincial universities are key bases for talent cultivation and technological innovation. Due to their long-standing separation, both have developed independent management and operational systems, leading to issues such as fragmented governance, multiple management, overlapping functions and scattered resources. At this new stage of development, with the goal of fostering innovation-driven growth and building a modern industrial system, it is imperative to promote institutional and systemic innovation between local research institutes and provincial universities. By integrating science and education, these institutions can drive high-quality and modernized development collaboratively.

1.2 Science-Education Integration as a Useful Exploration for Deepening Reforms in the Science and Technology System

As early as 2015, the nation introduced the Implementation Plan for Deepening Science and Technology System Reform, which called for exploring new models of science-education integration and tasked the Chinese Academy of Sciences (CAS) with leading the way. CAS was encouraged to leverage its combined strengths in research, academia, and education to create a uniquely Chinese system for modern national research institutes. Over the years, CAS has adopted innovative measures in talent development, faculty structures, and management systems, providing valuable insights for local research institutes and provincial universities. These experiences help facilitate deeper institutional reforms and further enhance the effectiveness of science-education integration.

1.3 Science-Education Integration as an Effective Measure to Improve Higher Education Quality

In the face of unprecedented global changes and the rapid evolving socio-economic landscape, higher education, especially at the local level, faces increasing competition and challenges. Many provincial universities struggle with limited resources and lack the overall strength to compete. Among the 116 universities affiliated to the central government, 90 have been selected as "double first-class" construction universities, accounting for 77.6%., while out of more than 1,000 provincial universities, only about 50 (roughly 5%) have achieved this distinction. Through science-education integration, the combined strengths of research and education can enhance the overall capabilities of these institutions, providing long-term support for the advancement of the "Double First-Class" initiative.

2. The Practical Challenges of Science-Education Integration Between Local Research Institutes and Provincial Universities

The integration between local research institutes and provincial universities is distinct from the widespread university mergers that occurred in China around the 2000s. Unlike the relative straightforward merging of universities with similar attributes, this type of integration involves the consolidation of two fundamentally different entities, making the process more complex and challenging. The primary challenges they face during the integration process can be categorized into three key areas:

2.1 Significant Differences in Functional Positioning

Local research institutes focus on the industrial and innovation chains, conducting applied basic research, technological development, and the transfer of scientific and technological outcomes primarily. Their core function is to serve as hubs for scientific research and technology development, as well as to train high-level technical talent and promote high-tech industries. In contrast, provincial universities are tasked with educating

specialized talent, advancing scientific knowledge, and serving society. Their key responsibilities include teaching and education, conducting scientific research, and engaging in various forms of social service. These differences in functional positioning lead to distinct priorities: research institutes prioritize technological innovation and the transfer of research outcomes to support regional economic growth and industry transformation. At the same time, universities focus on cultivating well-rounded socialist builders and successors, while also striving to improve discipline construction and fundamental innovation capabilities.

2.2 Significant Differences in Financial Support and Funding Sources

According to the Guiding Opinions of the Central Committee of the Communist Party of China and the State Council on the Reform of Public Institutions by Category in 2011, universities are classified as public welfare institutions. In 2017, Public Institution Reform Plan further clarified that "universities and public hospitals at the county level and above will no longer have staff quotas but will retain their public institution status." The operational funding for universities primarily comes from three sources: fiscal allocation and tuition fees of per-student, competitive research project funding, and donations. The primary funding channels are fiscal allocation and tuition, while competitive research funding is divided into government-sponsored projects and enterprise-sponsored projects. Provincial universities are less competitive than centrally-administered universities and those included in the "Double First-Class" initiative. Social donations also account for a small proportion of funding in most cases.

In contrast, research institutes are generally composed of central administrative bodies and affiliated institutes. Staff at the central administrative bodies are fully funded by the government, with management systems resembling those of civil servants, while the affiliated research institutes operate under a mixed funding system. Basic salaries are guaranteed by government funding, while additional income comes from technological service revenues, consulting, and business incubation. These differences in financial support create distinct working environments and cultural atmospheres. Universities general offer more stability, allowing teachers to focus on teaching and academic preparation. In research, faculty have more freedom to explore new ideas, more productivity will get more reward. On the other hand, research institutes face constant pressure to survive in a competitive environment, characterized by a "wolf pack" mentality. Researchers must compete for resources and ensure that their outcomes align with market needs to generate economic benefits.

2.3 Divergent Evaluation and Assessment Systems

Universities are subject to a multifaceted and complex evaluation system, often with a multi-task orientation. Numerous global rankings, such as the Times Higher Education World University Rankings, assess institutions based on indicators like teaching quality, research output, academic citations and impact, international outlook, and innovation. The QS World University Rankings consider academic reputation, employer reputation, student-to-faculty ratio, citations per faculty member, and international faculty and student ratios, with additional metrics like sustainability, employment outcomes and international studies added in 2024. China's Alumni Association University Rankings measure educational quality based on international impact, national development, and social contribution, with a focus on alumni achievements and academic accomplishments and total of 12 primary indicators are covered. In contrast, research institutes are primarily evaluated based on the effectiveness of their technological innovation. Focus on breakthroughs in critical technologies, addressing bottlenecks, and economic benefits. This divergence assessment leads to significant differences in institutional structures and policy orientations. Universities often face such phenomena as "big pot rice" of performance distribution and "lifetime tenure" of professional titles, where assessments are mainly based on basic research output, such as publications and grants. On the other hand, research institutes operate more like independent corporations, with research teams functioning as subsidiary entities. Team leaders have control over resources, and their performance is measured by applied research outcomes and funding income.

3. Effective Approaches for the Integration of Local Research Institutes and Provincial Universities

Globally, there are four main models of science-education integration. Endogenous Model: Establishing laboratories within universities to serve as research training platforms for graduate students. Embedded Model: Building laboratories near universities, with the university responsible for their management. Collaborative Model: Integrating research institutions and universities to co-build, gaining fresh momentum. Extended Model: Research institutions establishing universities independently[3]. For local research institutes and provincial universities, the integration primarily adopts the collaborative model, leveraging the advantages of both parties to create a combined force for integrated development. The specific implementation paths include the following three key aspects:

3.1 Establishing an "Integrated" Management and Operational Mechanism

The so-called "integration" refers to the concept of "one leadership team, two nameplates, and two functions." Following the integrated development approach, research institutes and colleges with similar disciplines can merge to form new science-education integrated entities. These entities will operate under a single party and administrative leadership group, with a unified middle management structure. Resources will be shared, and high-level talent will hold dual roles as both teachers and researchers, serving the needs of talent cultivation, scientific research, and discipline development jointly. The goal should be to build a "community" for talent cultivation and scientific research by thoroughly integrating systems for personnel, finance, teaching, research, assessment, and oversight. This will provide robust support for creating a platform for integrated science-education development.

In this process, it is essential to understand that integration is not simply a physical merger but a "chemical reaction" that generates substantive outcomes, where the advantages of both scientific and educational resources are combined to create synergistic effects. Furthermore, the original functions of both institutions should be preserved as much as possible, to maintain the unique strengths of each. Otherwise, innovation capacity, particularly within research institutes, may decline. Lastly, integration must not be rushed. It should respect the inherent principles of research and education, through exploration and innovation progressing gradually, improving the governance system and its modernization ultimately.

3.2 Establishing a "Segmented" Talent Development Model

Post-integration, fostering moral integrity and educating people remains the fundamental task, with talent cultivation still at the core. According to the requirements of the development of new engineering, should pay attention to the unique advantages of the integration of science and education, build a carrier of science and education collaborative education, implement the "2+2" segmented training, and establish and improve the basic course system of "general education course + professional basic course" in the first two years, led by the faculty, according to the talent training plan and discipline requirements. In the last two years, the training direction will be determined according to the economic and social needs and academic frontier fields, and the professional curriculum system of "professional-oriented courses + scientific research project training" will be established and improved. Create a distinctive talent training model. The key principles in this process is adhere to the principle of combining science and education, which include integrating the latest scientific research into the curriculum, transforming research platforms into teaching innovation platforms, and using rich research resources to support high-quality education. Small-class teaching methods should be adopted, with more group discussions and inquiry-based, heuristic teaching approaches to stimulate students' creativity and innovative abilities. Moreover, graduate-style training should be employed, with academic advisors assigned to students and opportunities provided for them to join research teams and participate in real research projects, enhancing their practical skills and scientific literacy.

3.3 Establishing the "PI System" for Research Team Organization

"PI" stands for "Principal Investigator," referring to the team leader or academic head.

The PI system is a management mechanism where human resources are organized around the PI, financial resources are allocated based on project costs, and material resources are distributed with an emphasis on research resource sharing. Research institutes have already made significant strides in this area, creating a relative comprehensive research organization system. Universities should fully leverage these valuable experiences.

Firstly, a team-based management system should be implemented. Based on the characteristics of personnel in colleges and research institutes, different teaching and research teams should be formed, team members to self-organize flexibility or with designated leaders forming their own teams. Importantly, all personnel must be part of a team—no one should be left out. Secondly, team leaders should be given full management authority, with responsibility for personnel, finances, and resource distribution. Each team operates as an independent unit, with the team leader overseeing all aspects of team performance. Finally, evaluations and assessments should be team-based rather than individual. Tasks and goals are assigned to teams, and their performance is evaluated as a whole.

3.4 Establishing a "Full-Chain" System for Research Commercialization

While universities tend to focus on basic or applied basic research, research institutes emphasize applied research or engineering technology, making them natural upstream and downstream partners in the innovation ecosystem. In the process of science-education integration, discipline construction should be the guiding principle, with basic and applied research unified and aligned in a shared direction. The integration of the innovation chain and industrial chain should be strengthened, constructing a "full-chain" system for the transfer and commercialization of research results, from nursery, incubation, and acceleration to industrialization.

Firstly, a collaborative model of "government-industry-university-research-finance-service-application" should be established. Partnerships with various innovation entities should be actively pursued, with bilateral or multilateral cooperation agreements formed. Local governments should guide fiscal investments, attracting leading enterprises to concentrate innovation resources and establish "collaborative innovation funds" to address common and key technical challenges.

Secondly, an innovation model of "research-pilot testing-industrialization" should be created. Funding mechanisms like pilot testing and industrialization funds should be set up to support projects that transition research results from the laboratory to pilot tests, and eventually to industrialization.

Lastly, a "technology+capital+industry" commercialization model should be formed. Experts in capital operations, financial management, and corporate law should be brought in to transform research achievements into equity stakes via intellectual property, thus fostering commercialization and providing comprehensive financial services for enterprises.

In 2021, at the annual conference of the Chinese Academy of Sciences and the Chinese Academy of Engineering, as well as the 10th National Congress of the China Association for Science and Technology. The president of China Xi Jinping emphasized that national research institutions and research-oriented universities are essential components of the country's strategic scientific and technological power, and that efforts must be made to enhance the overall effectiveness of the national innovation system. In 2022, the Ministry of Education, Ministry of Finance, and National Development and Reform Commission jointly issued the "Several Opinions on Deepening the Construction of World-Class Universities and Disciplines," which also stated the need to elevate regional innovation development levels clearly, strengthen collaborative innovation among universities, research institutes, and other entities, and promote deep integration among industry, academia, and research.

From the statements made by Communist Party of China and national leaders, as well as the policy orientation in relevant institutional documents, it is clear that the integration of science and education, or the integration of science, education, and industry, has become a significant option for advancing the strategy of innovation-driven development. As long as grasp the direction of this integration effectively, address the challenges encountered during the process, leverage the unique

advantages of integration, and unite our efforts for development, it is possible to provide stronger strategic support for local economic and social development and achieving high-level technological self-reliance and strength.

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