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Exploration of the "Four Integrations" Applied Talent Training Model with Demand Driven Output Oriented Approach

Shangjiu Meng, Zhiwei Song*, Jianfeng Sun, Zhenqian Dang, Ping Tan, Guangmeng Ren
Heilongjiang University of Science and Technology, Harbin, China
**Corresponding author.*

Abstract: With China's economic transformation and higher education reform, local universities are facing new challenges and opportunities in cultivating high-quality applied talents. Heilongjiang University of Science and Technology, as a demonstration university for the construction of provincial characteristic applied undergraduate programs, actively explores the training mode of applied talents and has established a "four integration" talent training system, namely, the integration of science and education, discipline integration, specialty innovation integration, and industry education integration, in order to enhance students' comprehensive quality and innovation ability. In addition, the school has deepened education and teaching reforms, promoted the construction of professional courses, and 8 majors have passed engineering education certification, and 6 majors have been approved as national first-class professional construction points, further improving the matching degree between talent cultivation quality and social needs. Through these measures, the school has provided solid talent support for regional economic development, forming a new model of diversified collaborative education, and improving the effectiveness of education and social service capabilities.

Keywords: Applied Talents; Cultivation Mode; Innovation Ability; Collaborative Education

1. Introduction

With the profound transformation of China's economy and the continuous reform of higher education, the development of applied colleges and universities has become a basic consensus in the field of higher education [1]. Local colleges and universities bear the important mission of cultivating talents for local economic and social development as well as industrial transformation and upgrading. How to align with industrial changes, cultivate high-quality applied talents that meet the needs of national development and industries, and promote the vigorous development of new technologies, new models, and new industries are urgent tasks facing local universities [2].

Local universities can only continuously resolve the structural contradictions between talent supply and demand and cultivate more high-quality applied talents to provide a stronger support for national and regional economic development by closely following the pulse of the times, keeping pace with the development of cutting-edge technologies, and meeting the needs of industries and sectors, and actively exploring the reform of talent cultivation models.

High-quality applied talents should have the following characteristics: (1) Possessing comprehensive professional knowledge and overall quality. Talents with broad professional knowledge and extensive cultural cultivation, multiple capabilities and development potential, as well as harmonious and creative personalities, represent the new development trend of future talent cultivation; (2) Having an interdisciplinary perspective. Breaking through the boundaries of one's own discipline, interacting, permeating, and integrating with multiple disciplines to form new theories, concepts, and methods, thereby enhancing decision-making and innovation capabilities; (3) Capable of solving complex engineering problems. As a multi-disciplinary complex entity, modern engineering is growing in scale, increasing in elements, and becoming more complex. Therefore, the ability to solve complex engineering problems has become an important criterion for measuring high-quality applied talents [3]; (4)

Possessing innovation and entrepreneurship capabilities. College students, as the driving force for social progress, must adapt to the requirements of the knowledge-based economy and have strong capabilities in innovation and entrepreneurship.

Heilongjiang University of Science and Technology, as a provincial demonstration university for the construction of distinctive applied undergraduate programs, focuses on the characteristics that high-quality applied talents should possess. It adheres to demand-driven and outcome-oriented approaches, builds a "four-integration" talent cultivation system, strengthens "three" guarantees, and actively explores the cultivation models for applied talents, striving to cultivate first-class applied talents.

2. Setting the Target for High-Quality Applied Talent Cultivation and Building a "Four-Integration" System

The university, based on its applied-oriented educational positioning and focusing on the talent cultivation goal of "high quality and strong capability," implements the "Five-Education Integration" approach and constructs a "Four-Integration" talent cultivation system to carry out the practice of cultivating high-quality applied talents at the university.

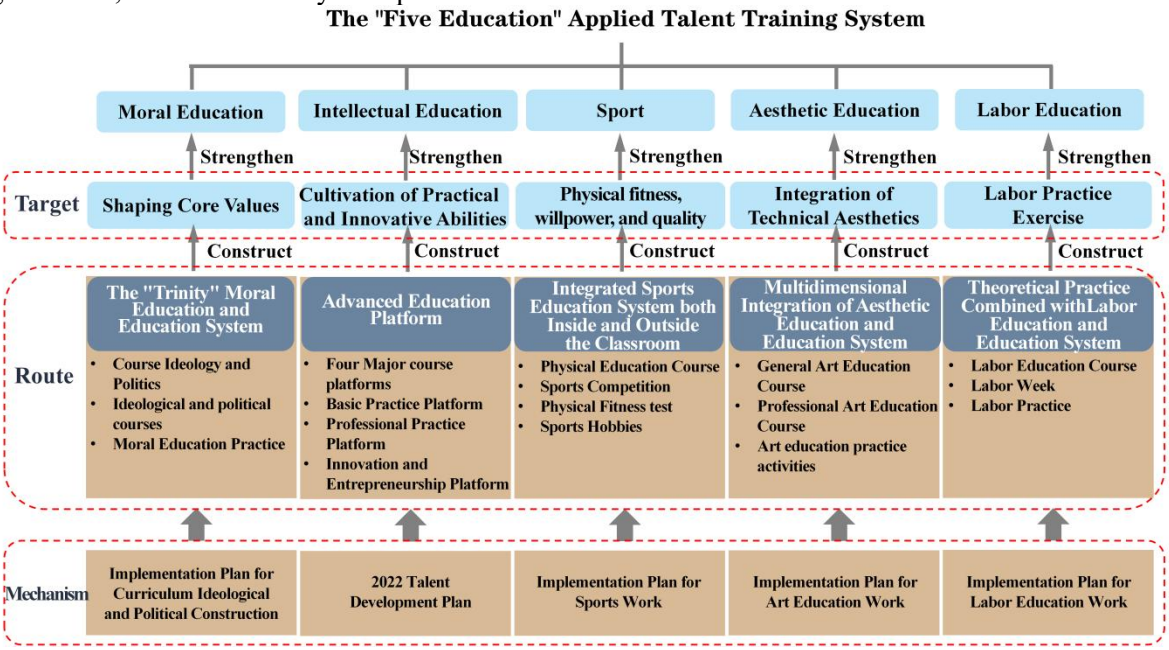

Figure 1. The Talent Cultivation System of "Five-Education Integration"

2.1 Promoting the "Five Strengthenings" to Facilitate Students' Comprehensive Development

High-quality applied talents in the new era should meet the basic standard of all-around development in morality, intelligence, physical fitness, aesthetic appreciation, and labor skills. This is the fundamental requirement for contemporary college students, and accurately grasping its connotation is the key to exploring the path of talent cultivation [4].

Considering the existing problems in current talent cultivation, such as overemphasis on intelligence, neglect of morality, weakness in physical education, scarcity of aesthetic education, and deficiency in labor education, the university has strengthened top-level design, optimized the talent cultivation plan, and built a "Five-Education Integration" education system (Figure 1). It has also established a safeguard mechanism and introduced relevant systems to ensure the implementation of the "Five Strengthenings". A progressive intellectual education system has been built, integrating four dimensions of general education, specialized education, vocational education, and innovation education organically to strengthen the cultivation of practical and innovative abilities. An integrated physical education system combining in-class and out-of-class activities has been developed to ensure continuous physical education throughout the four years, emphasizing physical and willpower training.

A multi-dimensional aesthetic education system has been established, focusing on specialized aesthetic education and creating the "Riverside Sunrise" aesthetic education brand activity to promote the integration of professional and general education. A labor education system combining theory and practice has been developed to strengthen labor practice training. The university has set up a labor week, and the long-standing tradition of students clearing snow independently has become an excellent carrier for labor education

2.2 Promoting the "Four Integrations" to Enhance Diversified and Collaborative Talent-Cultivation Capabilities

As the main battleground for talent cultivation, applied universities face the contemporary challenge of what kind of applied talents to cultivate and how to do so [5]. The development of national strategies has put forward higher requirements for talent cultivation. Based on the positioning of applied talent cultivation and relying on national policies such as deepening the integration of industry and education, our university has practiced applied talent cultivation guided by industrial demands and has deeply promoted the "Four Integrations" (Figure 2), namely the integration of scientific research and education, interdisciplinary integration, integration of specialization and innovation, and integration of industry and education, to strengthen the cultivation of students' comprehensive qualities, interdisciplinary learning abilities, innovation and entrepreneurship capabilities, and practical application skills.

Firstly, the integration of scientific research and education is promoted. A talent-cultivation model that links teaching, practice, online learning, and social engagement has been implemented. By aligning the "three axes," the curriculum system has been restructured to incorporate scientific research achievements into textbooks and classrooms. Shared platforms have been built, and the undergraduate mentorship system has been implemented, transforming high-quality scientific research resources into educational resources and enhancing the cultivation of students' innovative thinking and capabilities.

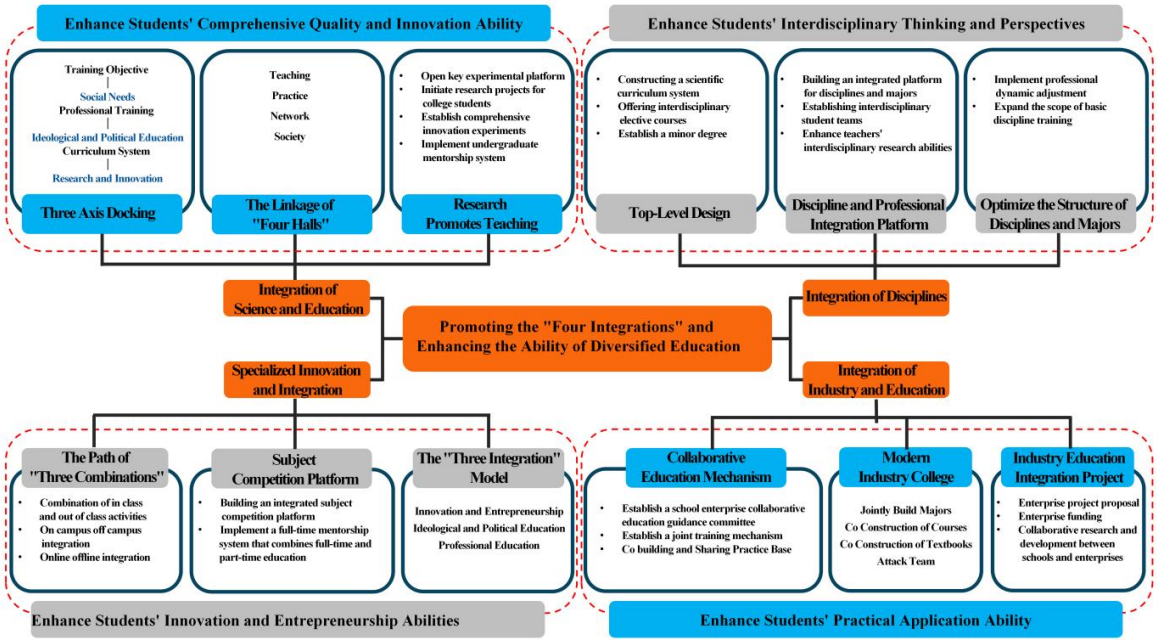

Figure 2. The "Four Integrations" Talent-Cultivation System for Applied Talents

Secondly, promote the integration of disciplines. Strengthen the cross-integration of science and engineering with arts and humanities. By optimizing the structure of academic disciplines and majors, and establishing an integrated platform for disciplines and majors, we enhance the interdisciplinarity of students' knowledge structure through the addition of interdisciplinary courses, the establishment of minor degrees, and the introduction of micro-majors, thereby cultivating composite talents who can meet the needs of economic and social development.

Thirdly, promote the integration of industry and education. Focus on the construction of modern industrial colleges and establish a talent cultivation mechanism between the school and enterprises, which includes collaborative development of talent cultivation programs, enterprise course development, practical base construction, teacher team cultivation, and innovation platform creation. Explore diversified collaborative talent cultivation models, such as modern industrial colleges, school-enterprise co-built "experimental classes," "special talent classes," and joint vocational qualification training, to effectively connect the talent chain with the industrial chain.

Fourthly, promote the integration of specialization and innovation. Establish a College of Innovation and Entrepreneurship and explore a "three-combined" approach to create an integrated innovation and entrepreneurship platform, which includes a "college student maker community + incubation platform + entrepreneurial space + industrial base." Develop a "six-in-one" innovation and entrepreneurship education model that integrates courses, projects, training, competitions, incubation, and entrepreneurship, continuously enhancing students' innovation and entrepreneurial capabilities.

3. Focusing on the Cultivation of High-Quality Applied Talents and Strengthening the "Three Guarantees"

3.1 Building a "Dual-Competent" Faculty Team to Strengthen Talent Support

Deepening the "talent-strong university" strategy and establishing a coordinated talent policy system for "attracting, cultivating, employing, and retaining" talent is a key measure for universities to achieve high-quality development [6]. Talent is the core resource for university development, and its quality and quantity directly affect the university's teaching, research, and social service capabilities. By constructing a systematic policy framework, universities can effectively enhance their talent competitiveness, promote rational talent mobility, and optimize resource allocation, thereby providing a solid talent guarantee for long-term development. Specific measures include:

Implementing a "Four-Drive" Talent Attraction Mechanism: This includes demand-driven, platform-attractive, policy-incentive, and flexible talent attraction strategies. Based on the university's development strategy and disciplinary needs, a scientific talent demand plan is formulated to clarify the quantity, quality, and structure of talent to be recruited. High-level research platforms and innovative teams are built to attract top-tier talent. Talent attraction policies are improved to offer attractive remuneration, research funding, and living support. Flexible talent attraction methods, such as part-time positions, visiting scholar programs, and project collaborations, are also employed to achieve the principle of "not necessarily owning, but effectively utilizing" talent. Over the past three years, the university has recruited 135 doctoral degree holders and 32 high-level talents, including two candidates for academician positions.

Implementing a Faculty Capacity-Building Plan: This plan prioritizes the cultivation and utilization of talent through a "hard approach." A mentorship system for young faculty members is continuously implemented, with senior faculty providing one-on-one guidance to accelerate their growth. The university also promotes the training and certification of "dual-competent" faculty members through university-enterprise cooperation, practical training, and qualification certification. Regular professional training, academic conferences, and exchange activities are organized to enhance faculty members' teaching and research capabilities. Within the past three years, over 50% of full-time faculty members have become "dual-competent."

Implementing a Categorized Faculty Evaluation System: Evaluation standards are tailored to different faculty roles, such as teaching-focused, research-focused, and combined teaching-research positions. Performance-based incentives are deepened by linking faculty achievements with remuneration to boost motivation. Professional ethics are emphasized as a key evaluation criterion to guide faculty members to uphold high moral standards. Over the years, many faculty members have dedicated themselves to grassroots services, embodying the university's commitment to integrity and

dedication, which serves as the best education for students.

3.2 Building the "Three Pavilions, Three Institutes, and Three Centers" to Strengthen Platform Support

Constructing an interdisciplinary and integrated talent cultivation platform is essential for implementing the "Four Integrations" system and nurturing high-quality composite talents [7]. Such platforms break traditional disciplinary barriers, promote knowledge integration and innovative thinking, enhance students' comprehensive qualities and innovation capabilities, and better meet societal demands for composite talents. Through interdisciplinary integration, students gain broader knowledge and skills, enhancing their adaptability to complex future societies.

Constructing Comprehensive Talent-Cultivation Platforms: The university has established a Mining Pavilion, a University History Pavilion, and a Geology Pavilion. These platforms integrate the university's distinctive educational features, practical training, and heritage, offering a multidisciplinary space for students. They showcase the university's history and culture, provide rich practical resources, and foster students' patriotism and school loyalty, playing an irreplaceable role in value guidance.

Establishing Interdisciplinary Research Institutes and Innovation and Entrepreneurship Colleges: The university has founded the Smart Mining Interdisciplinary Research Institute, the Graphite Research Institute, and the Innovation and Entrepreneurship College. The Smart Mining Institute promotes interdisciplinary integration and innovation in research and talent cultivation. The Graphite Institute focuses on graphite material research and development, driving the integration of materials science and engineering. The Innovation and Entrepreneurship College strengthens students' entrepreneurial capabilities and integrates professional education with entrepreneurial education, earning the university recognition as a provincial pilot unit for university employment and entrepreneurship.

Developing Practical Training Bases: The university has established three centers: the Engineering Training Center, the Mining Engineering Practice Center, and the Innovation and Entrepreneurship Center. These centers, shared across the university, promote the integration of industry-education and science-education, enhancing students' practical skills. The university has also been approved as a "National Technology Incubator," creating a full-chain innovation platform that integrates "Innovation and Entrepreneurship College + Interdisciplinary Research Institute + Incubator + Innovation and Entrepreneurship Ecosystem + Industrial Base."

3.3 Building an "Internally and Externally Connected" Monitoring System to Strengthen Quality Assurance

Constructing an "internally and externally connected" monitoring system is a crucial measure for universities to enhance educational quality [8-10]. Fully implementing national and provincial requirements for deepening educational evaluation reform in the new era, the university explores a quality assurance system featuring "full participation, full coverage, and integration of all elements" with continuous improvement and closed-loop feedback. This system not only promotes the scientification and refinement of educational evaluation but also provides strong support for educational reform, driving comprehensive quality improvement. Specific measures include:

Improving Quality Standards: Over 30 teaching management systems have been formulated and revised.

Conducting Six Special Assessments: These assessments aim to promote improvement and strengthening through evaluation.

Establishing a Multi-Dimensional Talent Evaluation Mechanism: This mechanism reinforces closed-loop quality management, ensuring that evaluation results are effectively applied to teaching improvement and talent cultivation.

Implementing a Dynamic Adjustment Mechanism for Disciplines and Majors: The university conducts performance evaluations of disciplines and "six-dimensional evaluations" of majors, comprehensively assessing majors from aspects such as teaching quality, research level, social service, faculty, student development, and educational

conditions to optimize the structure of disciplines and majors. The university has been approved as a provincial pilot university for deepening educational evaluation reform in the new era.

4. Deepening the Reform of Applied Talent-Cultivation Models to Achieve "Four Enhancements"

4.1 Developing New Models of Diversified and Collaborative Talent Cultivation to Improve Educational Outcomes

The university has established modern industrial colleges and jointly built "customized classes" and "experimental classes" with enterprises. It has also collaborated with enterprises to conduct engineer qualification certifications, forming diversified and collaborative industry-education integration models for talent cultivation. The first graduating class of 287 students from the Longmei Modern Industrial College has joined four mining companies of Longmei Group. The university encourages a group of post-2000 students to take root in the mines and serve the mining industry.

4.2 Focusing on "Dual Carbon" Goals to Build "Dual Chains" and Enhance Social Service Capabilities

In alignment with the construction of the modern industrial system in Heilongjiang Province (referred to as "4567"), the university focuses on the coal and graphite industrial chains to build an innovation chain, creating new types of productive forces and generating a series of "black technologies":

Serving the Coal Industry Chain:

The university leads a project with a total budget of 120 million yuan, titled "Key Technology Research and Demonstration of Intelligent Mining in Extremely Thin Coal Seams." This project has successfully broken through the "bottleneck" technologies in intelligent mining of thin coal seams, resulting in the development of a thin-coal-seam mining robot. The robot was successfully tested in the Longmei Shuangyashan Mine, achieving a monthly output of over 50,000 tons. This innovation has empowered the traditional coal industry and involved a large number of graduate and undergraduate students in the research, promoting teaching through scientific research.

Serving the Graphite Industry Chain**:**

Focusing on the key areas of the graphite industry chain, including exploration, mining, selection, processing, and environmental protection, the university has established the Graphite Research Institute. More than ten products have been developed, including a graphene barbecue stove (a "black technology" product characterized by environmental friendliness, freshness preservation, and enhanced flavor), and these innovations have been successfully commercialized. This has driven the high-quality development of the graphite industry in Heilongjiang.

Supporting the Construction of the "Circular Entrepreneurship and Innovation Ecosystem around Heilongjiang University of Science and Technology":

The university is actively advancing the key tasks of the "Carbon Valley" ecosystem, following a master plan that includes one core, two belts, and three zones. Applied research is used to promote the cultivation of applied talents.

4.3 Deepening Connotation Development and Enhancing the Quality of New Engineering Programs

Strengthening Professional Course Construction to Improve the Alignment of Talents with Social Needs. The university has been committed to advancing professional course construction to ensure that the talents cultivated meet societal demands. Eight majors have passed engineering education accreditation, guaranteeing that the quality of professional education meets international standards. Six majors have been approved as national first-class professional construction sites, further enhancing the teaching level and social recognition of these majors. Additionally, the university has developed two national first-class courses and 23 provincial first-class courses, providing students with high-quality learning content. Deepening Educational Reform to Improve the Precision of Talent Cultivation. In recent years, the university has been granted nearly 300 provincial educational reform projects, covering various aspects such as curriculum reform and innovative teaching methods. These projects have provided strong support

for educational reform. The university has also received 92 provincial and ministerial-level teaching achievement awards. It has promoted research-oriented teaching methods such as case teaching and project-based teaching, with a focus on comprehensive project training to enhance students' ability to solve complex engineering problems.

5. Conclusion

Heilongjiang University of Science and Technology has successfully cultivated high-quality applied talents through establishing a "Four Integrations" talent development system and strengthening "Three Safeguards", achieving remarkable results in Emerging Engineering Education Initiatives and effectively addressing talent demands arising from economic transformation and industrial restructuring. Moving forward, the university will continue its demand-driven approach by advancing the integration of science and education, disciplinary convergence, synergy between specialization and innovation, and industry-education collaboration. These initiatives aim to enhance students' comprehensive competencies and innovative capabilities, thereby providing robust talent support for regional economic development, improving social service capacity, and driving comprehensive quality enhancement in education.

Acknowledgments

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