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Research and Practice on Integrating Local Universities' Pathways for Cultivating High-level Applied Talent with Regional Economic Development

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Abstract: This study addresses the reform of the supply side of applied talent cultivation in higher education amid regional economic transformation, with a focus on a municipal engineering university in Beijing's Western District. In response to key challenges such as homogeneous training standards, superficial industry-academia collaboration and rigid evaluation systems, we have developed a 'Knowledge-Ability-Quality' tri-spiral practical education model. Through differentiated training standards, innovative industry-education mechanisms and AI-driven evaluation platforms, the model bridges the gap between educational provision and industry needs. Empirical results show: Academic postgraduates achieved 18% annual growth in SCI/EI publications. Professional postgraduates achieved a 22.3% industry project engagement rate. Utilization of collaborative bases surged from 30.8% to 60%, resolving 36 corporate R&D challenges. Student outcomes included 563 national competition awards, a 95.7% employment rate and 90% employer satisfaction. The study offers a replicable solution to the 'theory–practice divide' in talent cultivation. It provides insights into the synergy between higher education and the regional economy under the 'new quality productivity' framework.

Keywords: Postgraduate Education; Practical Education; Industry-Academia Collaboration; Regional Economic Development; Competency Evaluation

1. Research Background

China's macroeconomic policies and higher education reforms present new opportunities and challenges for postgraduate students practical training. The 2023 national economic policy emphasized employment stability as a key priority, with a particular focus on graduate employment and strengthening partnerships between industry and education in advanced manufacturing, digital transformation, green technologies and the silver economy. The Ministry of Education's 2024 guidelines further urge universities to enhance graduate employability through internships, industry-academia integration and the establishment of high-quality practice bases.

In line with China’s high-quality development goals, the 'new quality productivity' theory [1] requires robust education systems to support talent development [2]. The 2020 'Opinions on Accelerating postgraduate Education Reform' document emphasized the need for closer collaboration between industry and education, particularly through the establishment of joint training bases. The industry-education integration talent cultivation mechanism clarifies the direction of reform for cultivating technical talent, while also providing continuous talent support for regional economic development. This is achieved by optimizing the mechanism for aligning higher education with social needs.

Meanwhile, guided by the national strategy of integrating industry and education, as well as Beijing's policy of 'differentiated and distinctive development' for higher education institutions, the western Beijing region - a national-level industrial transformation and upgrading demonstration zone - is accelerating the implementation of the 'Western Beijing Region Transformation and Development Action Plan (2022–2025)'. This study uses a university specializing in municipal engineering within the region as a case study. As the only higher education institution in the region with complete undergraduate, master's and doctoral degree programmes, the university bears core responsibility for supplying applied talent to the local economy. However, a retrospective analysis of the university's talent cultivation process prior to 2017 revealed several issues in the practical training of engineering postgraduates: first, there was homogenization in cultivation, with academic and professional postgraduate practical training content being highly similar. This resulted in an 83% homogeneity rate in core courses and failed to reflect the needs of categorized cultivation. Second, collaboration was superficial, with insufficient corporate participation and a practical training base utilization rate of only 30.8%. Third, the evaluation process was overly standardized, with practical credit recognition relying on the traditional 'academic lectures & teaching assistantship' dual-signature verification method, which was not in line with the Ministry of Education's requirements for diversified practical training. Based on these findings, this study proposes a 'knowledge-ability-quality' three-spiral practical education pathway. Through credit-based reforms in professional practice, academic innovation, social service and comprehensive quality scenarios, the education, industrial and talent chains are integrated organically, providing a universally applicable solution for the reform of practical education for engineering postgraduate students.

2. Research Status

2.1 Current Landscape of Industry-Academia Collaboration

The current university-industry collaboration mechanism primarily utilizes joint postgraduate training bases as key platforms. These bases create authentic professional environments where students engage with cutting-edge technologies, systematically enhancing their practical skills and professional competencies. Existing research has yielded multidimensional findings: Ma et al. [3] analyzed 28 national demonstration bases to identify exemplary talent cultivation pathways. Wu et al. [4] proposed quality assurance measures from four dimensions: base selection, mentor evaluation, guidance processes, and supervision systems. As Yang [5] pointed out, the construction of joint training bases for local universities usually requires a differentiated design that is closely integrated with professional characteristics and industry needs. However, local universities face multiple challenges in the process of establishing a research base. Constrained by factors such as school reputation, faculty strength and alumni resources, they generally suffer from issues such as unstable cooperation, limited funding, poor faculty matching and ineffective implementation. In response to these challenges, the research team proposes establishing a collaboration mechanism between research, industry and education, guided by the concept of 'new-quality productive forces'. This involves integrating innovative elements (technology, talent and capital), coordinating the interests of multiple stakeholders (universities, enterprises and the government), practicing green development principles (such as low-carbon models) and establishing an open resource-sharing platform with digital management tools. It also involves establishing a mechanism for sharing outcomes (such as intellectual property distribution). The goal is to cultivate composite talent with engineering expertise and innovative capabilities.

2.2 Key Research Themes

The domestic academic community has conducted systematic research into ways of enhancing employment competitiveness. Topics covered include new productive forces, industry-education integration, joint graduate training bases and practical skills. In the field of research on new-quality productive forces, scholars generally agree that this concept encompasses characteristics such as digitization, intelligence, and green development [6]. They emphasize the core role of higher education in forming new-quality productive forces [7], particularly the strategic support role played by new, high-level science and engineering universities. These universities are key nodes that integrate science and technology, talent, and innovation [8]. Research on industry-education integration primarily focuses on innovative collaborative talent cultivation mechanisms, encompassing three key areas: establishing joint training bases, developing industry-specific courses and setting up off-campus mentor teams [9]. Research indicates that industry-education integration enhances the quality of graduate education and promotes the development of regional high-tech industries, thereby fostering a virtuous cycle between talent cultivation and industrial upgrading [10]. Empirical research on practical abilities and employment competitiveness has found that social practice is a crucial component of employment guidance education for postgraduate students. It plays an irreplaceable role in helping postgraduate students to understand the actual conditions in rural areas, western regions and key industries, enhancing their practical work capabilities and strengthening their sense of social responsibility and historical mission [11]. During recruitment, employers place greater emphasis on the practical work experience and comprehensive qualities of postgraduate students. A one-year internship can boost employment competitiveness by 23.6% [12], and establishing a 'practice-innovation-employment' linkage mechanism can help to achieve the 'Three Highs and Four News' strategic goals [13]. Research on graduate joint training bases indicates a trend towards diversified development. Scholars have proposed various construction schemes, including domain, regional, and industry-based models [14], as well as innovative mechanisms such as the 'three-teacher talent cultivation' model [15] and the 'four-tier cultivation system' [16]. These initiatives aim to promote the 'practicalisation' of mentor-graduate training processes, adhere to the 'master-apprentice' model, enhance graduate employment competitiveness and improve service levels for local economic development [17].

2.3 Research Entry Point

While the prior research conducted by domestic scholars is worthy of study and reference, there are still areas that require further investigation. Notably, 80% of existing research findings are based on cases from 'Double First-Class' universities with superior resource endowments. However, insufficient attention has been paid to local universities, which bear 80% of the national postgraduate student training burden. Key issues such as constructing an effective practice system under resource constraints and breaking through the 'name without substance' dilemma require in-depth exploration and constitute the core focus of this research project.

3. Research Foundation

The sample school, which is based in the Beijing-West region, addresses the urgent need for highly skilled professionals in the context of industrial transformation and upgrading. The school has developed a 'knowledge-skill-quality' three-spiral practical education model. It is implementing progressive plans, such as restructuring training standards, enhancing industry-education collaboration and diversifying evaluation systems. This model strikes a dynamic balance between knowledge transmission, skill development and character cultivation by facilitating the spiral-like interaction of these three elements. This ensures that graduate education is precisely aligned with individual development needs. The implementation process follows an evolutionary logic of 'top-level design–institutional evolution–platform empowerment'.

3.1 Strategic Deployment Phase

By the spirit of the recently convened university-wide graduate education work conference, the 'Implementation Opinions on the Reform and Development of Graduate Education at North China University of Technology' were officially promulgated and implemented, systematically advancing innovations in talent cultivation models. The reform measures primarily focus on three areas: first, a comprehensive revision of the training programme is launched to establish differentiated training standards for academic and professional postgraduate students; second, a comprehensive evaluation indicator system is constructed to promote all-round development of morality, intelligence, physical fitness, aesthetics and labour; and third, practical teaching components are strengthened to enhance postgraduate students' capabilities in knowledge innovation and engineering practice through industry-academia-research collaboration mechanisms, as shown in Figure 1.

3.2 Institutional Reform Phase

The institutional reforms to graduate practical education at the pilot university exhibit distinct phased characteristics (2005–2025). During the initial institutional development phase (2005–2008), academic postgraduate students were managed under a two-tier disciplinary system implementing a 'lecture series + teaching assistant' dual-signature approval mechanism. However, issues such as a loosely structured management system persisted. The development of professional degree education (2009–2016) and the establishment of three engineering master's programmes (including mechanical engineering) led to the introduction of an external mentor system and a professional practice assessment system. However, reform of the practical education system for academic postgraduate students lagged until the first-level discipline authorization points were expanded in 2012. During the standardization phase (2017–2020), institutional breakthroughs were achieved. Based on university-wide research and argumentation, the Graduate School promulgated the 'Regulations on the Management of Graduate Practical Training', systematically constructing a practical teaching system comprising three categories and 12 projects. The School also issued detailed rules for subject competitions and completed standardized registration for 104 practical training bases. The current innovation and deepening phase (2021–) has established a new governance framework centred on a '1+N' policy system, achieved through the construction of demonstration bases, optimization of practical credit standards (2024 version) and revision of training programmes. This innovation is reflected in the establishment of a classification guidance mechanism for academic and professional programmes, a dynamic management model for practical bases and a graded recognition standard for competitions. Ultimately, this improves the institutional support system for the 'knowledge-ability-quality' triple helix education model. (See Figure 2 for the specific evolution path.)

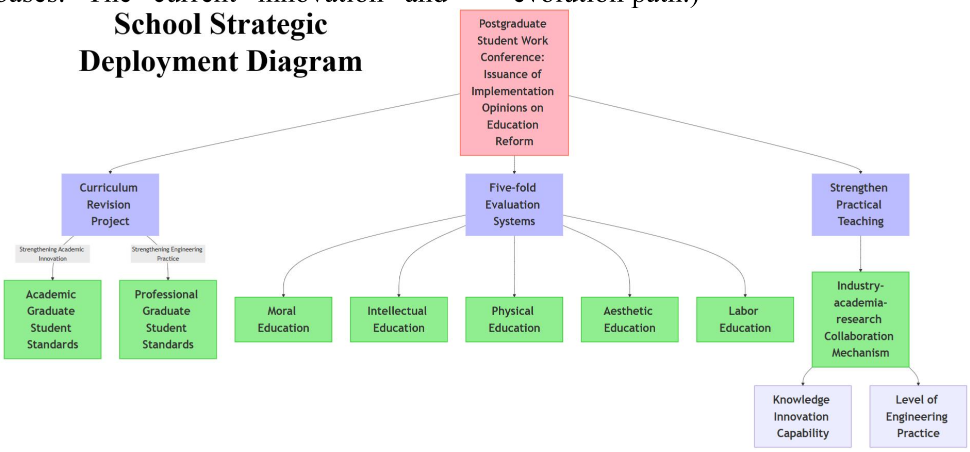

Figure 1. Strategic Deployment Diagram

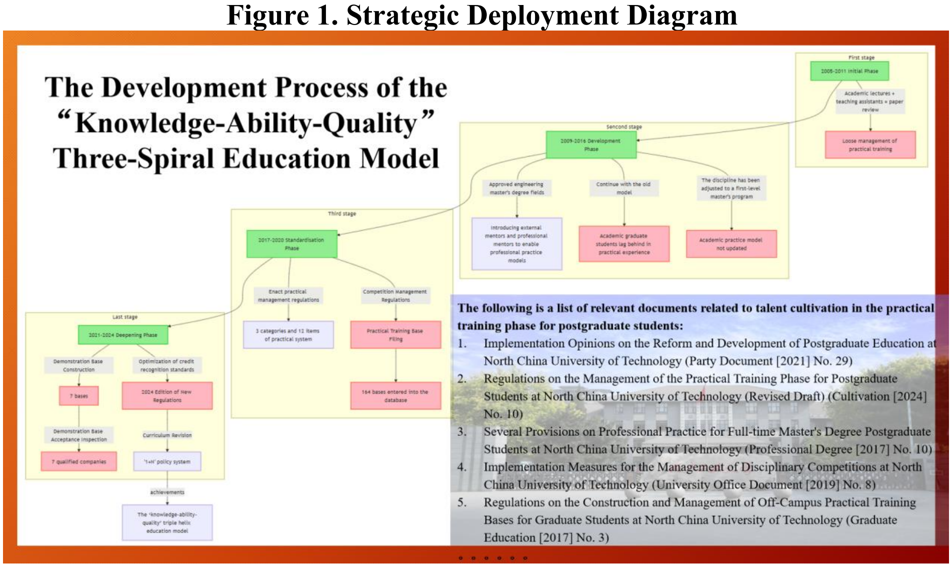

Figure 2. Institutional Reform Process Diagram

3.3 Platform Construction Phase

The construction of the graduate practical education platform at the sample university exhibits distinct characteristics of phased development. In 2017, the Graduate School allocated 299,000 yuan in special funds to launch the first phase of the graduate achievement recognition platform. It focused on developing three core functional modules: the practical credit recognition system (covering competition achievements, etc.), the discipline competition project management module and the professional practice management system. It enabled the online management of practical education processes to be achieved.

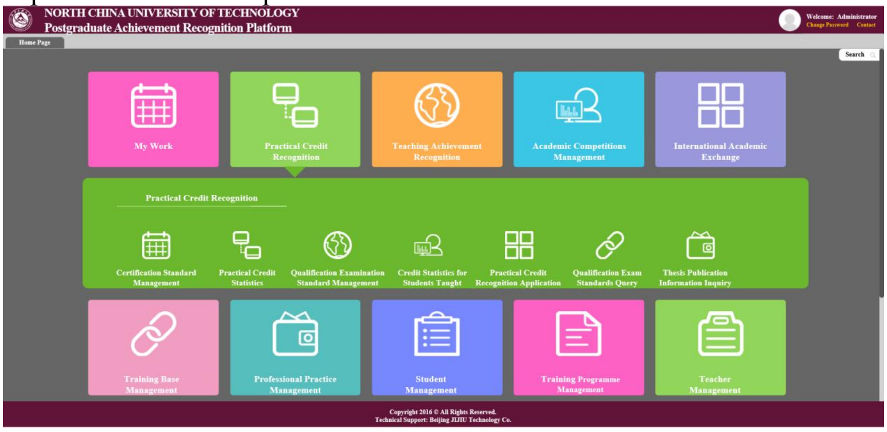

Figure 3. Platform Management Interface

In 2022, the school allocated an additional 290,000 yuan for the second phase of the platform's construction. It involved adding a joint training base management subsystem and an international academic exchange support module (see Figure 3 for the specific architecture). The platform adopts a routine maintenance mechanism of 30,000 yuan per year to ensure the system operates stably. Practical credit recognition, a core functional module, innovatively constructed a standardized management system covering 16 types of practical scenarios, as shown in Table 1. See Appendix 1 for details. The system employs a tiered credit allocation mechanism with decreasing credits based on attribution, incorporating 42 quantitative assessment standards. The system achieves fully digitalised management of the entire process, from application and review to recognition, and has established data linkage mechanisms with core business systems such as academic record management, academic warning and degree conferral. Based on 51,600 data points on the practical achievements of postgraduate students, it has become a core indicator for academic warnings and comprehensive quality evaluations across all 38 master's programmes at the university.

Table 1. List of Postgraduate Student Practical Scenarios

Serial Number	Scene Name
1	Professional Practice (including fieldwork, practical internships, research projects, etc.)
2	Academic Lectures
3	Research Surveys
4	International Exchange
5	Publications
6	Competitions
7	Scientific Research Innovation Practice Activities
8	Apply for a patent or software copyright
9	Technical Standards
10	Monographs
11	Teaching Practice
12	Certification Exams
13	Volunteer Work
14	Social Surveys
15	Service Management Activities
16	Physical Education, Art, and Labor Practice Activities

4. Research Content

4.1 Core Content

This study focuses on local applied universities with weak industry backgrounds and uses field survey data to explore operational models that can enhance the practical innovation capabilities of postgraduate students at these universities. A three-helix collaborative education model is formed through a dynamic meshing mechanism of knowledge foundation, capability-driven and quality leap. This model focuses on solving problems such as inaccurate training positioning, empty industry-education integration and evaluation target deviation in the training of engineering postgraduate students.

4.2 Key Contents

4.2.1 Reconstructing differentiated training standards

In order to address the issue of 'inaccurate training orientation', a classification-based practical ability standard system has been established. By implementing classified guidance and differentiated training, the quality of training for postgraduate students and their social adaptability have improved. It resolves the issue of homogenization in traditional training models and meets the diverse needs of regional industrial development for high-level talent.

This differentiated training standard system adopts a dual-track design for academic and professional degrees. Academic graduate programmes focus on enhancing scientific research and innovation capabilities, forming a progressive path of scientific research capabilities from 'simulation experiments' to 'topic modelling' to 'theoretical innovation'. Professional graduate programmes emphasize training in engineering application capabilities, creating a chain of engineering capability training from 'case analysis' to 'project training' to 'industrial transformation'. In terms of achievement recognition, a differentiated certification system for degree types has been implemented, with certifications specific to professional degrees accounting for 40% of the total. Additionally, a competency-oriented practical credit bank has been set up to facilitate the recognition and conversion of credits between professional and general competencies. Evaluation indicator systems differ significantly: academic evaluations emphasize innovation and academic value (30% weighting) and foundational knowledge and research capabilities (30% weighting), while professional evaluations emphasize problem-solving capabilities (35% weighting) and theoretical application capabilities (25% weighting).

4.2.2 Demonstrating industry-education collaboration

In response to the issue of "idle integration of industry and education", a base grading management system was implemented. The implementation of an 'application-filing system' and a demonstration-based construction strategy formed a collaborative education mechanism between schools and the outside world, significantly improving the efficiency with which resources are utilized.

The campus-wide collaboration system uses a multidimensional coupling mechanism to establish a closed-loop training pathway integrating competition benchmarking, project development, achievement recognition and career transition. In terms of competition benchmarking, a tiered scoring system has been implemented. National-level competitions award up to 4.5 credits per event, while provincial/ministerial-level A-class competitions award between 1.5 and 2.5 credits per event. A dedicated annual fund of 400,000 yuan is provided to support this initiative. Through a 3:1 credit correspondence ratio between project-based and exam-based competitions, the programme effectively encourages postgraduate students to participate in top-tier events. In the project development phase, a complete lifecycle management system is implemented covering four practical forms: entrepreneurship incubation (three credits per project), research project initiation (one credit per project), international exchange (two credits per instance) and off-campus research activities (0.3 credits per instance). It enables a quantitative assessment of postgraduate students' research contributions. In terms of recognizing achievement, a dual-track system combining academic achievements and general competencies is adopted. Academic achievement evaluation includes papers (2–5 credits per paper), patents/software copyrights (1–4 credits per item) and standards/publications (1–4 credits per item). In comparison, general ability evaluation covers activities such as public welfare volunteering and social research (0.3 credits per instance), as well as teaching assistant work (0.5 credits per class). During the career transition phase, 31 career certification recognition pathways have been established (1–3 credits per item), along with a 'dual-base rotational training system' (0.3 credits per week at both on- and off-campus bases) and 'mentor-guided industrial practice' (0.3 credits per week). These form a spiral-shaped, closed-loop training system.

Off-campus collaboration adopts a complete lifecycle management model, implementing dynamic optimization of off-campus practice bases through an 'entry-cultivation-evaluation-exit' mechanism. Demonstration bases are subject to a dual-track evaluation system based on 'utilization rate–elimination rate' (annual elimination rate $\geq$ 5%), which effectively addresses the traditional issue of 'emphasizing application over construction' in base development. This system ensures the sustained and stable fulfilment of base educational functions through institutional innovation and dynamic regulation.

4.2.3 Three-dimensional Innovation in the Evaluation System

In response to the phenomenon of 'evaluation target deviation', a smart assessment model based on multi-source data fusion has been developed. This model uses a quantitative evaluation system to assess both professional and general competencies, achieving precise alignment between graduate practical training and individual development needs. At the institutional design level, a dual closed-loop mechanism based on the 'Regulations on the Management of Graduate Practical Training Programmes' has been established: the process management closed-loop includes a three-tier supervision process of 'real-time reporting, departmental review, university-level filing', while the quality control closed-loop establishes a dual-track exit standard of 'credit bank certification and professional qualification pre-review'. It significantly reduces the risk of formalism in practical teaching.

In terms of the assessment system, a recognition platform has been developed that integrates a three-dimensional digital profile based on 'goal attainment, process completeness, and contribution to results'. The platform covers 16 practical scenarios (including one professional practice scenario, 11 professional skill scenarios, and four general skill scenarios) and supports the recognition of 585 competitions and 31 professional qualifications. It effectively promotes the alignment of academic achievements with core competencies, achieving dynamic optimization of practical content and training programmes. Additionally, the dynamic supervision mechanism employs a 'dual-subject' quality monitoring system based on 42 process-based evaluation indicators. The student evaluation end implements a phased, progressive warning mechanism: a completion rate of less than 30% in the third semester triggers a yellow warning; a completion rate of less than 70% in the fifth semester upgrades to a red warning; and failure to meet standards by the sixth semester results in delayed graduation. The evaluation system implements a three-tier intervention mechanism: a yellow intervention is implemented if the utilization rate is below 60% in the first year; if it remains below 60% for two consecutive years, it upgrades to a red intervention; and if it remains below 60% for three consecutive years, cooperation is suspended while maintaining a 5% elimination rate.

5. Implementation Outcomes

This study involved the systematic reform of the graduate practical education system. Based on the practical experience of the first seven research-industry integration joint training demonstration bases (covering fields such as intelligent manufacturing, new energy and integrated circuits), a training mechanism that integrates theory and practice was developed. The achievements of this reform are primarily reflected in three areas: the standardized construction of the training system; the enhancement of engineering problem-solving capabilities; and the innovation of industry-academia-research collaboration mechanisms. It provides an effective solution to the dichotomy between theory and practice in the traditional training model.

In terms of categorized training, differentiated practical credit recognition standards have been implemented to provide precise training for academic and professional postgraduate students. Data shows that the annual growth rate of SCI/EI papers among 1,138 academic postgraduate students was 18%. During this period, 16 national-level innovation and practice competition awards were won and the postgraduate enrolment rate was 23.8% higher than that of professional postgraduate students. Of the 1,976 professional postgraduate students, 73.3% completed their practical training periods and 52 obtained professional certifications. They also completed 44 corporate projects and achieved a 77.2% employment rate in their respective industries. Following the reforms, the participation rate of academic postgraduate students in vertical research projects increased to 41.8%, while the industry project alignment rate for professional postgraduate students reached 22.3%. It effectively addresses the issue of homogenization in training.

In terms of university-industry collaboration, the utilization rate of practical training bases co-built with 57 leading enterprises increased from 30.8% to 60%. This supports an annual practical training scale of 320 person-months and forms a virtuous cycle of 'talent cultivation-technological breakthroughs-technology transfer'. Demonstration bases have cumulatively produced 225 industry-academia-research achievements, supported the formulation of 19 industry standards (including four provincial-level standards), achieved patent conversion worth 2.6 million yuan, resolved 36 enterprise technical challenges and established a sustainable, collaborative talent cultivation ecosystem.

The quality of talent cultivation has significantly improved, as evidenced by: (1) competition achievements: 563 national-level awards were won, 43% of which were provincial first prizes or higher; (2) career development: 120 individuals obtained registered engineer qualifications and 22.3% of theses originating from enterprise-based research projects; (3)Technology transfer: 268 applied research outcomes (including 36 invention patents) have been produced in key fields; (4) Employment quality: the annual employment rate is 95.7% (65.9% in the Beijing-Tianjin-Hebei region), and employer satisfaction is at 90%. In terms of institutional innovation, the credit completion rate reached 95.2% after practical credits were incorporated into degree conferral criteria, and the rate of delayed defences decreased by 4.5 percentage points. It achieved a paradigm shift from formal compliance to competency-based education.

6. Conclusions and Recommendations

Under China's industry-education integration strategy and Beijing's higher education development guidelines, this study developed an innovative "Knowledge-Ability-Quality" tri-spiral model to address critical challenges in engineering postgraduate education: (1) Differentiated training standards, with an academic track focused on the research innovation chain and a professional track emphasizing the engineering practice chain. These are implemented through customized credit recognition systems. (2) Enhanced industry-academia collaboration, featuring a 'dual-field, four-dimension' cooperation model with 31 professional certification reciprocity mechanisms and a dynamic base evaluation/elimination system. (3) A smart evaluation platform covering 16 practical training scenarios, enabling personalized development tracking and precise talent-industry matching. This integrated approach addresses the cultivation of classifications, collaborative effectiveness and the accuracy of evaluations in graduate education reform.

Against the backdrop of rapid development in new productive forces, this study makes personal recommendations for further research into the link between industry-academia-research collaboration and career development. These recommendations include establishing a dynamic adjustment system for postgraduate student career planning, with a focus on strengthening interdisciplinary integration and technological innovation capabilities. In terms of implementation, training institutions can compile industry resource databases through industry-academia-research projects while simultaneously developing career development tracking systems to optimize training programmes dynamically, ensuring talent cultivation remains in sync with industrial technological transformation.

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