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Reform and Considerations of the High-Quality Talent Cultivation Model for New Engineering Disciplines in Local Universities in China Empowered by New Productivity Forces

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Abstract. New productivity is based on digitization, intelligence, and greening, driven by disruptive technological innovation and centered on emerging and future industries, aiming to serve high-quality living through efficient and high-quality development. This new type of productivity continuously raises the standards and challenges for engineering science and technology, also posing higher demands on the education of new engineering disciplines. With the continuous emergence of new technologies, new economies, and new business models, the connotation and extension of the new engineering discipline have undergone profound changes, leading to a disruptive transformation in traditional engineering jobs and industrial chains. There is an urgent need to innovate and optimize the talent cultivation model for new engineering disciplines, aligning closely with the evolutionary laws of productivity and production relations in the new era. The development of new productivity poses new requirements for talent cultivation in new engineering disciplines, emphasizing innovation, a more integrated training model, a diversified subject base, and a dynamic development of goals and content. However, current talent cultivation models for new engineering disciplines still face challenges in several areas: unclear goal setting, weak interdisciplinary integration, slow transformation towards digitization and intelligence in education, and a lack of a scientific and comprehensive quality evaluation system. To address these challenges in the context of new productivity, it is necessary to promote reforms in the talent cultivation model for new engineering disciplines through the following approaches: integrating digitization, intelligence, and green development into the entire talent cultivation process; reshaping training concepts; breaking down disciplinary barriers to promote integration; continuously optimizing the training model; introducing virtual simulation and other auxiliary teaching technologies to create a collaborative model of student-teacher assistance in talent cultivation; deepening industry-education integration, and innovating cultivation mechanisms to contribute positively to the training of high-quality new engineering talents.

Keywords: New productivity, New engineering disciplines, Local universities, Talent cultivation model

1. Introduction

In September 2023, General Secretary Xi Jinping introduced the concept of "new productivity" for the first time during an inspection tour in Heilongjiang. The Central Economic Work Conference in December of the same year further emphasized, "To promote industrial transformation through technological innovation, particularly by leveraging disruptive and frontier technologies to generate new industrial forms, new models, and new momentum, it is crucial to develop new productivity [1, 2]." This concept refers to a new form of productivity driven by strategic emerging industries and future industries, formed through the integration and transformation of technological innovation resources. New productivity is characterized by high efficiency and high quality, allowing for more effective utilization and modification of nature. It represents a new manifestation of productivity in the new era and is the core force driving innovation and high-quality development. The key to its development lies in high-quality human resources [3, 4].

New productivity is the core driver of industrial upgrading and economic development, and its connection with higher education is becoming increasingly close. As a key platform for cultivating high-quality talent and advancing knowledge innovation, higher education plays a critical role in the development of new productivity. The two are showing a synergistic development trend. With the rapid development of the new generation of information technologies, the evolution of new

productivity will deeply influence teaching models, curriculum settings, and talent cultivation methods in higher education, prompting continuous adjustment and innovation to meet the needs of the times.

Research around the integration of new productivity and higher education primarily focuses on two aspects: first, top-level design. Zhang Zhijie et al. analyzed the three core elements of new productivity—talent, knowledge, technology, and industry innovation—and discussed the development models of higher education from micro, meso, and macro perspectives [5]. Zhang Pei et al. studied the coupling relationship and mutually reinforcing effect of new productivity and the high-quality development of vocational education [6]. Han Fei et al. analyzed the internal logic, value system, and implementation path of new productivity and educational development from the perspectives of top-level design, resource flow, and progressive integration. The second aspect is specific practical pathways [7]. Li Yuqian et al. constructed a multi-dimensional logic of industry-education integration communities from theoretical, historical, and practical perspectives, proposing the cultivation of technical-skilled personnel, the construction of technical collaborative innovation platforms, and the promotion of internationalized development of industry-education integration platforms to enhance their quality [8]. Zhang Haizhi et al. emphasized the need to innovate education models, deepen talent training reforms, and drive the comprehensive development of finance-related professionals, aligning closely with the new demands of high-quality development driven by new productivity [9]. Huang Tian focused on the digital transformation model of ideological and political education empowered by new productivity [10], while Li Chaomin et al. analyzed the teaching presentation and strategy choices of new productivity in high school ideological and political education, providing a new perspective for curriculum reform [11].

2. Research Status and Development Trends of New Engineering Talent Cultivation Models

In response to a new round of technological revolution and industrial transformation, the country has successively launched a series of major strategies, including “Made in China 2025.” Against the backdrop of the changing international competition landscape and increasing national strategic needs, the concept of “new engineering” has emerged. As an important direction for educational reform, “new engineering” represents a new idea and path adapting to the needs of the new era. It is a crucial strategic deployment for the future development of education, aiming to cultivate engineering innovation talent that meets the demands of this new period and to drive engineering education toward global leadership. The core objectives of “new engineering” construction revolve around the three key issues: the goals of training, the content of training, and the methods of training.

China has entered the era of Industry 4.0, and the key to regional economic development lies in cultivating interdisciplinary engineering talent that meets the needs of regional enterprises. Local universities occupy the majority of higher engineering education in China; therefore, exploring innovative models for cultivating new engineering talent in these institutions has become a critical point in addressing the mismatch between talent training and enterprise needs.

Research on the new engineering talent cultivation models at local universities has primarily focused on fields such as computer science, civil engineering, electronic information, and safety engineering. Liu Lihua et al. proposed a talent cultivation scheme for new engineering information technology majors, emphasizing professional orientation, the re-establishment of talent cultivation goals, the improvement of the system, and innovative pathways in four areas [12]. Yan Changbin et al. took the example of civil engineering and stressed that the key to enhancing the quality of talent training lies in systematically cultivating students’ engineering consciousness and craftsmanship during the educational process [13]. Zhou Jing designed a “three-layer three-vertical layered” talent cultivation model for computer science, effectively meeting the needs of enterprise job positions [14]. Shi Xiaoqiu et al. used the example of Wenzhou University’s network engineering program to propose a new engineering talent cultivation model driven by engineering education certification and industry-university integration [15]. Jing Guoxun et al. focused on the safety engineering program at Henan Polytechnic University, advocating for the deepening of the “two-up and two-down” reform, the strengthening of learning assessment, the enhancement of students’ “three-creation” abilities, and the strengthening of collaborative education [16].

A comprehensive analysis shows that existing research provides some reference for further exploration, but studies on the innovation of new engineering talent cultivation models focusing on new productivity are relatively scarce. Most research concentrates on top-level design and pathway implementation in higher education. However, the rapid development of new productivity cannot be achieved without high-quality talent support. The new engineering talent cultivation model, with its interdisciplinary, cross-professional approach, can better meet the requirements of new productivity for engineering talent. Meanwhile, facing the challenges of the new generation of information technology revolution and industrial transformation in the Industry 4.0 era, by innovating the new engineering talent cultivation model, deepening engineering education reforms, and cultivating innovative talent with a combination of innovative thinking, interdisciplinary abilities, and technical expertise, the new engineering model not only has significant theoretical value for sustained innovation in China’s new productivity but also plays an indispensable role in practice.

3. Theoretical Logic of New Productivity and the Cultivation of New Engineering Talent in Local Universities

The rapid formation of new productivity has presented new demands and challenges for the cultivation of new engineering talent. As new technologies, new industries, and new models develop rapidly, the field of engineering technology and application scenarios are expanding, and the demand for new engineering talent is also undergoing profound changes. Specifically, compared to traditional engineering talent, the demand for new engineering talent under the background of new productivity mainly reflects the following three aspects:

First, there is a need for the cultivation of interdisciplinary engineering talent with digital literacy and technical innovation capabilities. New productivity is driven by technological innovation and relies on the development of digital technology. In the era of intelligence, it is essential to integrate intelligent concepts with technical thinking comprehensively into engineering education, promoting the deep integration of digital technology and education. Digital literacy and technical innovation capabilities have become key standards for assessing the professional competitiveness of new engineering talent and core indicators of educational quality. New engineering talent should have strong digital literacy, the ability to analyze complex problems using digital technology, design solutions, and drive business development through informed decision-making.

Second, new engineering talent must possess innovative thinking and creative problem-solving abilities. Under the background of new productivity, technological innovation acts as a driving force, fostering deep integration between different industries and within industries, which gives rise to new engineering technology models and entirely new application scenarios. This requires new engineering talent to keep pace with industrial transformation trends, integrating theoretical knowledge with practical skills, cultivating interdisciplinary and cross-domain perspectives and capabilities. At the same time, with the rapid development of digital technology, there has been a significant improvement in the production, dissemination, and acquisition efficiency of knowledge. Using technologies such as big data and cloud computing allows for precise design of personalized learning paths. Therefore, new engineering talent must continuously learn, enhancing their overall abilities and developing creative learning capabilities to address uncertainties and meet the demands of complex social production.

Finally, new engineering talent must have the ability to serve the digital economy and intelligent society. New productivity has a distinctive Chinese characteristic, focusing on meeting the people's pursuit of a better life. New engineering education should closely follow national strategies and industrial development needs, closely matching economic and social real scenarios, and strive to cultivate high-level talent with both engineering technical abilities and social responsibility. This will drive the development of the digital economy and intelligent society.

In summary, the rapid development of new productivity poses higher demands for the cultivation of new engineering talent and also creates vast opportunities. To respond to this change, universities must continuously optimize and innovate new engineering talent cultivation models, focusing on the close integration of theory and practice, deepening the integration of digital technology with engineering education, and cultivating engineers with diverse capabilities who meet the demands of the new era.

4. Issues in the Cultivation Model of New Engineering Talent

The traditional model of engineering talent cultivation is based on the industrial economy era. With the advent of Industry 4.0 and the era of digitization, the cultivation model for new engineering talent needs continuous optimization to meet the demands of society for this new type of talent.

4.1. Vagueness of the Goals for Cultivating New Engineering Talent

Higher education is a crucial force in promoting new productivity development. With the widespread application of frontier technologies like big data and artificial intelligence in economic and social contexts, humanity is gradually entering an era of intelligence, which requires profound reforms in education and significantly impacts the connotations and goals of cultivating new engineering talent. New engineering talent needs to keep pace with the times, actively adapt to changes, and seize the opportunities brought by the new round of technological revolution and industrial transformation. However, many universities still adhere to a "conservative" mindset, lacking proactive awareness in serving national strategies, insufficient innovation spirit, and openness, with weaker enterprising and autonomous awareness.

The rapid development of new technologies, new industries, and new models is reshaping the connotation and extension of the "engineering" field, causing traditional engineering roles to undergo disruptive changes. Therefore, the goals for cultivating new engineering talent must be dynamically adjusted to cope with a complex and changing technical and industrial environment. However, the systemicity and challenges of these reforms demand high requirements for top-level design and specific implementation. Currently, in the reform practice, some universities have not yet achieved full participation, and some faculty members lack awareness of reform. The cultivation model tends to focus more on knowledge transmission, neglecting the cultivation of innovative thinking, with limitations such as "emphasizing theory over practice," focusing on specialization and standardization while overlooking interdisciplinary integration and personalized development.

Cultivating new engineering talent requires not only the active participation of professional course teachers but also the involvement of management staff and students in understanding the core concepts of engineering education in the new era, clarifying key issues such as "who to cultivate, what to cultivate, and how to cultivate." Otherwise, the cultivation goals are difficult to effectively implement. Therefore, universities should strengthen the awareness of reform among the entire faculty, comprehensively promote in-depth changes in new engineering education, and facilitate the deep integration of education and industry to cultivate innovative engineering and scientific talent that meets future demands.

4.2. Insufficient Interdisciplinary Integration Conditions for New Engineering Talent Cultivation

The rapid development of new industries, new business models, and new modes is characterized by cross-border integration, requiring new engineering talent to have strong cross-disciplinary integration capabilities. The future development trend of new engineering education involves the cross-disciplinary integration of disciplines, majors, and courses, but currently, the conditions for cross-disciplinary integration in the cultivation of new engineering talent are still weak. In practice, cross-disciplinary integration often remains superficial, typically through simplifying non-engineering courses into engineering course systems. However, even though students can choose courses from different disciplines, there is a lack of systematic planning and coordination among these courses, leading to the phenomenon of "virtual integration."

Educators and students are the key factors in achieving cross-disciplinary integration in the cultivation of new engineering talent. On one hand, cultivating a teacher team with cross-disciplinary integration capabilities is a core task for new engineering education. Especially in the context of the digital transformation of education, teachers must have the ability to combine digital technology with engineering knowledge. However, the current teaching force in the new engineering field tends to be single, with many teachers having deep theoretical foundations but lacking industry practice experience, resulting in a gap between teaching content and industry actual needs. Additionally, some teachers lack digital literacy, with limited grasp of emerging technologies. Although some universities have introduced teachers with a background in digital technology to supplement their faculty, these teachers often lack engineering expertise, making it challenging to integrate digital technology with engineering knowledge effectively.

On the other hand, students' adaptability to cross-disciplinary and cross-course learning is also a challenge for the integration development of new engineering talent. Many students lack the thinking abilities and methods necessary for cross-disciplinary learning, which may lead to difficulties in the learning process and affect their sense of belonging to the major. In terms of integration mechanisms, the traditional teaching system mainly relies on secondary colleges for the management of teachers and students. However, in the cross-disciplinary and cross-major education model, breaking down barriers in terms of teacher and student management systems, course settings, and teaching resources still requires in-depth exploration and practice.

4.3. The Delay in Digitization Progress in New Engineering Talent Cultivation Models

To cultivate and develop new productive forces, it is crucial to strengthen the digital economy and enhance the research and application level of digital technologies, promoting the process of digitization of industries. Driven by digital technology, cultivating new types of engineering talents has become a key breakthrough point for optimizing engineering disciplines in higher education. However, from the current practice of new engineering disciplines, the main lag in reform lies in the following aspects:

Firstly, many universities' new engineering talent cultivation has progressed slowly in terms of digitization transformation, with teaching content remaining relatively outdated and lacking close connection with industry practical needs. In the digital economy era, social technological development increasingly relies on the widespread application of emerging technologies, yet many universities have not integrated the learning and practice of these new technologies into the curriculum. This leads to insufficient ability among students to serve technological progress and industrial upgrading. In terms of teaching methods, many schools still adopt the traditional single-discipline model, neglecting the connection between different disciplines and the cultivation of innovative ability. The curriculum content remains centered on the classroom, teacher, and textbook, emphasizing knowledge delivery and professional skill training while overlooking the development of comprehensive abilities such as problem-solving and communication. This places students in a passive position, making it difficult to stimulate their initiative in learning and innovative thinking.

Secondly, there is insufficient innovation in teaching models. Although, with the advancement of digital education, some universities have realized the importance of digitalized teaching and have established massive open online courses (MOOCs), micro-courses, and online and blended learning platforms, the actual effects of these reforms are limited due to a lack of digital literacy and capabilities among many teachers. Many teachers simply transplant traditional teaching content onto digital platforms without effectively utilizing digital technologies to enhance teaching outcomes. They lack the construction of new teaching scenarios, such as human-computer collaboration and virtual simulation, which often results in low student engagement and insufficient interaction between teachers and students, ultimately affecting learning outcomes.

To achieve the digitization transformation of new engineering talent cultivation, universities need to carry out comprehensive reforms and optimization from curriculum content, teaching methods, resource allocation to faculty development to improve students' overall abilities and ensure they have the competitiveness to adapt to future technological developments.

4.4. The Insufficiency in the Quality Assurance System of New Engineering Talent Cultivation

Currently, many universities have introduced content and methods for cultivating talents based on digital technology, information technology, and innovative concepts to enhance the overall quality of talent cultivation in new engineering disciplines. However, the corresponding quality assurance mechanisms, standards, and implementation details are still incomplete, which to a certain extent restricts the scientific nature of the evaluation of cultivation quality.

Currently, there is a lack of a systematic evaluation system that adapts to the diverse and personalized cultivation goals in assessing the quality of new engineering talents. The existing evaluation methods often focus too much on academic grades and knowledge mastery, neglecting the growth of students in practical innovation, cross-disciplinary cooperation, teamwork, and solving complex engineering problems. Furthermore, the evaluation methods for the effectiveness of teaching models based on digital technology are still relatively single, making it difficult to comprehensively reflect the actual impact of teaching reforms and technological applications on student ability enhancement.

At the same time, the quality assurance system's evaluation standards are not detailed enough, lacking specific indicators tailored to the practical needs of new engineering disciplines. For example, there is still a lack of universally applicable and operational evaluation tools for effectively assessing students' innovation capability, industry practice ability, and digital application capability. The coordination mechanism between educational management departments and universities is not well established, leading to differences in the formulation and implementation of evaluation standards, which in turn affects the effectiveness of educational reform policies.

Therefore, to enhance the quality of new engineering talent cultivation, it is urgently needed to build a scientific, comprehensive, and multi-dimensional quality evaluation system. This system should combine the development needs of new engineering disciplines, integrate theory and practice, and comprehensively measure students' overall performance in solving complex engineering problems, cross-disciplinary collaboration, and innovative entrepreneurship. Additionally, the quality assurance mechanisms must be improved, with clear standards and constraints to drive the continuous optimization and development of the new engineering talent cultivation model through scientific evaluation methods.

5. Conclusion

The cultivation of new engineering talents must respond to the internal demands of emerging productivity, adhering to the core characteristics and logic of the development of new engineering disciplines. Therefore, local universities' training models for new engineering talents need to undergo reforms to meet the specific requirements of emerging productivity for talent development.

(1) Redefining Goals: Establishing a quality concept for cultivating new engineering talents

In the context of accelerating the development of emerging productivity, emerging technologies such as big data, cloud computing, and artificial intelligence have become important forces driving economic and social development. Faced with this change, local universities should closely integrate future industrial development trends, exploring diversified and personalized approaches to talent cultivation aimed at cultivating compound engineering technical talents with innovative entrepreneurial and interdisciplinary integration abilities. Thus, establishing a quality concept for cultivating new engineering talents, defining professional orientation, and reshaping talent development goals is crucial.

① Clarifying Professional Orientation: Through the analysis of industry needs, school orientation, and professional characteristics, the direction for professional talent development should be determined to ensure that the development goals focus on "serving industry needs, meeting regional development, emphasizing interdisciplinary integration, and valuing practical application."

②Responding to Industry Needs: The development of emerging productivity has spurred new industries, new models, and new business forms, urgently requiring the cultivation of talents with interdisciplinary knowledge, comprehensive abilities, and innovative thinking to meet the diverse needs of the information technology industry.

③Serving the School's Orientation: Based on the school's orientation, it is essential to closely align with national strategies, regional economic development, and industry needs to create a high-level finance-oriented university with distinct characteristics, training highly skilled engineering talents with financial literacy and innovation capability, thus providing talent support for regional economic development.

(2) Reconstructing the Model: A new model for cultivating new engineering talents in three dimensions and three gradients

①Establishing a Multi-gradient Hybrid Talent Training Model with a Capability Goal Orientation: The first gradient is basic comprehensive quality capability, centered on "general education courses" and "basic courses in major subjects," aiming to comprehensively enhance students' humanistic quality, professional foundation, and basic application practice skills; the second gradient is professional comprehensive skill capability, with "professional core courses" and "core courses in major subjects" at its core, focusing on cultivating students' professional knowledge and abilities; and the third gradient is students' comprehensive vocational skills and innovative entrepreneurial capabilities, centered on "professional expansion courses" and "scientific research training," cultivating independent analysis and problem-solving capabilities in engineering, computational thinking, and other abilities such as developing student innovation projects and self-employed entrepreneurship on e-commerce platforms.

②Designing a Talent Training Model Reconstructed Driven by Emerging Productivity and New Engineering Paradigms: Driven by emerging productivity, with engineering certification as a guide, and supported by the theory of new engineering paradigms, the model includes top-level design focusing on multi-layered capability goals, systematizing quality improvement; a mid-level design driven by emerging productivity, enterprise demand-oriented, highlighting the core role of "new ideas"; and a bottom-level design focusing on talent training pathways, forming a multi-disciplinary knowledge intersection framework with general courses, professional courses, and cutting-edge courses. The model also constructs a multidimensional hybrid teaching process, deepening the course structure and teaching methods of the "new model"; it forms the foundation of practice relationships with modules such as curriculum design, school-enterprise practice, internships, and training, thus reinforcing the "new system's" practical system.

(3) Empowering Technology: Establishing a new form of reciprocal assistance between teachers and students

①Innovating Intelligent Teaching Forms: Teachers use new concepts, technologies, and methods to change the traditional "teaching and learning" relationship, breaking through the limitations of classroom teaching in terms of time and space, providing a virtual and real integration of new fields. Relying on intelligent teaching platforms, a diversified interactive teaching mode is formed.

②Building a New Field for Student-Driven Learning: Driven by emerging technologies such as VR and AR, a virtual and real interconnected smart teaching platform is created, relying on shared physical and intelligent spaces to form a community of teachers and students, a student learning community, where research projects, social practice, and informal exchanges are conducted, thus expanding students' learning fields and enhancing students' innovative practical capabilities.

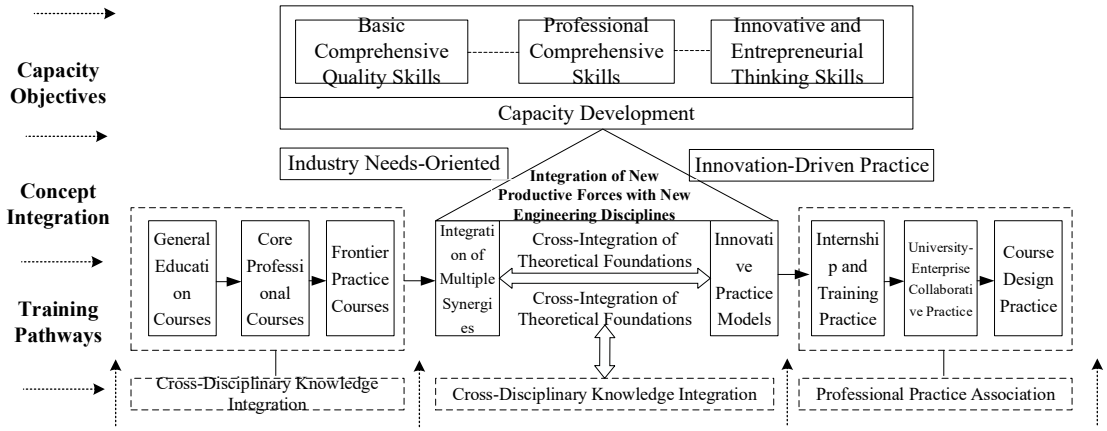

Figure 1. Multi-dimensional and Multi-gradient Hybrid Talent Training Model

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