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Innovation of Classified Cultivation and Classified Evaluation in Training Outstanding Engineers in Energy and Electric Power

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Abstract: Driven by both the "new engineering" initiative and the energy revolution, the traditional engineering education model can hardly meet the demand of the energy and electric power industry for diversified and interdisciplinary outstanding engineers. Based on the "industry-university-research-application" four-in-one collaborative education concept, this paper constructs a new training system centered on classified cultivation and classified evaluation. The system aims to solve core problems such as homogeneous training, disconnection between industry and academia, single evaluation method, and insufficient faculty. Through measures including modular courses, the dual-tutor system, and diversified practical platforms, it realizes differentiated and precise talent training, so as to deliver outstanding engineers with the ability to "define problems, break through technologies, and create value" for the energy and electric power industry.

Keywords: Classified cultivation; Classified evaluation; Outstanding engineers; Energy and electric power; Industry-education integration

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1. Introduction

With the in-depth development of the new round of scientific and technological revolution and industrial transformation, engineering education is facing unprecedented opportunities and challenges. In 2024, engineers are an important force in promoting engineering science and technology to benefit humanity and create the future, as well as a key component of the national strategic talent force. It is imperative to accelerate the construction of a large-scale contingent of outstanding engineers [1]. Currently, the training of outstanding engineers is one of the strategic tasks for building a strong country in higher education [2]. In January 2025, the *Outline of the Plan for Building a Powerful Education Country (2024–2035)* proposed to "strengthen the National Academy of Outstanding Engineers," which provides strong support for fostering the talent foundation for the development of new productive forces [3].

At present, universities led by engineering colleges have also taken the initiative to carry out the training of outstanding engineers in an orderly manner. However, it should be noted that due to the influence of the traditional engineering education model and the limitations of the majors themselves, there are still certain dilemmas in practical training. The multi-dimensional training goals of integrating comprehensiveness, practicality and innovation for engineers have not been well achieved, and it is difficult to cultivate high-quality outstanding engineers who can perfectly adapt to social development [4]. Therefore, it is urgent to promote the connotative development of engineering education through the innovation of classified cultivation and classified evaluation mechanisms.

2. Research background and significance

Energy and electricity serve as a crucial foundation for the development of the national economy. To achieve the goals of "carbon peaking and carbon neutrality" and strongly support the comprehensive construction of a modern socialist country, China's 14th Five-Year Plan for Energy and Electricity has determined to implement the national new energy strategy of "four revolutions and one cooperation" and build a clean, low-carbon, safe, and efficient modern power industry system. This puts forward new expectations and requirements for higher education in energy and electricity, especially for the cultivation of high-level talents [5], while outstanding engineers are an important support for the development of new productive forces. Currently, China's engineering education is in a critical stage of transformation from scale expansion to quality improvement. Taking the School of Mathematics and Physics of Shanghai University of Electric Power as an example, the school currently has five master's and doctoral degree authorization programs, initially forming a pattern of coordinated development of academic and professional degrees. However, in the actual training process, there are still problems such as the disconnection between the curriculum system and industrial needs, the lack of systematic practical platforms, and the singularity of evaluation standards.

Preliminary research shows that the existing training system fails to take "solving complex engineering problems" as the core goal and lacks identification of and response to differences in talent types. Therefore, constructing an educational mechanism driven by both classified cultivation and classified evaluation has important theoretical significance and practical value: on the one hand, it can promote theoretical innovation in engineering education; on the other hand, it can provide a replicable and promotable high-level talent training model for the energy and electricity industry.

3. Research objectives and core issues

In the early stage, through discussions, questionnaires, individual interviews and other methods, we investigated the opinions of supervisors and students on training models, curriculum systems, etc., identified the shortcomings, difficulties and key focus areas in cultivating outstanding engineers, listened to relevant needs, and proposed a full-chain optimization path centered on "industry-education integration." It is emphasized that measures such as strengthening practice orientation should be taken to improve graduate students' ability to solve complex engineering problems and serve the national innovation-driven development strategy in the energy and power field.

According to the research, the existing training system has not taken "cultivating future outstanding engineers" as the core goal throughout the process, failed to fully reflect the characteristics of engineering education in key links, and there is a significant gap from the training requirements. For many years, China's

postgraduate education has been dominated by academic degrees, and the talent training model is single, leading to a relatively single curriculum system and other issues [6]. It is imperative to build a new training ecosystem.

Driven by the new engineering discipline and energy revolution, this project innovatively constructs a coordinated system of "classified training and classified evaluation," focusing on solving four core issues in the cultivation of outstanding engineers in the energy and power field. By clarifying differentiated training paths, addressing industrial pain points, establishing dynamic classified evaluation standards, reconstructing modular courses and a "double-qualified" faculty team, we aim to cultivate outstanding engineers with specific capabilities and build a core technology innovation engine and high-level engineering talent pool in the energy and power field.

4. Research methods and implementation paths

The graduate training system encompasses corporate cognition, theoretical courses, and other components. Supervisors should delve into the logical relationships among various links and establish connections between "practical innovation courses" and other parts. Currently, the three-stage training model of "theoretical learning → professional practice → thesis completion" is widely adopted. To cultivate graduate students' practical and innovative capabilities, innovation and entrepreneurship education should be integrated with professional education, teaching should be combined with engineering practice and innovation, "thesis practice and innovation" should complement "practical innovation courses," and the thesis and courses should proceed in parallel [7].

Addressing the issue of cultivating outstanding engineers under the construction of emerging engineering disciplines, particularly in response to the talent demands of the energy and electric power industry, this paper draws on the system of national colleges for outstanding engineers [8] and proposes a "production-education-research-application" four-in-one collaborative talent cultivation innovation model. Guided by market demands, this model integrates classified cultivation and evaluation mechanisms, designs differentiated training paths, and enhances training effectiveness through measures such as "reconstructing interdisciplinary curriculum systems."

(1) Cultivating a fertile ground for classified training: Formulate sound top-level design, establish a hierarchical and classified training program and evaluation standards, and set up incentive mechanisms. Encourage teachers to take temporary positions in enterprises and invite people with diverse backgrounds to give lectures on campus. Publicize typical cases of innovation and entrepreneurship, guide students to identify their directions, and create a favorable atmosphere.

(2) Strengthening the foundation through classification: Build a classified curriculum system, deepen the joint talent cultivation model, and enhance the classified allocation and capacity building of teachers. For example, formulate classified practical goals and graduation research standards for professional masters, employ off-campus tutors, provide classified training for in-campus teachers, and recruit enterprise experts to enrich the teacher pool.

(3) Developing classified guides: Deepen the "dual-tutor system" and form teams of in-campus and off-campus tutors. In-campus tutors focus on scientific research, while off-campus tutors connect with industrial needs. Tutor teams work together to formulate plans, implement classified evaluation, and empower students' growth.

(4) Creating classified training grounds: Integrate resources, take enterprise needs as the driving force, and jointly build school-enterprise bases and workstations [9]. Design diversified "training grounds" such as technical research grounds, engineering practice grounds, and integration competition grounds. Establish adaptive achievement evaluation standards and invite enterprise experts to participate in

guidance and review to ensure alignment with the classified talent cultivation goals [10].

5. Innovation points and practical value

With "classified cultivation and classified evaluation" as its soul, "in-depth integration of industry, academia, research and application" as its cornerstone, "precision practice + industry evaluation" as its breakthrough, and "faculty restructuring + collaborative empowerment" as its guarantee, this initiative has effectively addressed the key common issues in cultivating outstanding engineers amid the energy and electricity transition. It provides a replicable and promotable systematic solution for the development of new engineering disciplines.

5.1. Establishing an all-chain in-depth integration mechanism of "classified cultivation and classified evaluation"

In an innovative move, "classified cultivation" and "classified evaluation" are regarded as interlocking core engines that run through the entire talent cultivation process. They are deeply integrated into every link of talent development, ranging from top-level design (hierarchical and classified cultivation programs), curriculum systems (modular course selection), practice platforms (differentiated "training grounds"), faculty allocation (dual-tutor cooperation), guidance processes (personalized plans and dynamic feedback) to achievement recognition (diversified evaluation standards). This realizes refined and personalized cultivation based on talent type characteristics, industry development needs, and individual development potential, ensuring that the cultivation process is highly aligned with objectives. It significantly enhances the pertinence of cultivation and accurately responds to the industry's demand for diversified talents.

5.2. Building a collaborative education ecosystem with in-depth integration of "industry, academia, research, and application"

"To cultivate outstanding engineers, we must mobilize the enthusiasm of both universities and enterprises" [11]. The four elements—"industrial demand, education and teaching, scientific research, and engineering application"—are substantively, fully, and deeply integrated, rather than simply superimposed. Guided by real market demands, curriculum restructuring and practice design are driven forward; enterprises are deeply embedded in core educational links, such as micro-major courses, joint training bases, and tutor teams; major projects are directly transformed into teaching resources for "technological breakthrough fields"; and teaching achievements and engineering practices directly serve industrial applications. An open, collaborative, and mutually beneficial education ecosystem is built, which effectively solves the long-standing problems in traditional engineering education, such as superficial university-enterprise cooperation, separation of science and education, and disconnection between teaching and application. Through mechanisms such as "project-driven," "integrated collaboration," and "co-construction and sharing," practice training is ensured to not only involve "hands-on operation" but also "seriously" solve real industry problems. This improves the effectiveness of practical teaching and its recognition by the industry, and aligns talent cultivation closely with industrial transformation and cutting-edge science and technology.

5.3. Implementing the "faculty classification empowerment + collaborative tutor team" model

The dual-tutor system refers to assigning one academic tutor and one practical tutor to graduate students during their training, who provide guidance on academic research and practical ability respectively. Academic tutors

are usually university professors responsible for cultivating students' academic capabilities; practical tutors typically come from enterprises, research institutes, or other practical fields, focusing on guiding practical skills [12]. We will deepen the "dual-tutor system" into a collaborative tutor team covering multiple fields and types. On-campus and off-campus tutors will provide differentiated guidance based on student types, jointly develop personalized plans, and implement classified evaluation and dynamic feedback integrated into daily guidance. This breaks the bottleneck of a single-structured faculty team and builds a "dual-qualification and dual-competence" tutor team that can truly support classified training goals. The dynamic feedback mechanism of the collaborative tutor team upgrades the guidance process into a continuous and precise empowerment process, strongly supporting students' personalized growth and capability improvement.

6. Conclusion

From the perspective of the academic qualification system for talent cultivation, although China has basically formed an academic talent training system centered on the "bachelor—academic master—academic doctor" pathway and an applied professional talent training system covering "applied undergraduate—professional master's degree—professional doctor's degree," two issues deserve consideration: First, looking at these two development trajectories, vocational education, as an important channel for cultivating applied technical talents, has no place in the academic qualification hierarchy; second, there are relatively few types of professional doctorate disciplines, and the channels for academic qualification improvement are unequal and unsmooth [13]. The cultivation of outstanding engineers not only needs to emphasize general education, encourage governments, enterprises, the public and other subjects to share demand standards through a "broad-caliber" approach, and expand universal indicators such as moral education, law-abiding awareness, and basic scientific knowledge, but also needs to promote industrial technological progress and standard upgrading through a "narrow-caliber" approach. It is necessary to identify the unique needs of different division links in the industrial value chain, design personalized indicators that meet professional post requirements and individual talent development around tasks and practical projects in the industrial value chain division, and establish an outstanding engineer training standard system featuring "integration of general and specialized education" [14].

Therefore, classified cultivation and classified evaluation are important directions for engineering education reform in the new era. This paper expects that through systematic design and innovative practice, a new ecology for outstanding engineer cultivation with "classified cultivation–classified evaluation" as the core and "industry-university-research-application" as the support will be built in the future. This will effectively improve the pertinence, practicality, and innovation of talent cultivation, provide solid talent support for the high-quality development of the energy and power industry, and offer a replicable practical example for the construction of new engineering disciplines. The value orientations and interest demands of different subjects should be aligned in cultivating outstanding engineering talents to build a multi-stakeholder shared community of interests and a well-balanced collaborative cooperation relationship. This also relies on the establishment and improvement of organizational systems, operation models, and coordination mechanisms at the macro level to "endorse" the implementation of systems at the meso and micro levels. Therefore, research on the path of promoting outstanding engineer cultivation through industry-education integration at the macro level should be the focus of future research work [15].

Disclosure statement

The author declares no conflict of interest.

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