Journal of Contemporary Educational Research, 2025, Volume 9, Issue 11
http://ojs.bbwpublisher.com/index.php/JCER
ISSN Online: 2208-8474
ISSN Print: 2208-8466

Construction of the "Five-Element Synergy" International Talent Training Model for Featured Disciplines

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Abstract: The international development of the petroleum industry has posed an urgent demand for the internationalization capabilities of both academic and professional master's students. However, there is currently a shortage of such talent in the petroleum energy sector, along with a lack of a collaborative training system. Based on this, this study focuses on featured disciplines in the petroleum energy sector and systematically constructs an international talent training model centered around the "five-element synergy" of "government-school-enterprise-teacher-student." Firstly, it defines the connotations of the five-element synergy: "government (strategic guidance)-school (platform support)-enterprise (demand verification)-teacher (leading transformation)-student (practical co-creation)." Secondly, it sets distinct training objectives for academic (focusing on academic innovation) and professional (emphasizing engineering practice) master's students. Furthermore, it constructs a "categorized and layered, progressive and collaborative" curriculum system, builds an international faculty team through a "recruitment + training" dual-path approach, and cultivates students' sense of professional mission to "contribute to the nation's energy sector" through a "macro + micro" perspective. This model provides a practical pathway for international talent training in the petroleum energy sector and holds significant importance for enhancing the overseas competitiveness of petroleum enterprises and safeguarding national energy security.

Keywords: Energy; Five-element synergy; International talent; Training model

Online publication: December 10, 2025

1. Introduction

Against the backdrop of the continuous advancement of China's energy security strategy, the status of oil as a strategic foundational energy source has become increasingly prominent. Given China's high dependence on foreign oil and gas, there is an urgent need to ensure energy supply and solidify security safeguards by deepening international energy exchanges and cooperation, as well as expanding overseas resource layouts. The

acceleration of the internationalization process in the oil industry and the intensification of international market competition necessitate a cadre of compound international talents who "understand technology, are proficient in international affairs, excel in collaboration, and shoulder strong responsibilities." Throughout the process of Chinese oil companies "going global," various aspects of overseas project operation and management urgently require the support of international talents skilled in technological research and development, strategic analysis, engineering practice, and project execution. However, the current pool of internationally oriented talents cultivated by petroleum universities falls short of meeting this objective, with gaps still existing in the systematic and collaborative training systems for academic and professional graduate students. Therefore, establishing an international talent cultivation model for academic and professional graduate students based on the distinctive disciplines of petroleum energy holds significant importance for enhancing the overseas competitiveness of oil companies and safeguarding national energy security.

Currently, many schools have implemented diverse and collaborative international talent cultivation models, with the "units" of collaborative cultivation displaying diversity. For instance, the School of Metallurgy and Environment at Central South University has explored a ternary collaborative training model involving "government-school-enterprise" [1], vocational education institutions have expanded this ternary model to a quaternary one involving "government-school-enterprise-overseas institutions" [2], and the martial arts program at Capital Institute of Physical Education has constructed a quintuple integrated teaching system encompassing "government, application, industry, academia, and research" [3]. These models achieve diverse and collaborative education through various means, such as international curriculum design [1], virtual training scenario construction [2], precision cultivation assisted by digital intelligence [4], dynamic curriculum system design [5], interdisciplinary knowledge integration [6], integrated design of "curriculum-training-competition" [5,6], and multimodal literacy [7]. Additionally, schools are equipped with international faculty [5,8] and "dual-qualified" teaching teams consisting of school and enterprise instructors [1]. It is evident that these training models fully consider the principal roles of governments, schools, enterprises, and teachers, yet they overlook the collaborative role of students and have not yet formed a quintuple collaborative model centered on the logic of "government-school-enterprise-teacher-student," which is precisely the key to meeting the internationalization needs of the oil industry.

Based on this, grounded in the distinctive features of the petroleum energy sector and guided by the national energy security strategy and industry development needs, this study establishes "government-school-enterprise-teacher-student" as the core collaborative entities. Given the differing ability orientations of research-oriented and applied master's students, it systematically constructs a "five-element synergy" international talent cultivation model for master's students across four dimensions: optimization of training objectives, restructuring of the curriculum system, construction of the teaching staff, and cultivation of students' sense of professional mission. This aims to provide a practical pathway for the supply of international talent in the petroleum energy sector.

2. The connotation of the "five-element synergy" talent cultivation model

The "government-school-enterprise-teacher-student" five-element synergy is an organic whole centered on educational effectiveness, with resource integration and complementary capabilities as its logical foundation. The essence of five-element synergy is "government support, school platform, enterprise problem-posing, teacher guidance, and student practice," aiming at cultivating international talent and breaking down barriers

between schools and enterprises, as well as between teaching and learning, to foster interdisciplinary talent for the petroleum sector.

The government serves as the "strategic leader and resource guarantor" in collaborative education. As the core of top-level design, guided by national energy security and industry internationalization strategies, it ensures that collaborative education remains aligned with national strategies and industry needs through the formulation of special policies, dedicated financial allocations, support for research projects, supervision of degree authorization, quality inspections of training, international mutual recognition of academic degrees, and dynamic policy optimization.

Schools act as the "platform and institutional guarantors" for collaborative coordination. As the central hub, it breaks down disciplinary barriers through a system of open competition for leading roles, forming interdisciplinary research, teaching, and mentor teams, and integrating teacher resources to create innovative consortia. It establishes platforms for teacher transformation and student research through round-the-clock laboratory access, curriculum reforms, and small-class team teaching, and implements a dynamic adjustment mechanism for training programs.

Enterprises serve as the "providers and validators" of practical needs. They participate in collaboration through two-way interaction, on one hand, inputting industrial resources by bringing corporate mentors into the classroom, incorporating research achievements/equipment into teaching materials/experiments, and providing cutting-edge industry materials for teaching; on the other hand, supporting graduate theses with real-world projects, evaluating students' practical abilities, and feeding back to schools to optimize programs and teachers to adjust teaching, achieving alignment between cultivation and enterprise needs.

Teachers serve as "leaders and transformers" in collaborative implementation. Their roles have undergone a triple transformation: research has shifted from individual efforts to interdisciplinary team collaboration, forming a synergy between "research-teaching-nurturing"; teaching has transitioned from closed lectures to open team-based instruction, incorporating cutting-edge experiences to guide students in proactive learning; and guidance has evolved from single-discipline supervision to cross-disciplinary mentorship by teams, providing multidimensional support to students.

Students act as "practitioners and co-creators" in collaborative participation. They have upgraded from passive recipients to active participants, bridging curriculum and practice through universal involvement in research/teaching teams. This involves pre-class research, in-class interaction, post-class study, and even serving as teaching assistants. Leveraging teacher guidance and corporate projects, students apply their knowledge to research papers, with outcomes feeding back into teaching and corporate technological improvements, creating a positive feedback loop.

3. Objectives for international talent cultivation in master's programs

3.1. Academic master's degree students

Upholding the leadership of the Communist Party of China and guided by the Xi Jinping Thought on Socialism with Chinese Characteristics for a New Era, individuals should actively practice the core socialist values and achieve all-round development in morality, intelligence, physical fitness, aesthetics, and labor. They should possess a rigorous academic attitude and a certain degree of innovative capability. They should have an understanding of the general development trends of the first-level discipline of Petroleum and Natural Gas Engineering and the latest advancements in their specific research directions, with a solid theoretical foundation

and in-depth professional knowledge. They should also possess certain experimental operation skills, software programming and application abilities, as well as foreign language reading and writing proficiency. With strong analytical and problem-solving skills, they should be capable of engaging in scientific research, engineering design, and technical testing in related research fields of this discipline. The aim is to cultivate innovative talents urgently needed for the development of the Party and the country, who possess both moral integrity and professional competence, as well as a forward-looking and international perspective.

3.2. Professional master's degree students

Upholding the leadership of the Communist Party of China and guided by the Xi Jinping Thought on Socialism with Chinese Characteristics for a New Era, individuals should actively practice the core socialist values, achieve all-round development in morality, intelligence, physical fitness, aesthetics, and labor, and possess good professional ethics and a dedicated work ethic. The cultivation of master's degree professionals in the Resource and Environment category (with a focus on Petroleum and Natural Gas Engineering) aims to meet the demands of the resource and environment industry. Guided by the objective of resolving major technical and environmental issues in petroleum and natural gas engineering, the program places emphasis on nurturing individuals with a broad and solid theoretical foundation in resources and the environment. These individuals should have an understanding of the overall landscape and development trends in the field of petroleum and natural gas engineering, master the fundamental theories and systematic professional knowledge in this field, and be capable of applying advanced methods and modern technological means to solve practical engineering problems. In response to the urgent needs of the Party and national development, the program aims to cultivate high-level, interdisciplinary, and composite professionals engaged in the research and development of petroleum and natural gas engineering technologies, the testing of advanced technology applications, or the management of engineering organizations.

4. Reconstruction of the curriculum system

In response to the differences in the objectives of cultivating capabilities for academic and professional graduate students, a curriculum system featuring "classification and stratification, progression and collaboration" is established. In terms of cultivation dimensions, it covers four core aspects: course learning, research and study practice, thesis research, and campus activities, forming a complete cultivation chain of "theoretical foundation-practical refinement-innovative output-quality cultivation." Regarding curriculum modules, six modules are set up, including public compulsory courses, professional compulsory courses, professional elective courses, interdisciplinary elective courses, extended elective courses, and undergraduate remedial courses. This setup not only ensures the systematicity of the knowledge system but also provides space for personalized development, fully highlighting the foundational, cutting-edge, interdisciplinary, and petroleum industry-specific characteristics of graduate courses.

Differentiated cultivation is implemented for the two types of graduate students. For academic graduate students, with theoretical research capabilities and academic innovation literacy as the core, the course and practice designs focus on in-depth theoretical exploration, academic method training, and high-level scientific research practice, aiming to cultivate their original research capabilities in fields such as petroleum exploration and development and energy strategy research. Professional graduate students are oriented towards technical application capabilities and the effectiveness of engineering practices. Their courses and practical training focus

on applied content such as the transformation of petroleum engineering technologies and the operation and management of overseas projects, thereby strengthening their practical abilities to solve real-world problems in the industry.

The cultivation process follows a progressive growth model. In the first year of graduate studies, the emphasis is on coursework, with a focus on consolidating core knowledge in mathematics, foreign languages, petroleum geology, and other foundational subjects, thus constructing a broad knowledge framework. In the second year, research and practical training take center stage. Through on-site internships at enterprises and participation in industry projects, students select research topics based on industry pain points or corporate needs, facilitating the transformation of theoretical knowledge into practical skills. In the third year, thesis research becomes pivotal, encouraging academic graduate students to produce high-level theoretical achievements and professional graduate students to develop implementable application plans. This ultimately achieves a stepwise enhancement of abilities through "basic learning-extended training-innovative practice."

The curriculum system consistently integrates the principles of "holistic education encompassing moral, intellectual, physical, aesthetic, and labor education, the integration of industry, teaching, and research, and the infusion of ideological and political education into courses." Firstly, it incorporates the requirements for all-round development in morality, intelligence, physical fitness, aesthetics, and labor into various teaching aspects. Through campus activities such as petroleum culture exhibitions, professional competitions, sports competitions, and volunteer services, it cultivates the comprehensive qualities of graduate students, achieving a balanced approach to education. Secondly, it brings enterprise projects into the classroom, enabling real-time correlation between technological advancements in the petroleum industry (e.g., the development and utilization of unconventional energy sources and hydrogen energy) and course content, ensuring the timeliness and practicality of the knowledge system and deepening the collaborative integration of industry, teaching, and research. Thirdly, it subtly integrates the spirit of scientists and the Daqing Spirit into the curriculum, effectively realizing the linkage between courses and ideological and political education.

5. Faculty development

Adhere to the core strategy of "introduction + cultivation" working in tandem, and systematically build a teaching team with both professional competence and an international perspective through internal and external collaboration and tiered empowerment.

In terms of "introduction," the focus is on infusing young teachers with an international gene. Priority is given to recruiting young teachers with doctoral degrees from or study abroad experiences at renowned foreign universities. By integrating foreign teaching methods and concepts into the curriculum, leveraging their language advantages and international perspectives, and supporting them in leading or participating in the development and teaching of bilingual courses, we aim to enhance the internationalization of our teaching staff.

Regarding "cultivation," differentiated improvement plans are implemented based on the characteristics of local teachers of different age groups. On the one hand, local young teachers are encouraged to obtain international professional certifications and offer bilingual courses, disseminating the latest developments in their disciplines. On the other hand, local middle-aged and elderly teachers are trained to incorporate scientific and technological projects into their classrooms, innovate teaching methods, and assign more staged assignments such as small project reports. Using "course groups" as a platform, we promote cross-generational teaming among teachers of different ages. Regular joint lesson planning, teaching discussions, classroom

observations, and evaluations are conducted within these groups to facilitate the deep integration of teaching experience and innovative ideas. Through this gradient-based and complementary team-building approach, we aim to create a virtuous ecosystem where "senior teachers mentor, middle-aged teachers take the lead, and young teachers drive innovation," resulting in a high-quality teaching team with a reasonable age structure, strong professional capabilities, and prominent international perspectives, and achieving the coordinated development and gradient inheritance of teaching resources.

6. Cultivation of students' sense of professional mission

We conduct graduate mission education simultaneously from both macro and micro perspectives. From a macro perspective, we foster consensus on educational and teaching philosophies among teachers and students through various channels, including graduate orientation education, grand discussions on graduate education ideologies, professional grade meetings, faculty-student symposiums, academic forums, industry sharing sessions, career development salons, and themed class meetings. From a micro perspective, we vigorously promote curriculum-based ideological and political education reform by embedding energy security case studies into professional courses, organizing themed discussions on "inheriting the petroleum spirit" during practical sessions, and leveraging mentors' personal examples to convey industry missions. We should deeply integrate the petroleum spirit of "hard work, diligent practice, the 'Three Olds' and the 'Four Stricts,'" the school ethos of "fueling the country and striving for national pride," excellent traditional Chinese culture, and the concept of major national projects into the teaching process in the form of ideological and political cases, drawing on relevant course content. This approach aims to guide graduate students to cultivate a sense of patriotism and responsibility towards "serving the country through energy," and to grow into international talents in the petroleum field with both professional capabilities and a sense of responsibility. Meanwhile, we should enhance students' sense of professional mission and appeal by leveraging their sense of scientific research self-efficacy, academic interests, and academic passions. This initiative has effectively promoted students' engagement in learning, heightened their enthusiasm for research, improved their life satisfaction, reduced burnout, and further unleashed the innovative vitality of graduate students.

7. Conclusion

This study, grounded in the distinctive discipline of petroleum energy and guided by the national energy security strategy and the internationalization needs of the industry, addresses the pain points in the differentiated cultivation of academic and professional master's graduate students. It systematically constructs a "five-element synergy" international talent cultivation model. The main conclusions are as follows:

(1) It clarifies the core logic of the five-element synergy in talent cultivation within the petroleum energy sector, forming an organic closed-loop of "government guidance, school support, enterprise problem-posing, teacher guidance, and student practice."

(2) It constructs a differentiated international cultivation system for two types of graduate students from four dimensions: "cultivation objectives, curriculum system, faculty, and students' sense of professional mission." This system facilitates a stepwise improvement in "foundational knowledge-abilities-innovation."

Funding

Key Project of Postgraduate Education and Teaching Reform and Research at Southwest Petroleum University (2022JG003); Degree and Postgraduate Education Research Project at Association of Chinese Graduate Education (2020MSA346); Sichuan Provincial Society for Degree and Graduate Education (2023YB0406); Higher Education Teaching Reform Research Project at Southwest Petroleum University (X2021JGYB003)

Disclosure statement

The authors declare no conflict of interest.

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