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Exploration of the Upgrade Path for New Liberal Arts Disciplines in Industry-Specific Engineering Colleges—Taking the Business Administration Discipline of Energy-related Universities as An Example

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Abstract: The new round of technological revolution and the green and digital transformation of the energy industry have raised new requirements for the cultivation of new liberal arts talents in specialized engineering colleges with industry characteristics. Currently, there are common practical problems in liberal arts majors of such colleges, such as the separation of arts and science, significant disciplinary barriers, disconnection between talent cultivation and industry demands, and fixed training models. Taking the business administration major of Southwest Petroleum University as an example, this paper clarifies the ability, knowledge and comprehensive quality requirements of the energy industry for "understanding energy, being good at management and being innovative" comprehensive new liberal arts talents, and systematically analyzes the existing problems and deep-seated causes of the construction of new liberal arts majors in specialized engineering colleges with industry characteristics. The research constructs a four-in-one construction concept of inheriting and innovating, cross-disciplinary arts and science, unified supply and demand, and collaborative dynamics. It builds a professional transformation and upgrading path from five dimensions: curriculum system, faculty team, teaching methods, practical teaching, and disciplinary platform, and designs a dynamic talent cultivation plan adapted to the development of the energy industry. It also builds a comprehensive guarantee system from six aspects: funds, faculty, platform, evaluation, system, and information technology. The pilot practice results show that this model effectively solves the problem of "two-faced" integration of arts and science, significantly improves students' practical innovation ability and industry job fit, and significantly increases the employment rate of graduates in the energy industry and the satisfaction of employers. The research forms a new liberal arts construction paradigm of "industry characteristics + cross-disciplinary arts and science", enriches the theoretical system of new liberal arts construction in industry-related universities, and can provide replicable and promotable practical references for specialized engineering colleges with industry characteristics in the petroleum, geological, mining, and power industries to upgrade new liberal arts majors and cultivate comprehensive talents.

Keywords: New liberal arts construction; Industry-oriented engineering colleges; Interdisciplinary integration of arts

and engineering; Talent training model; Energy industry

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1. Introduction

The rapid development of the digital economy and artificial intelligence has reshaped the structure of industries and talent demands, driving continuous changes in the training model of higher education. In 2020, the "Declaration on the Construction of New Liberal Arts" clearly proposed the reform direction of interdisciplinary integration of disciplines and the empowerment of liberal arts by information technology, providing important guidance for the transformation of liberal arts majors in universities.

Specialized engineering colleges in energy-related industries have deeply engaged in pillar industries and have significant advantages in engineering. However, influenced by traditional educational concepts, the foundation of liberal arts construction is weak, the characteristics are insufficient, and talent cultivation is disconnected from the new business models of the industry. With the green and low-carbon, intelligent transformation of the energy industry, the market urgently needs comprehensive management talents who possess management qualities, energy cognition, digital capabilities, and engineering thinking. The shortcomings of the traditional liberal arts training model in adapting to this situation have become increasingly prominent.

Southwest Petroleum University, relying on the advantages of the energy industry, has carried out explorations in the cross-disciplinary construction of new liberal arts and engineering in its national first-class business administration major. However, there are still problems such as insufficient integration of disciplines, insufficient cross-curricular courses, weak faculty and practical teaching, and an incomplete dynamic education mechanism. Based on this background, this paper takes the business administration major of this university as a sample to explore the upgrade path of new liberal arts majors in industry-specific engineering colleges, providing practical references for the transformation of liberal arts in similar universities.

2. Theoretical basis and current research status at home and abroad

2.1. The essence of the new liberal arts construction

The New Liberal Arts is a new educational form formed by adapting traditional liberal arts to the technological revolution and industrial transformation. Its core characteristics include interdisciplinary integration, technology empowerment, a practice-oriented approach, and distinctive development. It does not negate traditional liberal arts; instead, it builds upon the core advantages of cultivating humanistic qualities and value guidance in liberal arts, breaks through the barriers of single disciplines, promotes the deep integration of liberal arts with engineering, information technology, and modern industries, and focuses on cultivating interdisciplinary talents with a broad perspective, innovative thinking, and practical skills, aligning with the changing trends of industrial talent demands in the new era.

2.2. The theory of interdisciplinary integration

The integration of disciplines is the core process of mutual penetration and collaborative innovation among

multiple disciplines, which gives rise to new theories, new methods and new research directions. It is an important support for knowledge innovation and the cultivation of interdisciplinary talents in universities. The development of disciplines has gone through the stages of being single and independent, coexistence of multiple disciplines, cross-disciplinary collaboration, and ultimately reaching deep integration. The core educational goal is to break through the limitations of single-disciplinary thinking and cultivate students' comprehensive abilities to solve complex industrial and social problems.

2.3. The theory of industry-education integration and collaborative education

The core of industry-academia integration lies in connecting the education chain, talent chain, industry chain, and innovation chain. Through in-depth cooperation between schools and enterprises, high-quality resources are integrated to narrow the gap between talent cultivation and job requirements, and enhance the adaptability of talents. Collaborative education is an extension and expansion of industry-academia integration, advocating that multiple entities such as universities, enterprises, government, and industry organizations participate in the cultivation of talents throughout the process, pooling educational forces and constructing a comprehensive and three-dimensional educational system.

2.4. The theory of dynamic talent cultivation mechanism

The dynamic talent cultivation mechanism is centered on "demand-oriented and student-centered", breaking the rigid and closed drawbacks of the traditional talent cultivation model. Based on the dynamic changes in industrial development and job requirements, it continuously optimizes the training objectives, curriculum system, teaching content and evaluation model. This mechanism forms a closed-loop operation system, covering four core links: industry demand research, joint revision of training plans by schools and enterprises, iterative update of course content, and optimization of the entire process quality assessment. This ensures that talent cultivation is in sync with industry development.

2.5. Current research status at home and abroad

2.5.1. Current research status abroad

Foreign universities have been conducting reforms integrating humanities and social sciences with engineering disciplines earlier, and their concepts are highly consistent with the new liberal arts construction in China. The academic community has proposed a technological integration education paradigm, advocating the breaking of disciplinary barriers and the reconstruction of the new era's liberal arts talent cultivation system, providing theoretical support for the liberal arts reform in engineering colleges. Numerous empirical studies have shown that interdisciplinary humanities and social science courses can effectively enhance the innovation ability, critical thinking and social responsibility of engineering students. The academic community generally advocates promoting curriculum reform and diversified evaluation centered on students. At the same time, foreign scholars have carried out teaching practices based on engineering cases and integrating a humanistic perspective, providing practical references for embedding liberal arts in engineering industry scenarios. Overall, foreign research has formed a consensus on cross-disciplinary, industry-oriented, and dynamic adjustment in reforms. However, most of the research focuses on comprehensive and general engineering colleges, and there is a lack of systematic research on specialized colleges in energy and other sectors, making it difficult to directly adapt to the actual operation of industry-oriented colleges in China.

2.5.2. Current research status in China

Since the promotion of the new liberal arts construction in China, the academic community has conducted a large number of studies on the transformation of liberal arts in engineering colleges and the interdisciplinary education between literature and engineering. Generally, it is believed that the core of the new liberal arts construction is to promote the deep integration of liberal arts with new technologies and new industries, and to follow a development path that is characterized by cross-disciplinary features and practice-oriented. Existing research clearly indicates that liberal arts majors in engineering colleges generally have problems such as marginalization of cognition, insufficient resources, lack of characteristics, and mismatch between supply and demand. In terms of the transformation path, existing research focuses on four major directions: reconstructing interdisciplinary curriculum systems, cultivating dual-qualified teaching staff teams, innovating scenario-based practical teaching models, and deepening industry-education integration through industrial colleges. Currently, some industry-specialized engineering colleges have carried out pilot reforms, but existing research still has shortcomings: there are relatively few specialized studies for colleges in specific industries, the research on the intersection of literature and engineering mostly stays at the conceptual level, there is insufficient in-depth research on integration mechanisms and dynamic education mechanisms, and macro-level countermeasures are predominant, while relatively scarce are the micro-level implementation plans that can be implemented.

2.5.3. Research review

The existing domestic and foreign research has laid a solid theoretical and practical foundation for the research of this article. The foreign research focuses on interdisciplinary curriculum design and student-centered teaching models, while the domestic research clarifies the core direction and key path of the new liberal arts reform. However, overall, the existing research has not focused on the specific entity of energy-related industry-oriented engineering colleges, and cannot effectively solve practical problems such as shallow integration of liberal arts and engineering, rigid training plans, and fragmented implementation of reforms. Based on this, this article is based on the transformation scenario of the energy industry, builds a professional upgrading path with the intersection of liberal arts and engineering as the core, and effectively fills the gap in existing research.

3. Analysis of the construction issues of new liberal arts disciplines in industry-specific engineering colleges

3.1. The current core issues and their causes

3.1.1. The main issue

(1) The issue of separation between liberal arts and engineering is prominent. The disciplinary barriers have not been broken through. The curriculum system still follows the traditional framework of liberal arts, and the integration of energy engineering elements and industry content is insufficient. More than half of the students reported that the courses lacked the characteristics of the energy industry, and the cultivation of basic engineering knowledge and digital skills was lacking.

(2) The talent training model is monotonous. Teaching mainly focuses on classroom theoretical lectures, and the practical teaching link is weak. Nearly half of the students did not participate in social practice, and nearly 70% of the students did not participate in research training and academic competitions. The

cultivation of students' practical innovation ability is insufficient.

(3) The structure of the teaching staff is unbalanced. Most liberal arts teachers graduated from comprehensive liberal arts colleges and lack experience in the energy industry and engineering practice. Nearly 40% of the teachers did not participate in interdisciplinary teaching activities, and nearly 50% of the teachers did not receive specialized training in new liberal arts. The cross-disciplinary teaching ability is weak.

(4) The level of industry-academia integration is shallow. School-enterprise cooperation mostly remains in superficial forms, such as signing plaques for internship bases and holding enterprise lectures. Enterprises did not deeply participate in the formulation of training plans, course development, and teaching evaluation, and the long-term mechanism for collaborative education was lacking.

(5) The cross-disciplinary platform is lagging. The number of teaching, research, and practical platforms supporting the integration of liberal arts and engineering is insufficient. The cross-disciplinary communication mechanism is not smooth, and the channels for cross-disciplinary learning and research of teachers and students are limited.

3.2. Causes of the problem

From a historical perspective, industry-oriented engineering colleges have long focused on engineering as their core discipline, while liberal arts programs started relatively late and had a weak foundation. Resources were allocated more towards engineering, and the development of liberal arts was inherently lacking. From a practical standpoint, there are several issues: Firstly, the educational philosophy is lagging, with a deeply ingrained mindset of "emphasizing engineering and neglecting liberal arts", and the understanding of interdisciplinary education and the construction of new liberal arts is superficial. Secondly, there are institutional barriers. The independent operation model of departments and schools makes it difficult to share cross-disciplinary resources and collaborate with teachers. Thirdly, the incentive mechanism is lacking, and teachers' enthusiasm for participating in interdisciplinary teaching, enterprise practice, and curriculum reform is insufficient. Fourthly, the dynamic adjustment mechanism is missing, and the update of the talent training plan is slow, unable to keep up with the technological iteration and job demand changes in the industry.

4. Five paths for the transformation and upgrade of new liberal arts disciplines in industry-specific engineering colleges

Guided by the concept of "four-in-one", a five-dimensional professional transformation and upgrading path is constructed from five aspects: curriculum system, teaching staff, teaching methods, practical teaching, and discipline platform.

4.1. Path for the transformation and upgrading of the curriculum system

The curriculum system is the core carrier for the integration of arts and industry. It constructs a modular curriculum system consisting of general education, disciplinary foundation, professional core, distinctive direction, and practical teaching.

(1) Optimize the overall structure of the courses. Add courses such as engineering ethics, digital literacy, and energy national conditions to the general education module; strengthen mathematics and digital courses like advanced mathematics and computer basics in the disciplinary foundation module; streamline

redundant content in the professional core module to solidify the management theory foundation; set up three distinctive directions such as energy enterprise management, digital management, and low-carbon economy in the characteristic direction module, each with 6-8 specialized courses; increase the proportion of practical teaching credits to over 25%, and integrate it throughout the entire process of talent cultivation.

(2) Develop three interdisciplinary course groups. The energy management course group (petroleum enterprise management, energy economics, energy project management, etc.) strengthens industry cognition; the engineering foundation course group (introductory oil and gas engineering, engineering economics, etc.) fills the gap in engineering knowledge; the digital management course group (Python, business intelligence, big data analysis, etc.) adapts to the industry's digital transformation.

(3) Deeply integrate industry elements. Embed real cases from energy enterprises in professional courses, collaborate with industry experts to compile characteristic textbooks such as "Petroleum Enterprise Management" and "Energy Economics"; hire enterprise executives and technical experts to give cutting-edge lectures and undertake practical course teaching, promoting industry experience into the classroom.

4.2. The upgrading path for the construction of the teaching staff team

Build a high-level teaching staff team that is interdisciplinary, dual-qualified, and multi-skilled, to provide talent support for the reform.

(1) Systematically conduct on-the-job teacher training: Organize liberal arts teachers to study energy engineering knowledge, digital technology, and interdisciplinary teaching methods; implement the teacher's enterprise placement system, requiring teachers to participate in management practices in energy enterprises regularly and accumulate industry experience.

(2) Precisely introduce multi-skilled talents: Focus on recruiting high-level talents with engineering backgrounds in petroleum engineering, new energy, computer science, etc.; hire senior executives and technical experts from enterprises to serve as industry professors and part-time teachers, enriching the dual-qualified team.

(3) Establish a regular communication mechanism: Build a cross-departmental teaching research platform within the school, regularly hold academic salons and teaching discussions; improve the two-way personnel exchange system between the school and enterprises; support teachers to study abroad and attend conferences to expand international horizons.

(4) Optimize assessment and incentive mechanisms: Incorporate interdisciplinary teaching, curriculum reform, enterprise practice, and school-enterprise cooperation into the teacher assessment indicators, set up special rewards, and stimulate teachers' enthusiasm for reform.

4.3. Reform path of teaching methods and means

Completely transform the traditional imparting-style teaching model and implement a modern student-centered teaching model.

(1) Promote diversified teaching methods: Fully implement project-driven teaching, using real management projects of energy enterprises as the carrier to conduct inquiry-based learning; rely on the self-built case library of energy enterprises to deepen case teaching; create scenarios such as oil and gas field management and energy project negotiations to conduct scenario simulation teaching; carry out

discussion-based teaching around hot topics such as carbon neutrality and energy digitalization.

(2) Empower teaching through modern information technology: Build online high-quality courses and conduct online and offline blended teaching; develop virtual simulation experiments for energy enterprise operations and project decision-making; use intelligent teaching tools to achieve personalized tutoring; upgrade smart classrooms and create interactive teaching environments.

4.4. Optimization path of practical teaching system

Build a three-dimensional practical teaching system that integrates classroom and after-class activities, combines school and outside-school resources, and integrates online and offline elements.

(1) Integrate internal practical resources. Construct laboratories for energy economy and management, business intelligence, etc.; orderly open engineering laboratories such as petroleum engineering and geological engineering; hold disciplinary competitions such as management case competitions and data analysis competitions, and implement the college students' innovation and entrepreneurship training program.

(2) Expand external practical bases. Cooperate with leading enterprises such as China National Petroleum Corporation, China Petrochemical Corporation, and National Energy Group to establish long-term internship bases; implement a three-level progressive internship model of cognitive internship, professional internship, and on-the-job internship, and fully implement the dual guidance system of internal tutors and enterprise tutors.

(3) Deepen the collaboration between industry, academia, and research. Establish enterprise order placement classes and excellence experiment classes, and jointly customize training plans with enterprises; jointly build joint laboratories and research platforms, encourage students to participate in teachers' longitudinal projects and enterprises' horizontal projects, and enhance their innovation capabilities in scientific research practices.

4.5. Pathway for the construction of an interdisciplinary integration platform

Build multi-level platforms to provide hardware and carrier support for interdisciplinary collaboration and collaborative education.

(1) Construct interdisciplinary research platforms. Integrate existing energy research centers and key laboratories, establish interdisciplinary research special funds, and support teachers of both arts and science to jointly conduct research; regularly hold interdisciplinary academic activities to promote ideological exchanges.

(2) Build interdisciplinary teaching platforms. Explore the establishment of an interdisciplinary college, coordinate the construction of interdisciplinary majors and courses; establish an interdisciplinary course center to be responsible for the development and resource sharing of cross-disciplinary courses; implement minor studies and dual-degree systems to open up cross-disciplinary learning channels.

(3) Jointly build modern industry colleges. Collaborate with leading energy enterprises to jointly establish modern industry colleges, implement school-enterprise co-management, resource sharing, and mutual benefits in achievements, and promote seamless alignment of professional settings, course contents, and teaching processes with industrial demands.

5. Conclusion

The new liberal arts reform in industry-oriented engineering colleges should be based on the industry's

advantages and follow the development path of "industry characteristics + interdisciplinary arts and science". Currently, there are problems such as the separation of liberal arts and science, shallow integration of industry and education, and the absence of a dynamic mechanism in liberal arts majors. This article adopts the concepts of inheritance and innovation, interdisciplinary integration, unified supply and demand, and collaborative dynamics, and constructs a transformation path from five aspects: courses, teachers, teaching, practice, and platforms. It also provides a dynamic training plan and guarantee system. The business administration major at Southwest Petroleum University has been piloted and verified, demonstrating that this model can solve the problem of "two-layered" integration of liberal arts and science, enhance students' job adaptability, and provide a reference for the upgrade of new liberal arts in petroleum, mining, and power-related colleges.

Disclosure statement

The author declares no conflict of interest.

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