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RESEARCH

Exploration and practice of the "Four-Dimensional Forging" education model for ideological and political courses in industry-oriented universities under the background of "Great Ideological and Political Courses"

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ABSTRACT

Aiming at the common challenge of cultivating "non-technical skills" in global engineering education and the practical predicament of "insufficient affinity and weak pertinence" in university ideological and political courses, this study intends to explore how to transform China's unique cultural resource of "Petroleum Spirit" (characterized by hard work, solid work, and the principles of being honest, upright, dedicated, and strict) into effective educational elements. This transformation is committed to enhancing the educational effectiveness of ideological and political courses in industry-oriented universities and provide a path for cultivating outstanding engineering talents. Focusing on the teaching reform of ideological and political courses in Chinese petroleum industry-oriented universities and adhering to the concept of "Great Ideological and Political Courses", this study has constructed a "Four-Dimensional Forging" education model for ideological and political courses. The four dimensions of this model are "high-caliber faculty" as the key, "extensive resources" as the platform, "high-quality ideological and political courses" as the core, and "social practice classroom" as the extension. This model has effectively solved the problems in the teaching of ideological and political courses, with student satisfaction exceeding 90% for five consecutive years. The achievements have won more than 60 national-level awards, and a galaxy of outstanding talents with titles such as "National Excellent Communist Youth League Member" have been cultivated. The proportion of graduates employed at the grassroots level and in western China exceeds 70%, and the model has been promoted and applied in 14 similar universities across the country. The model has successfully integrated value shaping deeply into the engineering education system, and provided a systematic solution featuring cultural empowerment, scenario creation, and industry-education integration for meeting the "non-technical skills" requirement in the engineering education accreditation standards. It is not only a successful practice in the teaching reform of ideological and political courses, but also provides an important paradigm for the innovation of the cultivation model of outstanding engineering talents with Chinese characteristics, thus possessing broad theoretical value and demonstration significance.

Keywords: Petroleum Spirit, ideological and political courses, Four-Dimensional Forging, engineering education, non-technical skills

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INTRODUCTION

Since the 18th National Congress of the Communist Party of China, the Central Committee with Comrade Jinping Xi as the core has attached great importance to the ideological and political work in colleges and universities and the fundamental task of fostering virtue through education. General Secretary Xi Jinping has clearly pointed out that "we should take full advantage of classroom teaching as the main channel, and ideological and political theory courses should be strengthened while being improved, so as to enhance the affinity and pertinence of ideological and political education and meet the needs and expectations of students' growth and development". This important discourse has pointed out the direction for the reform and innovation of ideological and political courses in colleges and universities in the new era. At the same time, with the profound transformation of the global energy landscape and the proposal of China's "carbon peak and carbon neutrality" goals, the petroleum and petrochemical industry, as an important pillar of national energy security, is experiencing unprecedented transformation challenges. In the new era, petroleum engineers not only need to master a solid professional knowledge base and innovative capabilities, but also need to possess a deep sense of patriotism, perseverance, noble professional ethics, and a dedicated spirit of responsibility. That is the "Petroleum Spirit' with the core of "hard work and solid work" and "being strict and meticulous in ideology, work, and quality, and being honest and trustworthy", which has been emphasized by General Secretary Xi Jinping on many occasions (Dai, 2025). This spirit was born in the magnificent practice of petroleum campaign and is an important part of the spiritual pedigree of the Communist Party of China and a typical manifestation of advanced socialist culture. It also provides a unique and valuable resource for the ideological and political curriculum construction in industry-oriented universities.

However, for a long time, the teaching of ideological and political courses in universities has, to a certain extent, suffered from problems such as disconnection between theory and reality, single-minded teaching methods and low recognition and participation of students in the course content. Some students even regard it as an "easy-going course", and its educational function has not been fully realized. For universities with distinct industry characteristics like petroleum-related ones, how to combine the general requirements of ideological and political education with the inheritance of unique industry spirits, and how to connect the grand national narrative with vivid enterprise practices and students' career development is the key to improving the effectiveness of ideological and political course teaching.

Engineers serve as the primary practicing agents driving technological progress and industrial transformation, playing an indispensable role in the process of national modernization. Confronted with the deepening development of a new round of technological revolution and industrial transformation, coupled with the urgent demands of Chinese modernization for high-quality development and technological self-reliance and self-strengthening, the traditional engineer training model, predominantly focused on technical instruction, has become inadequate to address the complex challenges of the new era. Internationally, the perception of engineer competencies has long transcended purely technical boundaries, shifting towards a comprehensive examination of "competency." This concept integrates knowledge, skills, attitudes, and values, emphasizing the engineer's holistic capability to solve complex problems in real-world contexts (Pellegrino & Hilton, 2012). For instance, the “Engineer of 2020” vision proposed by the U.S. National Academy of Engineering underscores core literacies such as analytical skills, experimental skills, creativity, communication skills, and professional ethics (National Academy of Engineering, 2004). Similarly, engineering education standards in the European Higher Education Area focus on multidimensional abilities including knowledge application, engineering analysis, investigation, design, and teamwork (ENAEE, 2015). Domestic research has kept pace with this trend; for example, Professor Lin Jian explored the core competency structure for engineering talent in the new economy (Lin, 2017), while scholars like Yu Shouwen have long focused on the philosophical and cultural dimensions of engineering education (Yu, 2013). However, existing studies either lean towards macro-level conceptual exposition or are confined to analyses of specific skills, lacking a comprehensive competency framework that is both rooted in the Chinese context, engaged in international dialogue, and capable of systematically integrating values, knowledge, abilities, and practice.

Based on this, Southwest Petroleum University, in collaboration with brother universities such as China University of Petroleum (East China) and Liaoning Petrochemical University, as well as large-scale petroleum enterprises such as Yumen Oilfield (the birthplace of the Iron Man spirit) and Southwest Oil and Gas Field, jointly launched the comprehensive reform project of ideological and political courses in petroleum-industry universities. The project adheres to the concept of "grand ideological and political courses" and the principle of "open-door ideological and political education", aiming to break the teaching problems of ideological and political courses through systematic model innovation and explore a new path of ideological and political education that relies on industry advantages

and highlights petroleum characteristics. This thesis is a systematic summary and theoretical sublimation of this reform practice, aiming to elaborate in detail the specific connotation, implementation path, and main achievements of the constructed "Four-Dimensional Forging" model, so as to provide a reference for the ideological and political course reform and the cultivation of innovative engineering talents in similar universities.

THE INTERNAL LOGIC AND ERA NECESSITY OF INTEGRATING THE PETROLEUM SPIRIT INTO IDEOLOGICAL AND POLITICAL EDUCATION

Integrating the industry spirit into the ideological and political education in colleges and universities is not a simple addition of contents, but a deep integration and development based on inherent compatibility.

Theoretical basis for integrating the Petroleum Spirit into ideological and political education

Experiential Learning Theory and Situated Cognition Theory

John Dewey, an American educator, emphasized "learning by doing" and argued that education is the reorganization and transformation of experience (Dewey, 2018). Kolb's Experiential Learning Theory further constructs a learning cycle of "concrete experience-reflective observation-abstract generalization-active experimentation" (Kolb, 2014). Industry spirits, such as the Petroleum Spirit, originate from the magnificent production practices and possess strong practicality and situational characteristics. Placing students in historical scenarios of oilfield campaigns, the production frontlines of modern enterprises, or vivid narratives by model workers and experts creates opportunities for them to gain "concrete experience", thereby promoting their in-depth understanding and internalization of theoretical knowledge (such as the spirit of dedication and hard work). Situated Cognition Theory further holds that learning is essentially a social activity within a specific context (Lave & Wenger, 1991). Creating teaching contexts closely linked to the development of the petroleum industry can free ideological and political education from empty preaching, making it perceivable and tangible, thus enhancing the authenticity and effectiveness of learning.

Value Clarification Theory and the Demonstration Effect of Role Models

The Value Clarification Theory holds that the formation of values goes through three stages: Selection, cherishing, and action (Raths *et al.*, 1966). Mere theoretical indoctrination makes it difficult for students to truly develop stable values. By systematically presenting major decisions in the history of the petroleum industry's development (such as the Daqing Oil Campaign) and conducting in-depth analysis of the value pursuits and behavioral patterns of advanced model figures (such as "Iron Man" Wang Jinxi and Chen Jianjun, an "Iron Man-style outstanding cadre" in the new era), a reference framework for students' value judgment can be provided. It guides them to gradually clarify and establish their own values through comparison and introspection. Bandura's Social Learning Theory emphasizes the importance of role model demonstration (Bandura, 1977). Heroic models, technical experts, and management elites in the industry, with their authentic, vivid, and noble words and deeds, provide college students with highly inspiring learning role models. Their demonstration effect is far more powerful than that of dull doctrinal preaching.

The Concept of "Curriculum-Oriented Ideological and Political Education" and "Great Ideological and Political Education"

"Curriculum-Oriented Ideological and Political Education" requires all courses to undertake the responsibility of nurturing people, aligning with ideological and political theory courses to form a synergistic effect (Gao & Zong, 2017). In contrast, "Great Ideological and Political Education" further demands breaking the boundaries of classrooms, making good use of the broader social context as a "big classroom", and promoting the integration of small ideological and political classrooms with the big social classroom (Xi, 2020). For industry-oriented universities, their profound industry background, abundant corporate resources, and unique cultural genes provide inherent advantages for practicing the concept of "Great Ideological and Political Education". Integrating the Petroleum Spirit into ideological and political courses is a concrete practice of converting industry resources into talent-nurturing resources and introducing the big social classroom into small ideological and political concrete practices. It also serves as a crucial link in building a comprehensive pattern of "all-round education for all students throughout the entire process".

The petroleum spirit as a cultural carrier and contextualized path for cultivating "non-technical skills"

Since the start of the 21st century, the global engineering education community has increasingly recognized that nurturing outstanding engineers must go beyond mere transmission of technical knowledge. International engineering education accreditation systems, represented by the Washington Accord (Ministry of Education of the People's Republic of China, 2023), explicitly require graduates to possess a set of "soft skills" or "non-technical skills" beyond "hard skills". These skills

typically include the following aspects: (1) Engineering ethics and social responsibility: The ability to reason rationally based on engineering knowledge, understand the impact of engineering solutions on society, health, safety, law, culture and the environment, and take corresponding responsibilities; (2) communication and collaboration skills, meaning the ability to communicate effectively, collaborate and lead in cross-cultural and interdisciplinary teams; (3) lifelong learning ability which involves recognizing the necessity of independent and lifelong learning and acquiring relevant capabilities; (4) project management and cost awareness that entails understanding and mastering engineering management principles and economic decision-making methods; (5) global perspective and awareness of sustainable development, referring to the ability to address global challenges and consider environmental and economic sustainability when designing solutions. The Engineering Education Accreditation Standards formulated by the China Engineering Education Accreditation Association also regard "professional norms", "individual and team", "communication", "project management" and "lifelong learning" as core indicators of graduation requirements. However, how to effectively cultivate and evaluate these "non-technical skills" remains a common challenge for engineering education worldwide, and the traditional, fragmented teaching method that is attached to technical courses often yields poor results.

The core theoretical innovation of this reform practice lies in its identification of the "petroleum spirit", a unique cultural resource, as a powerful and context-specific vehicle to systematically address the requirements for "non-technical skills" in engineering education accreditation.

First, "hard work and dedication" and "engineering ethics/social responsibility" : The high risks (such as blowouts and environmental pollution) and strategic importance of the petroleum industry naturally place engineering ethics and social responsibility at the forefront. Behind the spirit of "hard work and dedication" lies the sense of responsibility for national energy security and the adherence to the professional creed that "every well is a commitment". This provides an extremely profound and authentic prospect for cultivating students' understanding of the social impact of engineering and their ethical responsibilities.

Second, "the Three Honests and Four Stricts" spirit and "professional standards/lifelong learning": When it comes to the revolutionary cause, one should be an honest person, speak the truth, and do practical things; when it comes to work, one should have strict requirements, rigorous organization, an assiduous attitude, and strict discipline. "The Three Honests and Four Stricts" accurately defines the professional qualities and codes of conduct that engineers should possess. Its connotation is highly consistent with the rigor, truth-seeking, and adherence to standards required in accreditation criteria. Meanwhile, the technological evolution of the petroleum industry from "manual well digging" to "digital oilfields" is itself a vivid textbook for lifelong learning.

Third, the traditional convention of oil campaign and "individual/team/communication": The exploration and development of large oil and gas fields is an extremely complex systems engineering project, which must rely on large-scale collaboration across disciplines and departments. The history of oil campaigns and the project-oriented operation of modern oil and gas fields perfectly illustrate the importance of teamwork and effective communication. Using this as a case for teaching is far more convincing than abstract theoretical preaching.

Fourth, the challenges of energy transition and "sustainable development/global perspective": Against the current backdrop of energy transition, the challenges faced by the petroleum industry are at the core of global sustainable development issues. Guiding students to reflect on the future of the petroleum industry, the substitution of new energy sources, and carbon capture technologies directly relates to fostering their global perspective and awareness of sustainable development.

Therefore, the theoretical premise of this project is to regard the inheritance of the "petroleum spirit" as an efficient, distinctive and inspiring path to achieve the training goal of "non-technical skills" in engineering education accreditation. It realizes the organic integration of value shaping, spiritual inheritance and competence development.

CONSTRUCTION AND IMPLEMENTATION PATH OF THE "FOUR-DIMENSIONAL FORGING" MODEL

This project is guided by the concept of "Great Ideological and Political Courses" and has constructed and put into practice an ideological and political education model of "Four-Dimensional Forging" with the core elements of "high-caliber faculty members, extensive educational resources, golden courses, and extensive practical programs". This model emphasizes the organic connection and synergistic effect among the four elements, which jointly contribute to shaping and enhancing students' values, knowledge structure, and competence.

Dimension one: Building a virtuous and competent teaching force by gathering high-caliber faculty members

The crux to addressing the predicament of ideological

and political course teachers working "alone" and lacking industry experience lies in building a "high-caliber faculty members" that combines full-time and part-time members with excellent qualifications.

We have innovated the recruitment mechanism and built a diversified and complementary teaching resource pool. The project has broken the traditional boundary that restricted ideological and political course teachers to full-time staff of the Institute of Marxism, and established an open system for "distinguished part-time professors of ideological and political courses". Through strict selection, 75 experts, model workers, and senior managers with rich practical experience and profound theoretical literacy have been recruited from petroleum enterprises, scientific research institutions, and party and government organs to work as part-time teachers. For instance, Wen Sheng, a special-level model worker of China National Petroleum Corporation (CNPC) and from the Refining and Chemical General Plant of Yumen Oilfield, Chen Jianjun, a role model cadre in the new era in the spirit of 'Iron Man', and a group of corporate management experts with doctoral degrees and senior professional titles have been invited to join. This initiative has not only increased the number of teachers, but also optimized the teaching structure, forming a complementary pattern where full-time teachers have solid theoretical foundations and part-time teachers have rich practical experience. Currently, the teaching resource pool includes 35 national-level talents and more than 160 provincial-level talents.

We have implemented the "Crossing the Petroleum Threshold" Initiative to enhance teachers' industry literacy. Relying on the established "Alliance of Marxist Colleges in Petroleum and Petrochemical Universities of China", we regularly organize full-time ideological and political course teachers to conduct practical training and on-the-job internships at traditional petroleum industry education bases (such as Yumen, Daqing) and modern production frontlines (such as Southwest Oil & Gas Field). Through on-site inspections, living and working alongside front-line workers and engineers, and interviewing veteran petroleum practitioners, teachers gain a profound understanding of the essence of the petroleum spirit and accumulate vivid teaching cases. This enables them to tell petroleum stories in class with "sincere feelings" and avoid "preaching empty theories". This initiative is referred to by teachers as the "petroleum barrier" for "shaping others' souls by first shaping their own".

Building an innovative faculty member to stimulate collective wisdom. With national and provincial-level distinguished teachers as the core, multiple teaching and research teams have been established, each focusing on specific research directions such as "The petroleum spirit and Its Contemporary Value" and "Energy Strategy and Ideological and Political Education". For instance, a studio themed on the "Internet + Petroleum Spirit + Problem-Chain" teaching model was selected as a National Model Studio for Ideological and Political Courses in Colleges and Universities. Through collective lesson preparation, teaching observations, and research project tackling, the teams jointly develop teaching schemes and share teaching experience, effectively enhancing the overall teaching standards and innovative capabilities; a group of outstanding representatives have also emerged from the teams, including Changjiang Scholars Distinguished Professors, National Model Teachers, and winners of the First Prize in the National Ideological and Political Course Teaching Demonstration.

Dimension two: Developing "extensive educational resources" to build a multi-dimensional and enriched repository for talent cultivation

To address the issues of scattered ideological and political course resources and weak integration with industry practices, the project has systematically integrated university-enterprise resources and established a three-in-one extensive teaching resource library covering "theory, cases, and digital content".

We deeply explore theoretical resources to consolidate the academic foundation for teaching. We have established an interdisciplinary research team to conduct systematic studies on the formation logic, contemporary value, and inheritance pathways of the Petroleum Spirit. To date, the team has published over 50 academic monographs, including *Research on the Emergence and Development of the Petroleum Spirit* and *Research on the Inheritance and Innovation of Campus Culture in Petroleum Industry Universities*. It has also published more than 200 high-quality papers in core journals such as *Ideological Education Research*, with titles like *Practical Exploration and Fundamental Experience of the Party's Leadership in Petroleum Culture Construction Over the Century Since Its Founding* and *Research on Inheriting the Red Legacy from the Development History of Sichuan's Oil and Gas Industry*. These theoretical achievements not only provide a solid academic basis for ideological and political courses but also offer theoretical guidance for the Party building and ideological work of petroleum enterprises.

We carefully select case resources to enliven classroom teaching content. We have deeply explored typical figures and events from the history of petroleum industry development and those emerging in the new era, and developed a case database containing over 300 teaching cases. The cases come from a wide range of sources, including *Overview of Moral Education Concepts and*

Innovative Cases from the Library of University Moral Education Achievements of the Ministry of Education, *Petroleum Cradle Culture* (an excellent case of petroleum ideological and political work), the advanced deeds of Wen Sheng (a national model worker), and reports on Jianjun Chen (a model of central enterprises). We pay special attention to developing "oral history" resources. We have recorded 12 oral history videos in which veteran petroleum workers and senior experts recall their struggle experiences, as well as 8 documentaries reflecting the history of major petroleum campaigns, making history vivid and perceptible.

We develop digital resources to expand the boundaries of teaching time and space. We have collaborated with enterprises to jointly build a large-scale video resource library, which contains more than 1000 items including microfilms, animations, documentaries, and short videos. For example, *Yumen Oilfield: An Epic of Endeavor*, co-produced with Yumen Oilfield, was broadcast on the Xinhua News Agency client and received a warm response. Using virtual reality (VR) / augmented reality (AR) technology, we have digitally restored red education bases such as the Yumen Oilfield Exhibition Hall and Laojunmiao No. 1 Well, and built a virtual simulation experiment center for ideological and political courses. Students can use VR devices to "immerse themselves" in visiting petroleum heritage sites thousands of miles away, which greatly enhances the interest and coverage of learning. Digital materials of red cultural relics—such as the old oil pumping unit used by Jinxi Wang —exhibited at the Exhibition Hall of the Communist Party of China's History have also been incorporated into the resource library after digitalization.

Dimension three: Developing high-quality "golden courses" to enhance the educational effectiveness of classroom teaching

Classroom teaching is the main channel. Guided by the standard of "three characteristics" (high-level, innovative, and challenging), the project has made every effort to build a cluster of "golden ideological and political courses" with petroleum characteristics.

We advance the connotative development of courses to realize the organic integration of the Petroleum Spirit. This integration is not a rigid addition, but a precise and natural incorporation of elements related to the Petroleum Spirit into the teaching content system in accordance with the inherent logic and teaching objectives of each ideological and political course. For example, the course "Fundamentals of Marxism" focuses on explaining the practical viewpoints, mass historical view, and dialectical materialist methods embodied in the Petroleum Spirit; the course "Introduction to Zedong Mao Thought and the Theoretical System of Socialism with Chinese Characteristics" emphasizes interpreting the great achievements and institutional advantages of the Party's leadership in the development of the petroleum industry; the course "Outline of Modern and Contemporary Chinese History" vividly reveals the historical process of the Chinese nation standing up, growing rich, and becoming powerful through the struggle history of the petroleum industry from scratch and from weakness to strength; the course "Ideology, Morality and Rule of Law" uses the touching deeds of petroleum models to explain professional ethics, social virtues and personal morality.

In order to innovate teaching methods, we promote the "Internet + Question Chain" model. We design interconnected "question chains" targeting students' ideological confusions and hot topics of concern, such as "Is hard work still necessary in the new era" and "What is the value of petroleum engineers in the age of artificial intelligence". Using online platforms like Xuexitong (a Chinese university learning management system) and massive open online courses (MOOCs), we release questions before class to guide students in previewing and thinking. During class, we organize group discussions, debate competitions and other activities for in-depth exploration. After class, we conduct extended reading and provide feedback to answer questions through online platforms. This model transforms teachers' "teaching" into students' "learning", effectively stimulating students' thought vitality and increasing the "head-up rate" (students paying attention in class) and participation in class. The relevant teaching achievements won the Special Prize in the National College Ideological and Political Theory Course Teaching Exhibition.

We build first-class curriculum platforms to demonstrate and lead teaching reform. Relying on platforms such as China University MOOC and Xuetang Online, we have developed a number of open online courses and blended courses. Among them, "Chinese and Foreign Petroleum Cultures" was selected as a national-level first-class online course, "Fundamentals of Marxism" was selected as a national-level first-class undergraduate blended course, and "Introduction to Feng Lei's Spirit" was selected as a national-level first-class undergraduate offline course. Courses including "Introduction to Zedong Mao Thought and the Theoretical System of Socialism with Chinese Characteristics", "A Concise History of the Communist Party of China", and "Ideological and Moral Cultivation and Legal Basis" were also selected as provincial-level first-class undergraduate courses. The development of these "golden courses" not only serves the students of our university, but also demonstrates the construction level of ideological and political courses in petroleum universities to the whole society, generating a wide-ranging radiating effect.

Dimension four: Expanding extensive practical programs to build an integrated platform for knowledge and action

Adhere to the unity of theoretical and practical aspects, and regard practical teaching as a key link to solidify, deepen, and transform the achievements of classroom learning.

Campus-based practice achieves "full coverage". No less than one-fourth of the total class hours are allocated to practical sessions with corresponding credits in all ideological and political courses, ensuring every student can participate. The "One Course, One Feature" initiative is implemented, creating brand practical activities such as the "Xiyou Youth Talk" speech contest, the "Energy Power" micro-video competition, and the "Petroleum Spirit" themed essay contest. These activities help students deepen their understanding through participation and creation.

Off-campus practice emphasizes "firsthand experience". Stable practical teaching bases have been established through cooperation agreements with 65 institutions, including the Iron Man Jinxi Wang Memorial Hall, the No. 1 Well Site Relic at Laojunmiao in Yumen Oilfield, and the shale gas development site of Southwest Oil & Gas Field. Eight characteristic practice routes have been designed, such as "Retracing the Petroleum Road", "Exploring the Red Petroleum Veins", and "Perceiving the Smart Oilfield". The brand project "Energy-themed Ideological and Political Course" organizes students to visit the frontlines of oil and gas production. It invites corporate experts and technical backbones to conduct on-site teaching, allowing students to witness and personally experience the development and challenges of the national energy industry. The activity "Dialogues on the Petroleum Spirit Pedigree" invites petroleum workers from different eras to discuss the inheritance of the spirit.

The virtual practice achieves "high simulation". We have built the first dedicated virtual simulation experiment center for ideological and political courses among universities in Sichuan Province, and developed multiple virtual simulation experiment projects such as "VR Experience of Oil Campaign" and "Oil Industry Safety and Responsibility". We revised the talent training program, stipulating that each ideological and political course includes 2 class hours of virtual simulation practice. Through the highly simulated virtual environment, students can safely experience high-risk and high-cost practical scenarios with low cost, breaking through the constraints of time and space and enriching the forms of practice.

REFORM ACHIEVEMETS AND INFLUENCES

After years of exploration and practice, the "Four-Dimensional Forging" model has achieved remarkable results and exerted a wide-ranging impact in aspects such as campus-based talent cultivation, social recognition, and demonstration and radiation effects.

Significant improvement in educational quality and stronger student sense of fulfillment

The most direct results are reflected in students. Data from teaching quality evaluations over the past five years shows that students' satisfaction with ideological and political courses has been rising steadily, remaining above 90% for five consecutive years. The teaching effectiveness of the courses has been widely recognized by students. More importantly, students' ideological and political quality as well as comprehensive abilities have been significantly improved. A large number of outstanding student models have emerged, represented by Huawei Chen, a "National Outstanding Communist Youth League Member", and Chenwei Li, a "Star of Self-improvement among Chinese College Students". Graduates have been highly acclaimed by employers for their "excellent ideological and political quality, solid professional foundation, hard work and willingness to contribute". The proportion of graduates choosing to work in arduous western regions such as Xinjiang and Qinghai, as well as front-line production posts, has remained above 70% for a long time, providing solid talent support for the implementation of the national energy strategy.

To validate the effectiveness and applicability of the "Four-Dimensional Forging" educational model, we developed a comprehensive assessment scale comprising four subscales. This was done by administering a questionnaire survey to 350 upper-year engineering students from five specialized industry-focused universities in China and conducting online assessments of 150 practicing engineers from fields such as manufacturing, information technology, and infrastructure construction. A total of 453 valid responses were collected. Each subscale corresponds to one dimension of the model and utilizes a five-point Likert scale (1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly Agree). The detailed scale is as follows (Table 1–4).

Fruitful teaching achievements widely recognized

Project practice has yielded a series of high-level teaching achievements. Three core participating universities have accumulated more than 60 national and

Table 1: Value guidance

Item No.	Item description	Strongly disagree → Strongly agree
1	I deeply understand the relationship between major national development strategies (*e.g.*, "Chinese Modernization", "Manufacturing Power") and the development of engineering science and technology.	1→ 5
2	I am willing to integrate my personal career development into the needs of the nation and society, contributing my intellect to them.	1→ 5
3	When facing engineering ethical dilemmas, I can adhere to professional ethics and prioritize public safety, health, and welfare.	1→ 5
4	I possess a strong awareness of environmental protection in my engineering practice and am committed to implementing the concept of sustainable development.	1→ 5
5	I am meticulous in my work, pursuing precision and perfection in every technical detail.	1→ 5
6	I possess a strong sense of quality awareness and responsibility, regarding engineering quality as a lifeline.	1→ 5
7	I firmly believe that the engineering profession holds significant value for promoting social progress and improving people's lives.	1→ 5
8	I can proactively take responsibility and am willing to contribute within a team.	1→ 5

Core elements: National identity and sense of mission, engineering ethics and professional conduct, craftsmanship spirit.

Table 2: Knowledge foundation

Item No.	Item description	Strongly disagree → Strongly agree
1	I have mastered solid foundational knowledge in natural sciences such as mathematics and physics, and can apply it flexibly.	1→ 5
2	I have mastered the core theories and foundational knowledge of my professional field.	1→ 5
3	I am able to track and understand the cutting-edge technologies and development trends in my professional field.	1→ 5
4	I am able to track and understand the cutting-edge technologies and development trends in my professional field.	1→ 5
5	I possess a foundational understanding of economics and management, enabling me to comprehend the cost, schedule, and quality constraints of engineering projects.	1→ 5
6	I understand humanities and social sciences knowledge such as history of engineering, philosophy, and sociology, and can recognize the socio-cultural impact of engineering activities.	1→ 5
7	I am able to integrate knowledge from different fields, forming a comprehensive knowledge network.	1→ 5
8	I am clearly aware of the gaps in my current knowledge structure and have plans to address them.	1→ 5

Core elements: foundation in mathematical& natural sciences and engineering, professional technical knowledge, interdisciplinary knowledge, economic, management, and humanities knowledge.

provincial-level teaching awards. These include important honors such as "National Model for Poverty Alleviation", "National Model Teacher", "National Civilized Campus", "National First-Class Undergraduate Course", "National Famous Teacher Studio for Ideological and Political Courses in Colleges and Universities", "National 'Most Beautiful Teacher Team'", and "First Prize of National Campus Culture Construction Achievements". Teacher Kai Li from Southwest Petroleum University, as a representative of the National Model for Poverty Alleviation, received the award in person from General Secretary Jinping Xi; Teacher Jianfeng Zhang was awarded the title of National Model Teacher and was received by Party and state leaders. Relevant reform experiences were selected as exchange materials for the National Conference on Ideological and Political Work in Colleges and Universities. These awards and honors are authoritative affirmations of the reform direction and achievements.

Extensive demonstration and radiating effects leading to strong brand influence

The successful implementation of this achievement has provided a valuable reference model for the reform of ideological and political courses in industry-oriented universities across the country. Fourteen universities, including Northeast Petroleum University, Fujian Agriculture and Forestry University, and Shandong University of Finance and Economics, have visited for research and study; based on this model, they promoted its application in combination with their own school-specific conditions, all reporting positive results. Experts from Tsinghua University, Shihezi University and other institutions, after on-site inspections, commented that this model "offers a demonstration path for industry-oriented universities to cultivate talents meeting industry needs through ideological and political courses". Meanwhile, mainstream media outlets such as Xinhuanet, People's Network, Guangming Daily and

Table 3: Ability forging

Item No.	Item description	Strongly disagree → Strongly agree
1	I am able to identify, analyze, and define complex engineering problems.	1→ 5
2	Based on professional knowledge, I can design feasible solutions to complex engineering problems and evaluate their pros and cons.	1→ 5
3	I am accustomed to thinking about problems from an overall system perspective, rather than viewing individual components in isolation.	1→ 5
4	I am willing to propose new, unconventional ideas and solutions.	1→ 5
5	I am able to quickly learn new knowledge and skills through various channels such as independent literature review and online courses.	1→ 5
6	I am able to clearly and logically express my technical views and solutions in written form.	1→ 5
7	I am able to deliver oral presentations and speeches clearly and effectively.	1→ 5
8	I am able to collaborate effectively with members from diverse backgrounds within a team to accomplish tasks.	1→ 5
9	I possess certain project management and organizational coordination skills.	1→ 5
10	When facing pressure and uncertainty, I am able to remain calm and actively seek solutions.	1→ 5

Core elements: Complex engineering problem-solving ability, innovative and systems thinking, lifelong learning ability, communication and collaboration skills.

Table 4: Practice enablement

Item No.	Item description	Strongly disagree → Strongly agree
1	I have actively participated in engineering training activities such as course experiments, course projects, and metalworking practice.	1→ 5
2	I have complete experience in participating in comprehensive/innovative engineering projects (*e.g.*, disciplinary competitions, final year projects, real enterprise projects).	1→ 5
3	I have been exposed to the real-world environment and demands of the industry through internships, collaborative research, *etc.*	1→ 5
4	I understand how to translate laboratory research results into practical products/technologies.	1→ 5
5	I follow the cutting-edge technologies and standard specifications in the international engineering field.	1→ 5
6	I possess certain cross-cultural communication skills, enabling me to read foreign language literature or conduct basic communication with international peers.	1→ 5
7	I am proficient in using at least one industry-standard software or simulation tool in my professional field.	1→ 5
8	I understand and can apply emerging digital/intelligent technologies such as big data and artificial intelligence in engineering practice.	1→ 5
9	In project practice, I am able to comprehensively apply values, knowledge, and abilities to solve encountered comprehensive problems.	1→ 5

Core elements: Engineering training and project practice, industry-university-research collaboration, international perspective, digital application.

China Education Daily have conducted in-depth reports on the project's distinctive practices and remarkable outcomes on multiple occasions, which has aroused widespread attention and positive comments from all sectors of society and created a sound brand effect.

THEORETICAL CONTRIBUTIONS AND TRANSFERABILITY OF THE MODEL

The success of the "Four-Dimensional Forging" model lies in its systematic solution to the core pain points in the teaching of ideological and political courses, and its exploration of a reform path that conforms to the characteristics of industry-oriented universities. Its successful experience holds important enlightenment for engineering education and higher education.

Theoretical foundation and pedagogical justification of the model

The "Four-Dimensional Forging" model does not emerge in a vacuum; it is grounded in profound theoretical foundations from both pedagogy and psychology. Firstly, it resonates with constructivist learning theory, which posits that learning is not a passive reception of knowledge but an active process of meaning construction by the learner (Bransford *et al.*, 2000). Within this framework, "Value Guidance" provides the meaning orientation and intrinsic motivation for the construction process; "Knowledge Foundation" constitutes the essential building blocks; "Ability Forging" serves as the cognitive tools and methods for

construction; and "Practice Enablement" acts as the ultimate arena for knowledge construction and ability application. Together, these four dimensions form a complete learning cycle of "meaning construction → knowledge internalization → ability externalization → practical creation". Secondly, the model draws upon the concept of "holistic education", aiming to cultivate a complete person who possesses not only professional skills but also a sound character, social responsibility, and correct values (Barnett, 2018). This aligns highly with China's fundamental educational task of "fostering virtue through education". Finally, viewed through the lens of situated learning theory (Lave & Wenger, 1991), the concept of "legitimate peripheral participation" emphasizes that learning occurs within authentic socio-cultural practices. By establishing "Practice Enablement" as an independent and crucial dimension, the "Four-Dimensional Forging" model intentionally situates the cultivation of engineers within the grand practical context of Chinese modernization, ensuring that their learning outcomes can be effectively transferred to solve real-world engineering problems.

Dialogue with mainstream engineering education models: From conceive-design-implement-operate (cdio) to culture-context-social responsibility-practice (ccsp)

The "Four-Dimensional Forging" model constructed in this study is not created out of air; it aligns with the advanced concepts of international engineering education reform and provides a practical scheme with Chinese characteristics.

Deepening and expanding the CDIO model: The CDIO model emphasizes that engineering education should run through the entire life cycle of products/systems, focusing on practicality and integrated learning. The "extensive practice" dimension in this model (especially virtual simulation and on-site practice) is highly consistent with the "Implement" and "Operate" of CDIO. However, the "Four-Dimensional Forging" model goes further: The "high-caliber faculty member" and "extensive resources" provide far more real and rich engineering scenarios and social networks beyond the campus scope for the implementation of CDIO, greatly materializing and deepening the "engineering context" into the "industry cultural context". The integration of ideological and political education into the "high-quality courses" ensures that the CDIO process not only focuses on "how to succeed", but also explores in depth "why to do it" and "for whom to do it", implanting engineering ethics and social responsibility into the source of project conception and design. Therefore, this model can be regarded as an exploration of CCSP, that is, strengthening engineering practice guided by social responsibility under cultural immersion and a broad context.

Support for "Outcome-Based Education" (OBE): OBE emphasizes that all teaching activities and resource allocation should be designed around the competencies (Outcomes) that students ultimately acquire. This model is fully in line with the OBE concept. The four dimensions of the "Four-Dimensional Forging" model collectively align with the graduation requirements specified in engineering education accreditation standards, especially the hard-to-quantify "non-technical competency" indicators. For instance, the "high-caliber faculty member" incorporates enterprise experts, directly targeting the cultivation of "communication" and "project management" competencies; the "case resource library" and "problem-chain teaching method" provide abundant formative assessment basis for evaluating students' ability to solve complex engineering problems and their understanding of the relationship between engineering and society.

Alignment with the "constructivism" learning theory: Constructivism holds that learning is a process in which learners actively construct meaning, with context, collaboration, conversation, and meaning construction as its four core elements. The "Four-Dimensional Forging" model embodies the idea of constructivism throughout: It creates and designs real contexts through "extensive resources and practice"; it promotes collaboration through university-enterprise synergy and team projects; it facilitates conversation through "problem-chain" teaching and in-class discussions; finally, it guides students to proactively construct the meaning of values and knowledge through interaction with the Petroleum Spirit, engineering practice, and social needs.

Universality and Chinese characteristics of the model

Many elements within the "Four-Dimensional Forging" model possess broad international universality and represent common goals pursued by the global engineering education community. For instance, a solid foundation in mathematics and science (Knowledge Foundation), the ability to solve complex problems and innovate (Ability Forging), and learning through project practice (Practice Enablement) are all strongly emphasized in international engineering education accreditation systems like the Washington Accord and in the competency standards for engineers across various countries (ABET, 2023; ENAEE, 2015; Fomunyam, 2019; National Academy of Engineering, 2004). This reflects the inherent logic of engineering science itself and the shared requirements of the globalized industry for engineer competencies.

However, the model is also deeply imbued with Chinese

characteristics. Firstly, the "Value Guidance" dimension is placed first and given core weight, particularly elements like "national identity and sense of mission". This stems directly from the essential requirements of Chinese modernization, which emphasizes collectivism, national strategic drive, and science and technology serving the people, marking a significant difference from the engineer values often shaped within Western individualistic cultural contexts (Downey & Lucena, 2004; Liang, 2020). Secondly, within the "Practice Enablement" dimension, the "deep integration of industry, academia, research, and application" reflects China's strategic pathway, under its nationwide system, of mobilizing resources to accomplish major tasks and fostering tight integration between technology and industry. The depth and breadth of this integration bear distinct systemic features. Finally, the "systems thinking" and "holistic perspective" permeating the entire model are not only reflections of traditional Chinese philosophy but also a necessary mindset for addressing the governance of China's ultra-large scale and its engineering construction practices (Borrego & Bernhard, 2011; Schön, 1983).

Therefore, this model is an innovative framework that incorporates international consensus while being rooted in the Chinese context, achieving a dialectical unity of universality and particularity.

Analysis of the transferability of the model: From "petroleum spirit" to "industry spirit"

The success of the "Four-Dimensional Forging" model does not lie in the specific industry of "petroleum" itself, but in the methodology it provides—on how to transform abstract industry spirit and cultural traditions into operable curriculum systems, teaching resources, and evaluation methods. Therefore, it has excellent transferability.

For other universities with profound industry backgrounds (such as those in geology, mining, metallurgy, transportation, water conservancy, electric power, *etc.*), they can fully refer to this model and make adaptations as follows. High-caliber faculty member: Recruit academicians, design masters, model workers, and outstanding entrepreneurs in the respective industry. Extensive resources: Explore the industry-oriented spirits such as the "Three Honors" spirit (for geology), the "Qinghai-Tibet Railway Spirit", and the "Manned Spaceflight Spirit", and establish corresponding case libraries and digital museums. "Golden Courses": Integrate industry spirit into ideological and political courses and professional courses, and develop characteristic online courses. Extensive practice: Jointly build practice bases with leading enterprises in the industry, and carry out social practices related to cutting-edge issues in the industry.

Through its systematic and integrative nature, the model fundamentally enhances the essential competencies of engineers, offering a Chinese approach that combines universal accreditation standards with specific industrial culture to address the global challenge of fostering "non-technical skills" in engineering education. Firstly, it achieves the unification of "value cultivation, knowledge impartation, and ability development", thereby avoiding the one-sided development epitomized by "talent without virtue" or "knowledge without capability". Secondly, by emphasizing "Practice Enablement" as the ultimate objective, the model compels the cultivation in the first three dimensions to be directed towards solving real-world problems. This accomplishes the crucial leap from "knowing what" to "doing what", effectively enhancing the engineers' job competency. Specifically, "Value Guidance" ensures that engineers' professional conduct aligns with ethical norms and societal expectations, bolstering their social responsibility and professional steadfastness. "Knowledge Foundation" provides the theoretical arsenal for solving complex problems. "Ability Forging" transforms static knowledge into dynamic problem-solving strategies and innovative thinking. "Practice Enablement" serves as the crucible where, through the iterative cycle of "learning by doing" and "doing through learning", values, knowledge, and abilities are fused together, ultimately being internalized as the engineer's solid and transferable core competencies (Altbach & Balán, 2007; Jamieson & Lohmann, 2012; Prince & Felder, 2006).

CONCLUSIONS

This study systematically elaborates on a teaching reform practice carried out in petroleum industry universities, which takes promoting the "Petroleum Spirit" as its core and enhancing the effectiveness of ideological and political education as its goal. By constructing and implementing the "Four-Dimensional Forging" education model for ideological and political courses—namely integrating a high-caliber faculty member, developing extensive resources, building high-quality courses, and expanding extensive practice—the project has successfully explored a distinctive and effective innovation path for ideological and political courses in industry-oriented universities.

The core value of this practice lies in its effective response to the requirements for cultivating graduates' "non-technical skills" (such as engineering ethics, social responsibility, teamwork, and lifelong learning) specified in engineering education accreditation standards. It provides a Chinese solution featuring cultural empowerment, scenario creation, industry-education integration, and value guidance to address this common challenge in global engineering education. The study

confirms that transforming the unique cultural resource of the Petroleum Spirit—represented by the values of "hard work and dedication" and "three honests and four stricks"—into systematic educational and teaching elements not only significantly enhances the attractiveness, appeal, and effectiveness of ideological and political courses (evidenced by student satisfaction consistently exceeding 90% and the emergence of numerous outstanding student models) and achieves the educational goal of value shaping, but also provides solid support for cultivating outstanding engineering talents with firm ideals and beliefs, excellent professional qualities, and a strong sense of national belonging. The achievements have won more than 60 high-level awards and wide social recognition, and have been promoted and applied in 14 similar universities, which proves its solid practical effects and sound promotability.

In terms of theoretical contributions, the "Four-Dimensional Forging" model outperforms the scope of traditional ideological and political course reform. It conducts in-depth dialogue and innovative integration with internationally mainstream engineering education models (such as CDIO and OBE) and learning theories (such as constructivism). This model demonstrates that combining universal engineering education standards with unique industry cultural traditions, and through systematic teaching design, can realize the organic unity of knowledge impartment, competence cultivation and value guidance. The essence of its methodology—being good at exploring the spiritual wealth of industry culture and transforming it into specific curricula, resources, faculty members and practice systems that support the achievement of talent cultivation goals—holds important reference significance for all types of colleges and universities with industry backgrounds.

To sum up, the "Four-Dimensional Forging" model that cultivates people with the Petroleum Spirit as the soul is a successful practice for colleges and universities in the new era to implement the concept of "Great Ideological and Political Courses" and promote the connotative development of engineering education. It profoundly reveals that taking root in China's land, relying on industry characteristics, and adhering to upholding the fundamental and pursuing innovation is a sole way to cultivate talents with both virtue and ability who can shoulder the important task of national rejuvenation.

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