# Integrating Industry and Education via "Two-In-One-Out": A "Four-in-One" Teaching Model for Hydraulic Transmission in Emerging Engineering

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**Abstract.** To address the disconnection between theory and practice in engineering education under the New Engineering Education initiative, this study develops and implements an innovative "Industry-Education Integration, Four-in-One" teaching model, using the Hydraulic and Pneumatic Transmission course as a case study. The model is anchored by a "Two-In, One-Out" interaction mechanism, which brings enterprise mentors and authentic projects into the classroom and channels student outcomes into practical applications, and executed through a "Four-Transformations Integration" pathway that restructures content, resources, pedagogy, and evaluation. Guided by the ADDIE framework and a "Three-Classroom Linkage" organization, the reform systematically guides students through a "Learn-Do-Apply-Innovate" competency progression. Empirical data from a two-year implementation show significant improvements: a 22.3 percentage-point increase in good final scores, a 31.5% rise in project task scores, and markedly enhanced student motivation and satisfaction. The model also fosters teacher development and deepens institutional industry ties. This study validates a transferable paradigm for bridging education and industry, offering a comprehensive package for curriculum reform with both theoretical and practical significance.

**Keywords:** Industry-Education Integration; Four-in-One Teaching Model; Hydraulic and Pneumatic Transmission; Engineering Education Reform.

## 1 Introduction

Amidst the accelerating global technological revolution and industrial transformation, which demands high-caliber engineering talent equipped with not only theoretical knowledge but also superior practical problem-solving skills, innovation, and interdisciplinary integration capabilities [1], China's promotion of Emerging Engineering Education (3E) has made deepening industry-education integration a critical reform pathway [2]. However, traditional teaching for core courses like Hydraulic and Pneumatic Transmission suffers from a "threefold disconnection": theory-practice misalignment where content lags industry needs [3], pedagogy detached from industrial frontiers due



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to teacher-centered methods [4], and monolithic assessments inadequate for developing comprehensive competencies [5, 6], necessitating a new pedagogical bridge [7]. To address this, this study develops and implements an "Industry-Education Integration, Four-in-One" model using the aforementioned course as a case. Its core is a "Two-In, One-Out" mechanism [8]—integrating enterprise mentors and real projects into teaching ("Two-In") and channeling student outcomes into practical applications ("One-Out")—which systematically guides students through a progressive "Learn-Do-Apply-Innovate" competency cycle [9]. The research contributes theoretically by operationalizing Outcome-Based Education (OBE) within the 3E context through methods like Project-Based Learning (PBL) to offer a transferable paradigm [10], and practically by providing a validated reform package (encompassing content, resources, instruction, and diversified evaluation) to foster a synergistic education-talent-industry ecosystem with significant demonstrative value [11].

## 2 Core Model: Construction of the "Industry-Education Integration, Four-in-One" Teaching System

The effective operation of the "Industry-Education Integration, Four-in-One" teaching system relies on the "Two-In, One-Out" core concept, which breaks traditional classroom boundaries to create an ecosystem of bidirectional resource flow. The "Two-In" mechanism systematically integrates industry through an institutionalized dual-tutor system, where senior engineers impart authentic cases and current insights, and by embedding authentic R&D challenges as "micro-projects" into the curriculum, shifting learning goals from knowledge acquisition to practical problem-solving. The ultimate aim is a high-quality "One-Out," where student outcomes—such as designs, models, or reports—are channeled into enterprise practice, academic competitions, and graduation theses for real-world validation. Crucially, this external validation process itself forms the most authoritative mechanism for teaching evaluation and iterative improvement. Feedback from enterprises, competition judges, and thesis defenses enables continuous adjustment of teaching methods, thereby connecting "Two-In" and "One-Out" into a closed loop of continuous improvement that aligns educational inputs with industrial demands and feeds cultivation outcomes back to industry, establishing the operational foundation for sustained teaching reform.

To effectively operationalize the core "Two-In, One-Out" concept, this study designed an integrated implementation pathway centered on "Four-Transformations Integration," which holistically reconstructs teaching content, resources, processes, and evaluation. Firstly, Task-Based Content Restructuring deconstructs authentic enterprise projects into progressive "hierarchical learning tasks," shifting learning objectives from passive memorization to active application and aligning the curriculum with practical needs. To support this, a Multidimensional Resource Ecosystem blends online digital repositories with offline access to labs and enterprise bases, employing a "virtual simulation first, physical operation verification" model. Concurrently, the instructional process is transformed into a High-Order Collaborative Workshop through the dual-tutor system and PBL methods, engaging students in complete problem-solving cycles

that integrate real-world constraints. Finally, a Diversified Evaluation System replaces exam-centric assessment with a continuous, process-oriented approach involving multiple assessors and dimensions; this system acts as a diagnostic tool, using multi-source feedback to scientifically inform the ongoing optimization of task design, resource allocation, and pedagogy, thereby achieving sustained, closed-loop quality improvement in both teaching and learning.

The "Two-In, One-Out" mechanism and "Four-Transformations Integration" pathway converge on the "Learn-Do-Apply-Innovate" competency progression model, an interlocking, spiraling cycle designed to transform students from foundational understanding to engineering innovation capability. This cycle begins with Learn, driven by real-world problems for active knowledge construction; proceeds to Do for hands-on internalization; elevates to Apply, requiring synthesis to solve multi-constraint projects; and culminates in Innovate for critical questioning and original design. These stages form a mutually reinforcing system where each phase informs the next: Learn enables Do, which consolidates Learn; together they underpin Apply, whose complexities drive deeper Learning and more refined Doing; sustained Application then fosters Innovation. This ensures capability develops via a spiraling upward trajectory, cultivating individuals who evolve from competent operators to proficient practitioners and potential innovators. As show in figure 1.

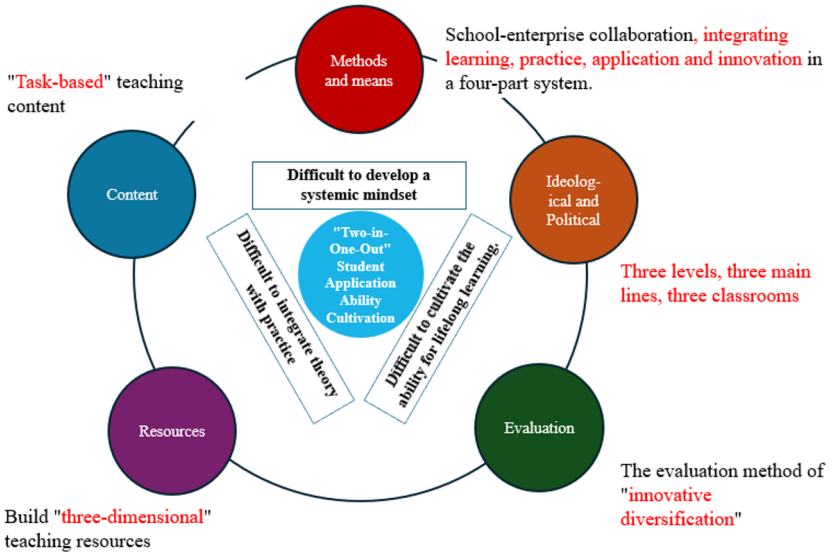


**Fig. 1.** Reform Plan Diagram.

## 3 Practical Application: Implementation in the Hydraulic and Pneumatic Transmission Course

To ensure the "Industry-Education Integration, Four-in-One" teaching model is scientifically operational and replicable, the course underwent systematic restructuring guided by a dual approach: first, adhering to the ADDIE model for closed-loop, iterative planning—progressing from collaborative industry-student needs analysis, through backward design of scaffolded "Learn-Do-Apply-Innovate" objectives and task-based modules, to resource co-development, implementation via dual-tutor guidance, and evaluation using multi-source data to fuel continuous improvement; and second, innovating the teaching organization through a deeply integrated "Three-Classroom Linkage" blended learning mechanism, where the Online Classroom provides foundational knowledge transfer, the Offline Classroom serves as a hub for interactive skill development and higher-order thinking around enterprise projects, and the Post-Class Innovation Classroom acts as an open incubator for practical prototyping and outcome transformation, collectively creating a multidimensional teaching field that supports the entire competency progression cycle.

This study centers on the Hydraulic and Pneumatic Transmission course to construct a systematic framework for organically integrating ideological and political education, avoiding didacticism through a "Three-Level Infiltration and Three-Thread Integration" model. This framework embeds value guidance across the Knowledge Level (revealing scientific spirit and ethics), Ability Level (cultivating resilience and systems thinking), and Value Level (fostering social responsibility), consistently threaded by Craftsmanship Spirit, Innovation Consciousness, and Social Responsibility. The core methodology is case-based teaching, exemplified by the "Breakthrough in Domestic High-End Hydraulic Pumps" case, which naturally links technical analysis (Knowledge/Innovation) to the R&D persistence narrative (Ability/Craftsmanship) and strategic national significance (Value/Responsibility). This approach makes ideological education concrete and credible, seamlessly integrating the cultivation of professional competence and moral character, thereby effectively enhancing the overall educational outcome.

## 4 Implementation Effectiveness and Data Analysis

To objectively assess the effectiveness of the "Industry-Education Integration, Four-in-One" teaching model, this study analyzed data from before and after the reform (2021 vs. 2023 cohorts) across academic and perceptual dimensions. Results show significant improvements in knowledge mastery, practical ability, and learning motivation. Quantitatively, post-reform final exam score distribution improved, with the standard deviation decreasing by ~15% and the combined proportion of "Good" (≥75) and "Excellent" (≥85) scores increasing by 22.3 percentage points. The average score for the comprehensive "Project Task" module rose by 31.5%. Survey data (5-point Likert scale, N=120 per phase, response rate >95%) revealed a strong positive shift in subjective experience: agreement with "this course stimulates my interest" jumped from 47.5% to 86.2%; reported high classroom interaction engagement rose from 35.0% to 78.4%;

91.5% found "enterprise projects in classroom" helpful for understanding, and 88.7% valued the "dual-tutor system's" practical perspective. These findings indicate the model not only enhanced academic performance but also fundamentally improved the learning experience and intrinsic motivation. As show in table 1.

**Table 1.** Implementation effectiveness and data analysis.

| Specific indicator | Pre-reform (2021 control cohort) | Post-reform (2023 experimental cohort) | Trend and interpretation |
|---|---|---|---|
| Rate of Good & Excellent Final Scores | 65.2% | 87.5% | Increased by 22.3 percentage points, indicating an overall rise in proficiency. |
| Average Score in Project Task Module | 72.4 | 95.2 | Increased by 31.5%, demonstrating significant enhancement of applied competence. |
| High Learning Interest (Questionnaire Agreement Rate) | 47.5% | 86.2% | Substantial increase in intrinsic learning motivation. |
| High Classroom Interaction Engagement (Questionnaire Agreement Rate) | 35.0% | 78.4% | Teaching methods effectively promoted active participation. |
| Recognition of the Value of "Enterprise Projects in Classroom" (Questionnaire Agreement Rate) | 60.8% | 91.5% | The industry-education integration model received high recognition. |

The implementation of the "Industry-Education Integration, Four-in-One" teaching model serves not only as a pedagogical reform for students but also as a powerful engine driving the renewal of teaching philosophies and the reshaping of professional competencies among faculty. By establishing an institutionalized school-enterprise collaboration context, this model provides teachers with a valuable "second classroom," facilitating significant professional development through the process of teaching and learning from practice. The enhancement of teaching capability is primarily reflected in the co-evolution of instructors' engineering practice literacy and instructional design skills. The mandated "dual-tutor interaction" mechanism requires academic staff to engage deeply with cutting-edge industrial practices. During collaborative lesson planning and delivery, enterprise mentors contribute real-world case studies and practical constraints, effectively remedying gaps in "tacit practical knowledge." This continuous interaction shifts the teacher's role from a knowledge transmitter to a designer of engineering scenarios and a coach of the learning process, fostering a fundamental transition in pedagogical thinking from theoretical logic to practical application. Furthermore, immersion in this integrated practice generates a steady stream of authentic research problems, leading to tangible outcomes such as provincial-level teaching reform projects, publications in journals like Vocational Education Development, and accolades including institutional and provincial-level course awards. These achievements

systematically validate the model's effectiveness, boosting instructors' professional fulfillment and creating a virtuous cycle of reform, outcome generation, and dissemination that radiates to other courses within the discipline.

## 5 Conclusion

This study, through constructing and implementing the "Industry-Education Integration, Four-in-One" teaching model, demonstrates its significant effectiveness in profoundly motivating engineering students, facilitating the translation of theoretical knowledge into practical engineering competency, and systematically cultivating innovative thinking. Anchored by the "Two-In, One-Out" mechanism and executed via the "Four-Transformations Integration" pathway, the model successfully integrates authentic enterprise demands and projects throughout the *Hydraulic and Pneumatic Transmission* course, guiding students through the scaffolded "Learn-Do-Apply-Innovate" competency progression. Practice confirms that the model enhances student academic performance, project quality, and competition outcomes, while also fostering the growth of teachers' practical teaching abilities and generating pedagogical research outputs. However, challenges persist, including the sustainability of enterprise resource commitment amidst operational fluctuations, the pressure on instructors to adapt to interdisciplinary collaboration and project-based teaching roles, and the operational complexity of implementing a unified yet diversified evaluation system. To promote its adoption, a phased implementation strategy is recommended. Pilot programs should begin with industry-aligned courses led by motivated teaching teams. Crucially, adaptation should focus on internalizing the core principles of deep industry-education interaction and competency progression, rather than mechanically replicating specific formats. Furthermore, institutional incentives and support mechanisms—such as recognizing enterprise participation in social contribution evaluations, establishing interdisciplinary teaching reform awards, and providing technical support for curriculum and assessment design—are essential to build a sustainable ecosystem for such reforms, enabling the leap from innovating a single course to transforming a talent cultivation paradigm.

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