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Research on the University-Industry Collaboration and AI-Enabled Teaching Model of Project Management Course in the Context of Work-Integrated Learning

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Abstract: The traditional Project Management course has long faced problems such as the gap between theory and practice, the clash between on-campus teaching and off-campus internships in the final year, and rigid assessment methods, which makes it difficult to meet the demands of emerging engineering education for interdisciplinary graduates in mechanical and electrical engineering. To address these problems, this paper explores and constructs a new teaching model based on university-industry collaboration and AI-enabled teaching, guided by outcome-based education (OBE). The paper first reviews the rationale of the model and outlines a three-phase reform roadmap, and then examines its core mechanisms: dual mentoring by university mentors and industry mentors, the decoupling of teaching from fixed times and places, and multimodal learner profiles. Questionnaire data from 2024 and 2025 show that students' self-assessed attainment of both course learning outcomes improved (Course Learning Outcome 1: 0.803 to 0.832; Course Learning Outcome 2: 0.778 to 0.831). Through this systematic reform design, the paper offers practical experience for other engineering programs that aim to deepen work-integrated learning (industry-education integration).

1. Introduction

With the accelerated transformation of China's manufacturing industry toward high-end, intelligent and green development, especially in light of the 15th Five-Year Plan (2026-2030) and the longer-term strategy of building a manufacturing powerhouse, engineering and technological talent are now expected to integrate machinery, electronics, information and management.[1] This shift has made interdisciplinary, practice-oriented graduates who understand technology, can manage projects and work well in teams increasingly important, thereby deepening work-integrated learning in engineering education.

In mechanical and electrical engineering, the Project Management course is intended to develop

students' systems thinking and planning ability, but current teaching often remains confined to theoretical lecturing and provides limited support for complex problems in real industrial settings. Students therefore have few opportunities to apply project management methods to changing, real projects. Although universities have extended teaching into enterprises, fixed teaching arrangements in the final year conflict with dispersed internships[2], limiting work-integrated learning to short, disconnected encounters.

2. Problem Statement

Under the national strategy of digital education transformation, AI is changing teaching models, learning pathways and assessment methods in higher education.[3] Advancing work-integrated learning therefore cannot rely on physical co-location alone; AI and digital technology must connect learning resources, project practice and assessment across campus and enterprise settings so that students can continue learning during dispersed internships.

As a core course integrating technology and management in mechanical and electrical engineering, Project Management develops students' systems thinking and ability to solve complex engineering problems[4]. However, fixed teaching schedules in the final year often reduce work-integrated learning to visits and lectures[5] rather than sustained project practice that connects theory with real projects.

Although academia has systematically summarized the paths of work-integrated learning [6], the AI-enabled reconstruction of teaching targeting engineering programs remains a weak link. Existing studies are mostly limited to local method improvements and fail to resolve the conflict between "centralized teaching" and "dispersed internships" in the final year; moreover, AI applications rarely include process-based higher-order assessment built on big data; the content is also not well adapted to mechanical and electrical engineering, and there is also a lack of rigorous action research documenting the decision-making and trial-and-error process[7].

Building on prior research on engineering-course reform and virtual simulation[8][9], this study uses the Project Management course reform at Guilin University of Electronic Technology as a case to construct and evaluate an AI-enabled work-integrated teaching model, focusing on the mechanisms linking university, enterprise and course-level learning.

3. Research Design and Methods

Taking the Project Management course reform in the mechanical and electrical engineering program at Guilin University of Electronic Technology as the empirical case, this study uses a mixed-methods action-research design that combines qualitative and quantitative data over three years. The process followed the planning, acting, observing and reflecting cycle. The main comparison involved intact classes from two consecutive cohorts with similar entry performance: the earlier cohort served as the control group and the later cohort as the experimental group. The groups were compared in complex problem-solving, decision-making competence and interdisciplinary collaboration.

In order to quantify higher-order competencies, this study relies on the AI teaching assistant tools of the smart teaching platform adopted by our university and a learning analytics system to collect multimodal learning data throughout the course. The system automatically collects process data such as how deeply students review the literature on the cloud platform, how they operate industrial software, and how quickly they respond in simulation-based exercises, and uses natural language processing and machine learning to analyze de-identified data and dynamically generate a learner profile for each student. This makes it possible to measure implicit competencies such as resilience under pressure and communication and coordination rather than relying on subjective

observation; it is consistent with the academic logic of "teacher-machine-student" collaborative symbiosis, and reconstructs the triadic learning relationship through big data analysis to optimize the higher-order cognitive decision-making mechanism[10].

In constructing the evaluation system, the study comprehensively uses multi-stakeholder feedback and course learning outcome attainment evaluation, forming a mixed evaluation and comparison framework that integrates theory and practice. On the one hand, before and after the teaching cycle, large-scale online questionnaires and semi-structured interviews targeting students, university mentors and industry mentors are used to explore the qualitative value of the new model in reshaping professional cognition and enhancing the depth of work-integrated learning. On the other hand, strictly benchmarking against the accreditation standards of the China Engineering Education Accreditation Association (CEEAA), the attainment of each indicator is weighted and calculated by combining final examinations, the quality of project plan preparation and regular formative assessment; and through multiple comparisons of longitudinal historical data and horizontal inter-group data, changes in educational quality are systematically evaluated.

4. Three-Stage Process of Teaching Reform Based on Action Research

This reform proceeded in three stages. First, prior-learning assessment and enterprise visits informed an OBE-based redesign of the syllabus, and the project team developed AI-generated cases, a shared resource library and a pilot combining online theory with enterprise practice and dual mentoring[11]. Second, the model was extended across the program. Dual-mentor selection and assessment standards were established with regional manufacturers, the case library was expanded to more than 20 cases, Oracle Primavera P6 was introduced, and AI was used to schedule flexible tasks for students in dispersed internships. Third, a large language model-based learning-behavior system generated learner profiles, which were combined with mentor scores and project plans in a multi-component assessment; the model was then documented and shared with other programs.

5. Core Connotation and Key Mechanisms of the Teaching Model

The "university-industry collaboration and AI-enabled teaching" teaching model of Project Management systematically constructed in this study is not a partial repair of the original teaching links, but a reconstruction of the underlying logic of the entire course ecosystem.

5.1 Theoretical Guidance and Connotation of the Teaching Model

This model builds on Chinese research on the integration of research and teaching, brings research thinking into industrial practice and defines how the reform is carried out at course level[12]. Teaching is guided by situated learning, cognitive apprenticeship and Kolb's experiential learning cycle; students are placed in real enterprise environments, and guided by dual mentors and AI-generated cases, they build knowledge by dealing with real engineering variables and project iterations[13]. At the same time, following OBE, the course moves away from a purely technical orientation and gives more weight to non-technical higher-order competencies such as communication and teamwork, which aligns with the CEEAA accreditation standards.

This model aims to develop interdisciplinary graduates with both mechanical and electrical technology and management capabilities, and consists of two tracks: theoretical teaching at the university and engineering practice in enterprises. On campus, the focus is on management theory and the application of industrial software; on the enterprise side, teaching is extended to product research and development and manufacturing sites through joint university-industry guidance. As the core support, AI and digital technology assist in the dynamic generation of resources, the

recommendation of learning paths and the intelligent evaluation of teaching effects, reconstructing the education system of deep work-integrated learning at the underlying logic level.

As shown in Figure 1, the operation of this model is a four-stage dynamic closed loop. Before class, the university and industry jointly build resources and plan layered paths; during class, students develop engineering competence through dual-mentor guidance and hands-on work with industrial software; after class, interaction data are collected automatically to generate a "learner profile" for formative assessment; finally, the syllabus and resource library are continuously revised according to multi-dimensional feedback. This closed loop effectively connects information among the university, industry and students, ensuring that teaching stays close to industry needs.

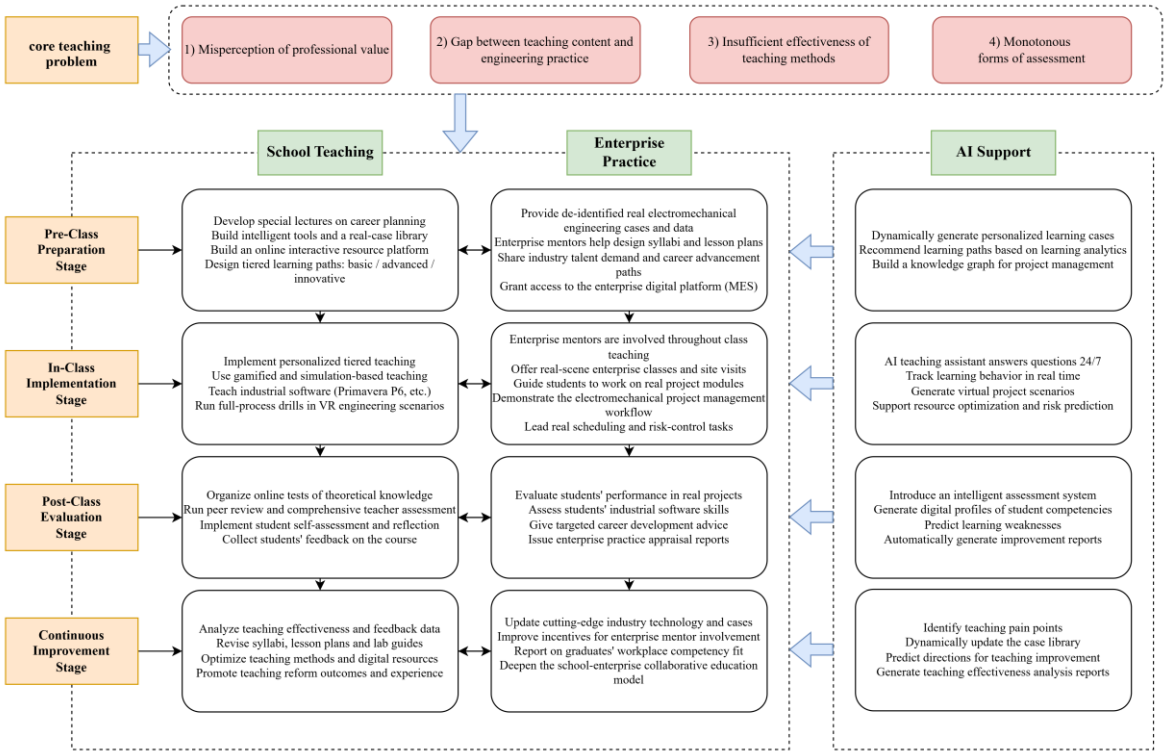


Figure 1: Overall Roadmap of Teaching Reform Measures.

5.2 Four Core Mechanisms and Practice Paths for Addressing Teaching Problems

As shown in Figure 2, the model links four teaching problems, namely cognitive fragmentation, collaboration failure, temporal and spatial mismatch, and evaluation distortion, to corresponding root causes and responses. To address cognitive fragmentation and collaboration failure, a joint university-industry curriculum committee revised the syllabus, moved career planning earlier, invited alumni to share career experience, and organized workshop observations so that students could see how technical and management work interact. At the same time, Dual mentoring was fully implemented: university mentors covered theory and methods, while industry mentors supervised practical work. Faculty secondment to industry and guest lectures by enterprise staff further connected campus teaching with current industrial practice. Together, these measures shifted attention from technical skills alone toward integrated technical and managerial competence.

To align teaching content with industrial practice and address the temporal and spatial mismatch facing final-year students, the university and industry jointly built a cloud resource library integrating theory, simulation and practice. This library supported two-way resource exchange: enterprises contributed engineering drawings and project materials, while university laboratories

and teaching resources were shared with industry partners. Building on this foundation, the course established a four-dimensional practical system in which students used Python or MATLAB for risk-calculation algorithms, Oracle Primavera P6 for project scheduling, virtual reality workshops for production simulation, and large language models trained on de-identified enterprise data for decision support. To accommodate graduate entrance examinations, employment and dispersed internships, foundational theory was delivered through cloud-based learning, while students prepared work plans for real projects at their internship enterprises. University mentors reviewed the theoretical basis and industry mentors supervised practice on site, allowing learning to continue across locations.

Finally, Evaluation distortion was addressed by replacing the closed-book final examination with a 50%-30%-20% assessment. The 50% formative component drew on learning-platform activity, simulation exercises and team communication, with learner profiles generated from behavioral data to support assessment of competencies that are difficult to capture in an examination. The final project plan defense accounted for 30%, and industry mentors provided the remaining 20% through on-site evaluation. This process-based evidence allowed instructors to observe participation and teamwork throughout the course rather than only at the end. The resulting mix rewards sustained project work and provides feedback for revising the syllabus.

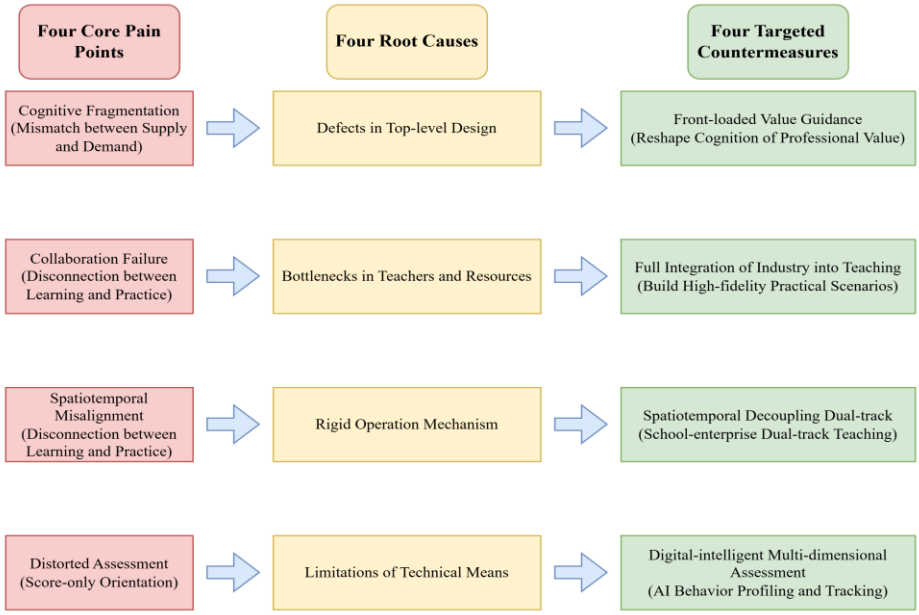


Figure 2: Analysis of the Problems, Root Causes and Strategies of the Existing Teaching Model.

6. Analysis of Teaching Reform Effectiveness

Based on the existing teaching baseline data, this study promotes steady improvements in educational quality through the continuous intervention of the "university-industry collaboration and AI-enabled teaching" model. The following sections analyze the effectiveness since the implementation of the reform from three aspects: student self-assessment, academic performance and advanced engineering competencies.

6.1 Annual Comparison of Student Self-Assessment and Learning Feedback

In order to objectively examine the implementation effect of the teaching reform, this study conducted a questionnaire survey of self-assessment of course learning outcome attainment among

the teaching classes in 2024 and 2025, before and after the teaching reform, with 94 and 113 valid responses respectively. The questionnaire covered 11 assessment dimensions around Course Learning Outcome 1 and Course Learning Outcome 2.

The questionnaire survey method designs questions related to each course learning outcome; students self-assess on a five-point Likert-type scale, namely "fully achieved, mostly achieved, partially achieved, minimally achieved and not achieved", with each level corresponding to a score of 5, 4, 3, 2 and 1. The attainment level Q_r is calculated from the distribution of responses at each level and their scores, and the formula is:

$$Q_r = \frac{\sum_{i=1}^{5} \mu_i K_i}{5 \sum_{i=1}^{5} K_i} \tag{1}$$

where $\mu_i \in \{5,4,3,2,1\}$, and K_i is the number of respondents at level i. When there are multiple questionnaire questions for the same course learning outcome, the attainment level of that outcome is the average of the attainment levels of all its questions.

The statistical results show that after the teaching reform, students' self-assessment of course mastery in 2025 is overall higher than that in 2024. As shown in Table 1 and Table 2, the attainment level of Course Learning Outcome 1 increased from 0.803 to 0.832, and that of Course Learning Outcome 2 from 0.778 to 0.831; the gap between the attainment levels of the two course learning outcomes narrowed from 0.025 to 0.001, and the scores for all sub-dimensions generally increased. This indicates that, with the continuous advancement of the teaching reform, students show relatively high acceptance of the course content; they are not only more confident in mastering course knowledge, but also their self-assessment of various core competencies of project management tends to be balanced.

Table 1: Student Self-Assessment of Course Learning Outcome Attainment in 2024.

Course Learning Outcome	Assessment Dimension	Fully Achieved (5)	Mostly Achieved (4)	Partially Achieved (3)	Minimally Achieved (2)	Not Achieved (1)	Score for Each Assessment Dimension	Course Learning Outcome Attainment Score
Course Learning Outcome 1	Project Organization	23	47	21	3	0	0.791	0.803
	Project Integration Management	23	40	29	1	1	0.777	
	Resource Management	27	47	11	6	3	0.789	
	Communications Management	38	37	16	2	1	0.832	
	Project Stakeholder Management	32	49	8	3	2	0.826	
Course Learning Outcome 2	Scope Management	32	31	23	5	3	0.779	0.778
	Schedule Management	23	40	29	1	1	0.777	
	Cost Management	8	58	26	2	0	0.753	
	Quality Management	26	35	28	4	1	0.772	
	Risk Management	28	44	17	3	2	0.798	
	Procurement Management	24	46	21	2	1	0.791	

Table 2: Student Self-Assessment of Course Learning Outcome Attainment in 2025.

Course Learning Outcome	Assessment Dimension	Fully Achieved (5)	Mostly Achieved (4)	Partially Achieved (3)	Minimally Achieved (2)	Not Achieved (1)	Score for Each Assessment Dimension	Course Learning Outcome Attainment Score
Course Learning Outcome 1	Project Organization	36	59	15	2	1	0.825	0.832
	Project Integration Management	41	52	18	1	1	0.832	
	Resource Management	40	49	19	2	3	0.814	
	Communications Management	53	37	18	4	1	0.842	
	Project Stakeholder Management	50	46	12	3	2	0.846	
Course Learning Outcome 2	Scope Management	55	28	20	7	3	0.821	0.831
	Schedule Management	46	45	18	3	1	0.834	
	Cost Management	51	41	17	3	1	0.844	
	Quality Management	52	36	18	5	2	0.832	
	Risk Management	57	25	24	5	2	0.830	
	Procurement Management	54	26	28	4	1	0.827	

6.2 Substantial Improvement in the Attainment Quality of Academic Objectives

In terms of objective academic outcomes, the existing traditional teaching model has formed a certain data baseline (e.g., in 2024 the class average overall grade was about 81.23 points, the pass rate was 100%, and 63.83% of students achieved a grade of good or above). Although these baseline indicators far exceed the 0.60 pass mark on the surface, most of their scores come from static paper-and-pencil tests and rote memorization. This teaching reform project redefines the "gold content" of these scores: after the implementation of AI-enabled teaching and work-integrated learning, the score distribution can more truly reflect students' higher-order decision-making ability. At the same time, by introducing industry expert scoring and real project plan defense, we transformed the previously inflated "memory-based attainment level" into a "practice-oriented attainment measure" that reflects the ability to solve complex industrial problems, a fundamental change in what the assessment indicators measure.

6.3 Analysis of the Transformation of Advanced Engineering Competencies and Professional Competence

The focus of the qualitative evaluation of this model shifts from daily behavior observation to core competency transformation. At the level of knowledge structure and practical ability, students shift from single theoretical memorization to applied practice, and can use management information systems (MIS) to comprehensively apply knowledge areas such as schedule, cost, scope and risk to carry out dynamic construction and overall calculation of mechanical and electrical engineering projects. In terms of collaboration and professional competence, through authentic scenario-based teaching by dual mentors from the university and industry, students realize the transformation to the role of actively participating project stakeholders. Through role-play and negotiation exercises, together with resource planning activities, students develop a systematic understanding of engineering management ethics and the overall decision-making skills needed to be effective team members in intelligent manufacturing enterprises.

7. Innovations of the Research

The study makes four contributions to work-integrated teaching in emerging engineering education:

First, it pioneers a flexible teaching organization that decouples theory from fixed times and places, connecting asynchronous online learning with practice in enterprise workshops.

Second, it integrates generative AI and learner profiles to generate practice-oriented resources and process-based assessment from de-identified enterprise and learning data.

Third, it reshapes practical learning through VR, industry-standard software such as Oracle Primavera P6, and on-site industry mentoring for complex project decisions.

Fourth, it connects career development and professional values with technical learning to prepare interdisciplinary graduates for both engineering and management roles.

8. Conclusions and Outlook

This study developed an AI-enabled, university-industry teaching model for Project Management and examined it in a three-year action-research project. The model combined dual mentoring, flexible learning across campus and enterprise, AI-generated resources, learner profiles and project-based assessment to connect centralized instruction with dispersed final-year internships. Questionnaire results from 2024 and 2025 showed higher self-assessed attainment of both course

learning outcomes, rising from 0.803 to 0.832 and from 0.778 to 0.831, while the gap between the two outcomes narrowed from 0.025 to 0.001. These results suggest that combining industry-based projects, flexible instruction and process assessment can strengthen the practical relevance of Project Management teaching while maintaining attention to both course outcomes.

These conclusions are limited to one action-research project in a local university's mechanical and electrical engineering program, so the model requires testing in other institutional and disciplinary contexts. The comparison also used two consecutive cohorts rather than random assignment. The evaluation also emphasizes short- and medium-term outcomes, including student satisfaction, course performance and initial employment. Longer-term tracking of graduates' career development and engineering leadership remains necessary.

Future work will extend generative AI in personalized learning and assessment, provide deeper support such as intelligent tutoring and virtual mentoring, and apply the model to other engineering courses and a broader multi-stakeholder education community.

Acknowledgements

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