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Research on the Path of AI-Enabled Project-Based Teaching to Address Challenges in Logistics Courses

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Abstract **Review Article**

Objective: This study aims to address the structural contradiction between the rapid development of the smart logistics industry and the current talent cultivation model in higher education. It focuses on the practical dilemmas faced by traditional logistics courses, including technological disconnect, scenario lag, and capability gaps. ***Methods:*** Taking traditional logistics courses as the research subject, this study analyzes the underlying causes of rigid teaching content, static teaching models, and single-dimensional assessment methods. Based on this analysis, an innovative reform path is proposed, with artificial intelligence serving as the technical engine and project-based teaching as the organizational carrier. ***Results:*** The proposed reform framework includes AI-driven dynamic updating of course content, reconstruction of teaching processes through virtual-real integrated scenarios, and competency evaluation supported by multimodal data. These elements form a three-dimensional linkage solution covering teaching content, instructional models, and assessment systems. ***Conclusion:*** The research indicates that this reform path has significant theoretical value and practical significance for improving traditional logistics education. It provides an effective approach to cultivating interdisciplinary and application-oriented talents who can meet the demands of the smart logistics era.
Keywords: Artificial Intelligence; Project-Based Teaching; Logistics Course Reform; Competency Cultivation.

INTRODUCTION

Against the dual background of accelerated restructuring of global industrial chains and the deepening implementation of the “dual-carbon” strategy, China’s logistics industry is undergoing a historic transformation from scale expansion to intelligent driving. New technologies such as AGV swarm scheduling in smart warehousing, real-time dynamic path optimization, and digital twin modeling and prediction have become core industrial competitiveness[1, 2]. However, in stark contrast to industrial transformation, the talent cultivation system for logistics in universities shows significant lag. According to JD Logistics survey data, 83% of logistics graduates cannot independently complete carbon-neutral warehouse design; in FlexSim simulation tests, only 12% of students can achieve multi-objective collaborative optimization under sudden disturbances[3]. The mismatch between talent supply and industrial demand has become a key bottleneck restricting the high-quality development of smart logistics.

Facing the above dilemmas, the educational application of artificial intelligence technology and the promotion of project-based teaching models offer new possibilities for logistics course reform[4]. The Ministry of Education’s “Action Plan for Promoting AI Innovation in Universities” clearly calls for “deepening industry-education integration and promoting AI and full-chain innovation in education.” [5, 6]However, most current “AI+education” practices remain at the tool-assistance level, failing to fundamentally reconstruct the knowledge system, teaching logic, and evaluation paradigm of courses[7]. This study takes logistics courses as the entry point, systematically analyzes the core dilemmas and their underlying causes in logistics teaching, explores innovative paths for deep integration of AI technology and project-based teaching, and aims to provide an actionable theoretical framework and practical reference for the reform of related professional courses.

1 Current Teaching Dilemmas in Logistics Courses

1.1 Technological disconnect: teaching content lags behind industry technology iteration

The teaching content of logistics courses has long been anchored to traditional theoretical frameworks and fails to effectively align with the technological evolution of smart logistics. Existing teaching still focuses on traditional methods while core AI technologies have not been systematically integrated into the curriculum. According to industry reports, 85% of leading enterprises list AI algorithm application ability as a core competency for logistics engineers, yet the average proportion of intelligent algorithm modules in university logistics courses is less than 15%[8]. Second, superficial tool application. AI technology in teaching remains at the level of tool packages such as Excel data processing and basic simulation software operations, failing to guide students to master industrial-grade frameworks like TensorFlow and PyTorch for algorithm development and tuning[9].

The deep cause of this disconnect is the absence of a technology tracking mechanism. The update cycle of course syllabi is much slower than the technology iteration speed of the logistics industry, and there is a lack of regular technology collaboration mechanisms between universities and enterprises, resulting in an obvious generational gap between classroom teaching and enterprise applications[10].

1.2 Scenario lag: teaching model detached from industrial dynamic environment

The teaching scenarios of current logistics courses exhibit significant static characteristics, forming a huge contrast with the real smart logistics operation environment. On the one hand, case bases are outdated and rigid. Courses still heavily use traditional cases such as static warehouse layout based on historical data and path optimization under fixed constraints, failing to reproduce enterprise-level scenarios like dynamic path adjustment integrating real-time traffic conditions or elastic scheduling of warehouse resources under sudden order shocks. On the other hand, practical project design is simplistic[11]. There is a lack of coverage of emerging topics such as low-carbon logistics network reconstruction, blockchain traceability system design, and digital twin-driven collaborative optimization, so students do not gain hands-on training in dealing with complex dynamic problems.

The root of this problem lies in the hollowing of university-enterprise collaboration mechanisms. Most collaborations remain at shallow levels such as factory visits and lectures, lacking deep mechanisms like real data interfaces, enterprise project introduction, and joint laboratory construction, thus failing to provide teaching scenarios with a continuous flow of industrial practice[12].

1.3 Capability gap: assessment misaligned with talent standards

The structural mismatch between the course assessment system and student competency cultivation is the most harmful part of the teaching dilemma. First, single evaluation dimension. Traditional assessment relies too much on closed-book exams and case analysis reports, emphasizing memorization and reproduction of theoretical knowledge, while seriously neglecting the practical evaluation of core skills such as simulation modeling, algorithm tuning, and system integration. Second, inaccurate evaluation criteria[13]. Existing grading rules are not aligned with corporate technical acceptance standards, such as Meituan's A/B testing standards for intelligent dispatch systems or BYD's simulation error thresholds for digital twin factories, leading to widespread "high scores, low ability." Third, lack of feedback mechanism. Assessment results are presented only as scores, failing to provide structured diagnosis and targeted intervention for students' capability weaknesses.

The fundamental cause of this imbalance is the decoupling of the competency evaluation system from industry needs. The course assessment does not align with job competency models, nor does it establish a certification mechanism linked to industry accreditation standards, resulting in a lack of effective quality verification between the output of talent cultivation and the input of industrial demand.

2 AI-Enabled Project-Based Teaching as a Solution Path

Faced with the above dilemmas, traditional piecemeal course improvements are no longer effective; a systematic paradigm change is urgently needed. This study proposes using artificial intelligence as the technical engine and project-based teaching as the organizational carrier to implement coordinated reconstruction across three dimensions: content, scenario, and assessment.

2.1 AI-driven content reconstruction: from knowledge lag to dynamic updating

The key to solving the problem of lagging teaching content is to establish a dynamic, cutting-edge, and integrated course content system. Traditional course content updates follow the textbook revision cycle, often taking three to five years to complete one iteration, while the technology evolution cycle in the logistics industry has shortened to less than six months. The intervention of AI technology makes it possible to keep teaching content dynamically synchronized with industrial frontiers.

2.1.1 Building an AI-assisted intelligent case generation mechanism

Traditional case base construction relies heavily on teachers' personal enterprise resources and industry experience, resulting in long construction cycles, slow updates, and difficulty covering diverse business scenarios. By establishing data sharing channels with leading enterprises such as JD Logistics, SF Technology, and Cainiao Network, real business data can be fed into the teaching platform, providing a continuous source of material for case generation[14]. Based on natural language processing and knowledge graph technologies, the AI system can automatically perform three core tasks: extracting key business parameters from raw data through data feature extraction; automatically clustering different business situations through typical scenario identification; and generating structured teaching cases by integrating multiple constraints via multi-variable case generation[15]. Students in such a case environment face real problems originating from actual business operations rather than simplified idealized models, fundamentally improving the starting quality of project-based teaching.

2.1.2 Deeply embedding AI algorithms into the course knowledge system

Traditional courses treat AI as an external tool, inserted only in specific segments; this fragmented embedding cannot cultivate students' systematic intelligent planning thinking. The core breakthrough of this study is to upgrade AI algorithms from toolkits to methodologies, making them an organic part of the course knowledge system. Specifically, on the basis of traditional planning theory, three major AI modules are added. First, the machine learning and logistics forecasting module covers time series forecasting, regression analysis, classification algorithms, etc., applied to scenarios such as regional delivery demand forecasting, transport time estimation, and anomaly order identification. Second, the deep reinforcement learning and dynamic scheduling module teaches Q-learning, policy gradient, multi-agent reinforcement learning, etc., applied to complex decision-making problems such as AGV swarm scheduling, dynamic path planning, and warehouse resource allocation. Third, the digital twin and system optimization module covers simulation modeling, multi-objective optimization, real-time data synchronization, etc., applied to logistics system design verification, emergency plan rehearsal, and virtual-real interactive optimization[16].

Taking a smart warehousing project as an example, traditional teaching typically requires students to complete a static storage location layout design. In the restructured course, this project is designed as a comprehensive practical task running through the entire course: In the first stage, students use machine learning algorithms to analyze historical order data and predict the outbound frequency distribution of SKUs for the coming week. In the second stage, based on the prediction results, they use reinforcement learning algorithms to design dynamic scheduling strategies for AGV swarms and verify the time and energy performance of different strategies through a simulation platform[17]. In the third stage, they deploy the optimal scheduling solution to a digital twin model, simulate system responses under the impact of peak orders like Double Eleven, and iteratively optimize scheduling parameters. This integrated design of theory-algorithm-simulation-validation enables students to systematically master AI-driven logistics planning methodologies throughout the complete project cycle[18].

2.1.3 Establishing an industry-education collaborative closed loop for content updating

Continuous updating of course content cannot rely solely on individual teacher efforts; an institutionalized industry-education collaboration mechanism is needed. This study builds a four-step closed loop: enterprise needs, teaching transformation, effect feedback, and iterative optimization. First, a university-enterprise joint teaching team regularly collects changes in the capability requirements of enterprise technical positions. Second, the AI system assists in analyzing the gap between capability requirements and existing course content, automatically generating content update suggestions. Third, the updated content is tested in teaching practice, quantitatively evaluated through student learning data. Fourth, the evaluation results are fed back to the enterprise side, forming the basis for a new round of needs collection[19]. This closed-loop mechanism ensures that course content always resonates with industrial technology development, fundamentally solving the persistent problem of lagging teaching content.

2.2 Reconstructing teaching models through virtual-real integration: from static cases to dynamic battlefields

To address the dilemma of lagging teaching scenarios, a "digital twin + AI simulation" core technology is used to build an immersive teaching environment integrating virtual and real elements. Specifically, based on simulation platforms such as FlexSim and AnyLogic, high-fidelity digital twin models of logistics systems are constructed[20]. Students can complete whole-process tasks such as warehouse layout design, distribution route planning, and supply chain network optimization in a virtual environment, while observing the real-time performance of their designs under dynamic conditions. The AI system can automatically generate disturbance events, driving students to make emergency decisions and strategic adjustments in dynamic situations[21]. This zero-risk, repeatable, strongly feedback-oriented training environment allows students to truly master the ability to handle complex dynamic problems through iterations of trial-error-reflection-optimization.

2.3 Reconstructing assessment mechanisms through multimodal evaluation: from score orientation to competency certification

The core of assessment innovation is to establish a dynamic evaluation system aligned with industry standards and covering all dimensions of competency. The introduction of AI technology provides technical support for this goal[22]. First, quantitative indicators aligned with corporate technical standards are established. Referring to the competency requirements and technical acceptance standards of leading enterprises, quantifiable skill evaluation dimensions are designed. For example, in digital twin modeling tasks, scoring standards refer to the simulation error thresholds of BYD's digital twin factory; in algorithm optimization tasks, the quality of student solutions is evaluated referring to Meituan's A/B testing standards. Second, multimodal data-driven dynamic assessment is implemented. Multiple sources of information such as FlexSim operation logs, code submission records, project report texts, and classroom interaction data are integrated, and AI technology is used to extract multidimensional features of student competency. Through machine learning algorithms, a three-dimensional competency radar chart of technical application ability, innovation and breakthrough ability, and system thinking ability is generated, enabling a multidimensional perspective on students' competency structure. Third, a certification mechanism integrating process, outcomes, and development is established[23]. Drawing on the traceability feature of blockchain technology, key competency evidence of students is stored on the chain, forming an immutable competency passport. This certification system not only serves course evaluation but can also be linked to industry talent pools, realizing the value transformation of learning outcomes into professional capabilities.

3 Significance and Value of the Innovative Path

The significance of the AI-enabled project-based teaching reform path lies not only in solving the specific problems of current logistics courses but also in providing a replicable paradigm for the deep integration of "AI+education" into engineering practice-oriented courses. From the perspective of student development, this path realizes a role transformation from knowledge container to competency subject. Students in real project situations must not only master knowledge but also learn how to use AI tools to define problems, analyze data, design solutions, and validate effects[24, 25]. This "learning by doing" and "learning by creating" experience helps cultivate critical thinking, collaboration skills, and innovative spirit, laying a solid foundation for students to cope with an uncertain future professional environment. From the perspective of teaching reform, this path promotes a paradigm shift from experience-driven to evidence-driven. AI technology makes the teaching process visible from a "black box" to a "white box"; students' learning behaviors, competency weaknesses, and development trajectories can be quantitatively presented, providing data support for teachers' instructional decisions[26]. At the same time, the dynamic updating mechanism of course content, teaching cases, and evaluation standards enables the teaching system to possess self-evolution capability, maintaining resonance with industrial technology development. From the perspective of industrial service, this reform path directly responds to the national strategic requirement of deepening industry-education integration. Through mechanisms such as university-enterprise data sharing, joint laboratory construction, and competency certification linkage, it opens up the value chain from talent cultivation to technology R&D and industrial application. The students trained are not only immediately adaptable to enterprise job requirements but also possess the potential to participate in technological innovation, becoming a new force driving the upgrading of the logistics industry.

4 CONCLUSION

The arrival of the smart logistics era poses unprecedented challenges to talent cultivation in higher education. Faced with the "gap" between teaching content and industrial technology, traditional incremental curriculum reforms are inadequate. This study has deeply analyzed the three dilemmas of technological disconnect, scenario lag, and capability gap in current logistics teaching and their underlying causes, and proposed a systematic solution path using artificial intelligence as the technical engine and project-based teaching as the organizational carrier. Through collaborative innovation in dynamic content updating, virtual-real scenario integration, and multidimensional quantitative evaluation, a closed-loop solution covering the whole talent cultivation cycle has been formed. Practice has shown that this path can effectively bridge the generational gap between teaching and industry, cultivating compound logistics talents who truly possess intelligent decision-making ability, complex system design ability, and continuous learning ability. For the majority of application-oriented undergraduate institutions, this study provides not only a curriculum reform plan but also an educational philosophy oriented toward industry and technology. In the wave of "AI+education," only by proactively embracing change and systematically reconstructing teaching can we cultivate future talents who can truly lead industrial development.

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