



# Empowerment and Reconstruction: A New Paradigm for Teaching Transportation Courses Integrated with AI Literacy

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## Abstract

As Artificial Intelligence (AI) technology profoundly reshapes the transportation landscape, cultivating versatile talents with AI literacy has become the core task of the curriculum reform in “Transportation Operations and Management”. This paper addresses problems in the traditional teaching model, such as the gap between theory and practice, insufficient student innovation, and the limitation of single evaluation methods. It proposes a new project-based teaching model that deeply integrates AI literacy and constructs a corresponding dual-layer interactive teaching evaluation system for teacher-student and student-student interactions. The article systematically elaborates on the design concepts and implementation path of this model. Through a closed-loop process of “grouping—topic selection—research—evaluation”, it uses intelligent connected vehicles as a specific practical field to guide students in addressing real industry problems. At the same time, the dual-layer evaluation system, through bidirectional evaluation between teachers and students as well as intergroup interactive assessment, breaks the traditional hierarchical barriers in education and establishes a teaching ecosystem characterized by “equal dialogue and collaborative competition”. The comprehensive reform strategy proposed in this paper can effectively stimulate students’ intrinsic motivation for learning, comprehensively enhance their abilities in AI technology application, teamwork, and critical thinking, and provide a replicable and promotable new approach for teaching innovation in transportation-related courses in the new era.

## Subject Areas

Business Analysis

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## Keywords

AI Literacy, Project-Based Learning, Teaching Evaluation, Intelligent Connected Vehicles, Transportation Operations and Management, Teaching Reform

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## 1. Introduction

We are on the eve of an intelligent transportation revolution driven jointly by disruptive technologies such as Artificial Intelligence (AI), big data, and the Internet of Things [1] [2]. As the core carrier of this revolution, connected and autonomous vehicles are fundamentally reshaping the operation models, management paradigms, and ecosystem of transportation systems [3] [4]. Vehicles are no longer standalone means of transport but have become mobile, intelligent data nodes, enabling coordinated vehicle-road-cloud interaction to achieve globally optimized travel services [5] [6]. This profound transformation has imposed strategic adjustments on the talent cultivation objectives of the “Transportation Operation and Management” course in higher education institutions. Future transportation engineers and managers will have integrated roles; they will need not only mastery of traditional traffic flow theory, transportation planning, and systems engineering methods but also the ability to be innovative interdisciplinary professionals with a high level of AI literacy. In this context, AI literacy goes far beyond programming or using AI tools. It also encompasses understanding the fundamental principles of AI, the ability to identify opportunities for AI applications in complex traffic scenarios, the critical awareness to evaluate AI model decisions, and a profound insight into the ethical, social, and legal issues sparked by the technology.

However, upon reviewing the current state of “Traffic Operation and Management” courses at numerous domestic universities, it is apparent that their traditional teaching models and evaluation systems exhibit a significant “structural disconnect” from the above-mentioned industry demands and talent development objectives. This disconnect not only constrains improvements in teaching quality but may also result in a mismatch between talent cultivation and industry requirements in the future. **Table 1** systematically summarizes the core issues, their specific manifestations, and the targeted solution framework proposed by this study.

The root of the aforementioned problem lies in the failure of the educational paradigm to adapt to changes in the technological paradigm. Firstly, the lag in teaching content stems from the inherent contradiction between the textbook update cycle and the rapid pace of AI technology development [7]. While classrooms are still teaching traditional signal control optimization, the industry has already begun exploring real-time adaptive signal systems based on deep learning [8] [9]. This “time gap” results in graduates having knowledge structures that are “obsolete upon graduation”.

**Table 1.** Current issues in course instruction and reform solutions.

Dimension	Current Situation	Specific Manifestations and Consequences of the Issue	Framework of the Solution for This Study
Teaching Model	1. There is a significant disconnect between theory and practice.	The curriculum focuses primarily on classical theories and lags behind the development of cutting-edge. Technologies such as intelligent connected vehicles and vehicle-road coordination. Students “know the theory but not its application” and are powerless when confronted with complex and dynamic issues in real traffic systems, demonstrating a lack of innovative capability.	Introducing project-based learning that integrates AI literacy: enabling students to autonomously construct their knowledge systems while solving real-world problems, achieving a seamless transition from theory to practice.
	2. Insufficient Student Autonomy and Innovation Incentives	The “teacher-centered” lecture-style classroom turns. Students into passive recipients of knowledge. Their motivation for autonomous learning, critical thinking, and spirit of inquiry is stifled under a single instructional approach, rendering them ill-equipped to adapt to a rapidly changing technological landscape.	Establish a “student-led, teacher-assisted” selection and research mechanism: grant students autonomy in choosing and conducting projects, transforming passive reception into active exploration, and fully stimulating their intrinsic motivation for learning and creativity.
Evaluation System	3. Teaching evaluation methods are singular and rigid.	Relying on final closed-book exams as an evaluation method cannot effectively assess students’ comprehensive competencies in areas such as teamwork, project practice, technical insight, and ethical reasoning. This “results-oriented, process-neglecting” evaluation tends to foster a test-taking mentality, which deviates from the original intention of cultivating abilities.	Establish a Two-Tier Interactive Teaching Evaluation System: a. Bidirectional Teacher-Student Evaluation: Break the one-way nature of evaluation to promote mutual growth in teaching and learning. b. Inter-Group Interactive Evaluation: Introduce anonymous peer review, focusing on process feedback and iterative optimization to achieve comprehensive, fair, and developmental evaluation.
Skills Development	4. Systematic Deficiency in the Development of Non-Technical Skills	Course design generally neglects the systematic development of “soft skills” such as teamwork, project management, communication, and engineering ethics. Yet these are precisely the core competencies that ensure the success of complex projects in modern engineering practice.	Integrate non-technical competency objectives into project and assessment design: Through clear group division of labor, role-playing, periodic presentations, and report writing, make teamwork, communication, and other skills the core teaching objectives and key evaluation criteria.

Secondly, the unidirectional nature of teaching methods arises from a misunderstanding of the essence of learning [10]. Viewing knowledge as a “solid” that can be transmitted in a one-way manner from teacher to student neglects the fact that learning is a dynamic process in which students actively construct meaning within specific contexts. This is especially true in the field of AI, where the knowledge system itself is rapidly evolving. Developing students’ ability to “learn how to learn” is far more crucial than simply imparting predetermined conclusions [11].

Finally, the one-sidedness of the evaluation system is a continuation of the “score-oriented” approach in engineering education. It acts like a twisted “baton”, guiding teachers and students to jointly pursue the mastery of quantifiable, simple knowledge points while avoiding higher-order thinking skills—such as analysis, evaluation, and creation—that are more important but difficult to assess. This not only fails to accurately reflect learning outcomes but also, in turn, reinforces outdated teaching models.

To address the series of issues detailed in **Table 1**, this study is based on the project “Exploring New Approaches to Teaching Traffic Operation and Management Courses” and proposes a systematic and comprehensive reform plan [12] [13]. This plan is not a mere application of a single teaching method; rather, it is a complete framework that organically integrates a “project-based teaching model incorporating AI literacy” with a “dual-layer teaching evaluation system” [14] [15]. Its aim is to promote the comprehensive development of students’ knowledge, skills, and competencies through the dual innovation of teaching structure and evaluation mechanisms.

## **2. Design Method: Constructing an Integrated Teaching Framework that is “Student-Centered and Competency-Oriented”**

The core of this educational reform is to establish a self-driven and self-optimizing teaching system. This system is grounded in constructivist learning theory and situated learning theory, which posit that learning is not a passive transmission of knowledge, but a process in which learners actively construct knowledge and develop abilities through authentic and meaningful project-based contexts. Based on this, we have designed a framework supported by two main pillars: first, a project-based teaching model deeply integrated with AI literacy; and second, a precisely aligned two-tier interactive teaching evaluation system. Together, these form a mutually reinforcing structure, creating a closed-loop ecosystem of “teaching-evaluation-feedback-improvement”.

### **2.1. Design of Project-Based Teaching Model Integrating AI Literacy**

This project-based learning model aims to transform students from passive “recipients” of knowledge into “problem-solvers” and “constructors” of knowledge. Its design follows a logical sequence of “why to learn, what to learn, and how to learn”, progressing step by step to ensure the effective cultivation of AI literacy.

1) Target Layer Design: Defining AI Literacy and Clarifying Instructional Directions

In order to prevent “AI literacy” from becoming an empty slogan, we have concretized its connotation in the course “Traffic Operation and Management” into three levels of observable and assessable competency objectives:

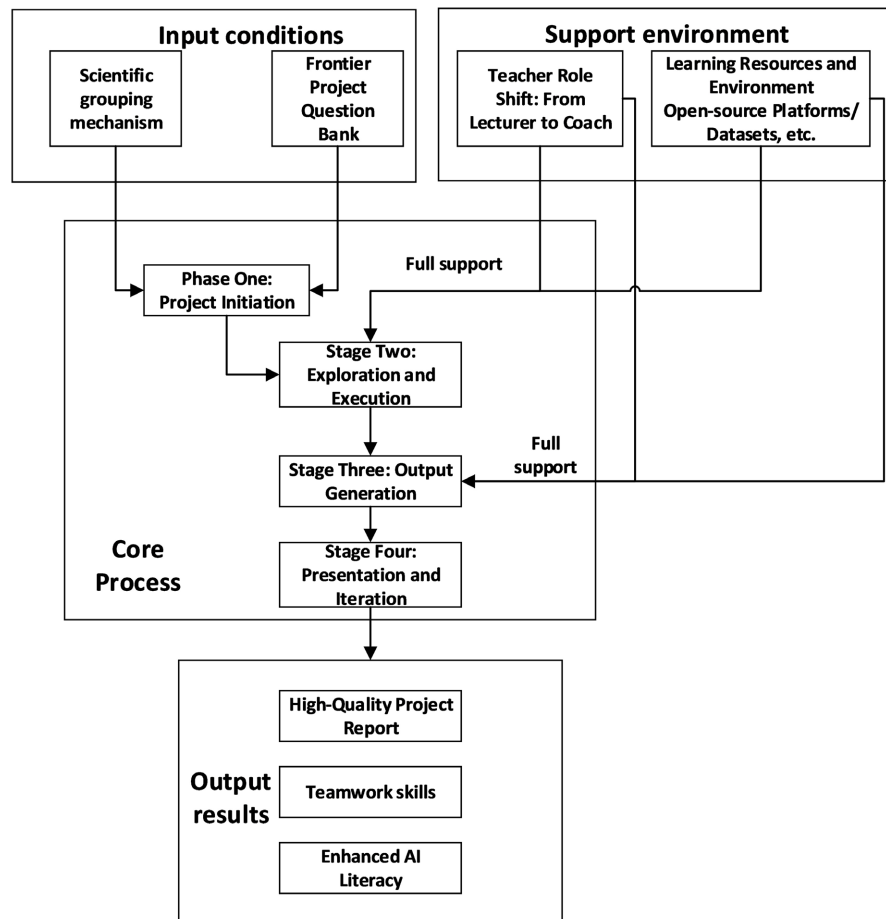
- Cognitive Level (Understanding): Able to explain the basic principles and in-

terrelationships of key technologies in AI and transportation operation and management (such as environmental perception, decision-making, planning, etc.).

- Application Layer: Capable of investigating, analyzing, and demonstrating the applicability, feasibility, and potential limitations of AI technology for a specific traffic operation or management issue.
- Critique & Innovation: The ability to engage in critical thinking regarding the ethical, social, and legal issues arising from the application of AI technology in the transportation sector, and to propose responsible and innovative solutions or optimization suggestions.

## 2) Activity Layer Design: Structuring Project Processes to Ensure Learning Depth

To achieve the aforementioned objectives, we have designed an interconnected project implementation process, the core structure and interactive relationships of which are illustrated in **Figure 1**.



**Figure 1.** Framework of the project-based learning process integrating AI literacy caption.

### Phase One: Project Initiation and Team Formation (Initiation Period)

This phase is the cornerstone of the project's success, aiming to form a well-structured team with clearly defined responsibilities and objectives, and to achieve

high-quality project planning. During the scientific grouping process, we strictly adhere to two key principles: “size control (5 - 8 members)” and “random generation”. Size control ensures that the team has sufficient manpower for complex task decomposition while avoiding the “social loafing” phenomenon caused by an overly large team or the limitations of resources and perspectives resulting from a team that is too small. The random generation is implemented through online tools, which not only reflect procedural fairness in group allocation but, more importantly, break students’ habitual social comfort zones, compelling them to learn to collaborate with peers from different backgrounds and with different thinking patterns, thereby simulating the formation and operation of cross-functional teams in a real workplace. On this basis, we introduced a “role self-nomination” segment, encouraging students to claim core roles within the group based on their own interests and strengths, such as “Project Manager” (responsible for scheduling and coordination), “Technical Expert” (responsible for algorithm research and implementation), “Data Analyst” (responsible for data processing and visualization), “Lead Writer” (responsible for report writing and refinement), and “Presenter” (responsible for results presentation). This process not only enhances each member’s sense of personal responsibility but also preliminarily establishes an internal professional division of labor within the team, laying a foundation for efficient collaboration.

During the project initiation phase, student groups are required to conduct internal brainstorming and preliminary literature research under the guidance of a structured question bank provided by the instructor, consolidating broad areas of interest into a specific and feasible research topic. The core output of this process is the preparation of the “Project Initiation Proposal”. This application is by no means a mere formality, but a serious research contract that requires clear definition. First, the core research question (*i.e.*, the specific problem being addressed, such as “A study on the accuracy and reliability of vehicle trajectory prediction models based on computer vision in intersection scenarios”). Secondly, the expected outcomes (such as a detailed research report, a simple algorithm prototype, or a set of solution designs). Third, preliminary technical approach (planned research methods, data sources, key technical tools, etc.). Fourth, division of responsibilities among members (assigning roles specifically to project tasks). Fifth, a detailed schedule (planning the milestones of each phase using Gantt charts or other formats). Subsequently, the teacher will organize a formal project proposal defense meeting. During the defense, teachers and peers play the role of the “academic committee”, questioning and evaluating each project’s innovativeness, feasibility, alignment with course objectives, and the rationality of the research plan. This review mechanism is designed to ensure that all projects have a “high starting point and correct direction”, preventing perfunctory work from the outset and cultivating students’ rigorous ability to define research questions and plan projects.

### **Phase Two: In-Depth Exploration and Plan Implementation (Execution Period)**

This stage is a crucial phase in the construction of students' knowledge and the development of their abilities, during which teachers shift from being leaders to supporters, providing the necessary assistance to students. Scaffolded learning is reflected in teachers designing and conducting a series of "mini-workshops" to address the common gaps in knowledge and skills encountered in project-based research. For example, the "AI Paper Reading and Review Writing" workshop explains how to quickly retrieve cutting-edge literature, critically read academic papers, and systematically organize and evaluate the literature. Similarly, the "Introduction to Traffic Data Acquisition and Processing" workshop introduces open-source traffic datasets such as NGSIM and High D, the basic use of data processing libraries in Python like Pandas and NumPy, as well as common methods for data cleaning and preprocessing. These workshops are not systematic courses but are provided "on-demand", aiming to remove technical barriers for students and empower them for independent inquiry.

In the process of conducting specific research, we strongly advocate for an iterative research model. We encourage student groups to abandon the perfectionist notion of achieving success in a single step and instead adopt the "rapid prototyping" mindset from agile development. This means first constructing a simplified research framework or analytical model based on preliminary understanding (for example, initially using a simple decision tree model for preliminary prediction), and then continuously discovering problems, adjusting directions, deepening understanding, and optimizing solutions through ongoing group discussions, further literature verification, preliminary data analysis, and regular consultations with instructors. This "build-evaluate-learn-reconstruct" cycle closely simulates real-world scientific and engineering practice, allowing students to deeply appreciate the nonlinearity and complexity of knowledge exploration and cultivate their resilience in dealing with uncertainty and solving ambiguous problems.

To ensure the rigor and transparency of the research process and to provide a basis for process evaluation, we require each group to maintain a dynamic process document—the "Team Collaboration Log". This log exists as a shared online document and must record, in real-time, the key points of discussion in each team meeting, major decisions and their rationale, task assignments and completion status, core challenges encountered and possible solutions, as well as action plans for the next phase. This log is not only an effective project management tool that helps students practice project management skills, but also a "mirror" that prompts the team to continuously reflect on their collaboration efficiency and research trajectory. It is also an important window for teachers to gain insight into each group's progress and provide timely, targeted guidance.

### **Phase Three: Deliverable Production and Report Generation (Output Period)**

This stage aims to systematically transform the preliminary exploration and discoveries into a final outcome that is logically coherent and well-argued, with the main vehicle being a high-quality project research report. We explicitly re-

quire that the report must follow the basic conventions of academic papers and include all the essential core elements.

First, the introduction should clearly articulate the research background, the issues being addressed, and the significance of the study. Next, the literature review should systematically summarize the current state of research in the relevant field and clearly identify the positioning and innovative aspects of the project. Furthermore, the research methods and procedures section should describe in detail and in a reproducible manner the technical approaches, data sources, processing steps, and analytical models used. In addition, the data analysis and findings section should objectively present the research results, supported by appropriate charts and visualizations. The discussion section is the soul of the report, requiring students not only to explain the results but also to delve into the underlying reasons, the limitations of the techniques, the uncertainties of the findings, and critically reflect on potential ethical and social implications of the project, such as algorithmic fairness and data privacy. Finally, the conclusion and future prospects section should summarize the key findings and propose directions for future improvement or potential applications. Through this structured academic writing training, we aim to systematically cultivate students' logical thinking, rigorous expression, advanced ability to critically examine the interplay between technology and society, as well as good habits in adhering to academic norms.

#### **Stage Four: Presentation of Results and Defense Iteration (Sublimation Phase)**

This stage marks the final phase of project-based learning and is closely integrated with the dual-layer evaluation system. Its purpose is to achieve a secondary leap in learning through public presentation and critical feedback. We emulate the format of academic conferences by organizing formal project defense sessions. Each group is required to concisely present their research process and core findings within a specified timeframe and respond to questions from teachers and peers in the audience. This process not only hones students' communication skills and ability to think on their feet but, more importantly, compels the groups to expose their internal logic to external perspectives and undergo diverse scrutiny.

After the defense session, the project does not conclude; instead, it enters the crucial stage of the "iterative learning loop". Each group will receive anonymous written feedback from both instructors and peers (the specific mechanism is detailed in the evaluation system section). Based on this constructive feedback, groups are given one week to revise, deepen, and refine their project reports. The final grade will be determined by the scores of both the initial and the final reports. This mechanism conveys a core principle: outstanding results are not achieved overnight but are perfected through continuous reflection and iteration. It greatly fosters students' academic resilience, a steadfast pursuit of excellence, and an open mindset for learning and growth from criticism—core qualities essential for innovative talent.

3) Environmental and Resource Layer Design: Building a Supportive Learning

## Ecosystem

The transformation of the teacher's role is key to the success of this model. Teachers need to shift completely from being lecturers at the podium to academic guides. Their specific responsibilities include designing challenging tasks, providing resource support, observing team dynamics, posing thought-provoking questions rather than giving direct answers, and offering support at critical moments when students encounter difficulties. This role shift places higher demands on teachers, requiring them to have stronger abilities in curriculum design, process guidance, and situational insight.

At the same time, we are committed to building a rich repository of learning resources to provide students with a powerful "arsenal" for independent exploration. This includes integrating open-source datasets, AI development platforms and tools, collecting publicly available authoritative transportation datasets from both domestic and international sources, organizing chapters from classic textbooks and cutting-edge academic papers, and compiling industry analysis reports on transportation operations and management. This repository is not static; rather, it is a dynamic knowledge system maintained and updated collaboratively by both faculty and students.

## 2.2. Design of a Two-Tier Interactive Teaching Evaluation System

Evaluation is a guiding tool. To thoroughly address the longstanding issues of overemphasizing knowledge over literacy and results over processes, we have established a dual-layer interactive evaluation system aimed at promoting "mutual learning between teaching and students, and collective progress among students". The design of this system strictly adheres to the "principle of consistency", ensuring that every evaluation activity is closely aligned with the AI literacy objectives that the curriculum aims to cultivate. (See **Figure 2**)

### 1) Level One: Reciprocal Evaluation between Teachers and Students—Building a Teaching Community

This level aims to break the traditional one-sided and power-imbalanced evaluation relationship between teachers and students, establishing a democratic, equal, and mutually respectful teaching dialogue. Regarding the student course evaluation mechanism, at the end of the course, structured feedback is collected through an online questionnaire on a group basis. The evaluation content not only focuses on traditional dimensions such as the "cutting-edge nature" of the teaching content and the "effectiveness" of teaching methods, but also places greater emphasis on assessing the teacher's "supportiveness" in project guidance and the "psychological safety" created by the course. All feedback results will be presented to teachers in a summarized form, serving as the most important basis for their teaching reflection, optimization of course design, and instructional strategies, thereby achieving the objective of "promoting teaching through assessment".

In terms of the teacher evaluation mechanism, we have developed a detailed "Project-Based Learning Assessment Rubric" as the core tool. This rubric is based

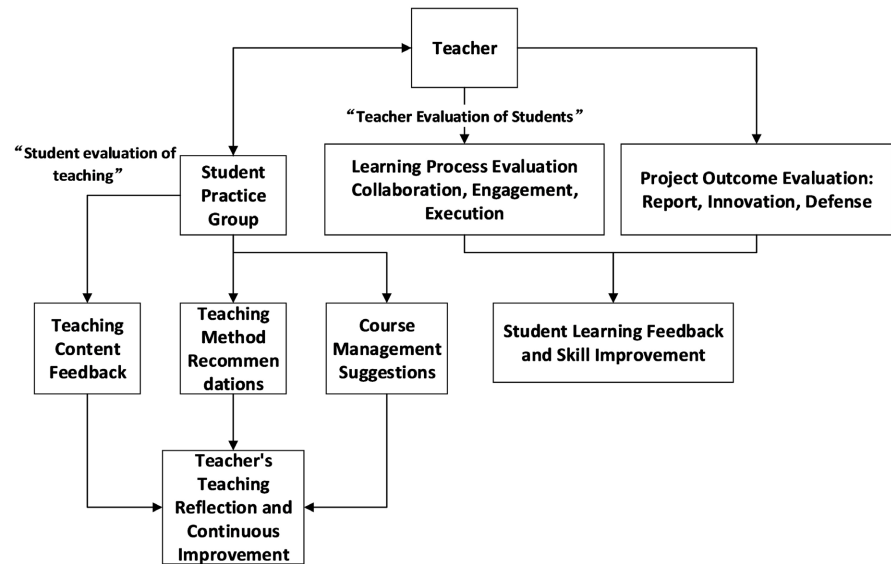
on the course objectives and provides clear behavioral descriptions across multiple dimensions, including “problem definition ability”, “information integration and literature research skills”, “critical thinking and ethical reflection”, “team collaboration and contribution”, “communication and presentation skills”, and “technical understanding and application”. It also sets specific standards for different levels such as “excellent, good, satisfactory, and unsatisfactory”, making the evaluation criteria fully transparent and allowing students to clearly understand the direction of their efforts. Teachers’ scores will comprehensively consider the quality of the “Project Proposal Application”, interim results (such as mid-term reports), records in team collaboration logs, the level of the final project report, and performance in the project defense. This approach enables continuous, multi-dimensional assessment of the entire learning process, truly balancing both process and outcome.

## **2) Second Level: Intergroup Interaction Evaluation—Cultivating the Spirit of Academic Criticism**

This perspective considers that learning occurs through social interaction, with peers serving as important learning resources and supporters within the “zone of proximal development.” Its intricate design aims to “deepen one’s understanding of quality standards and research paradigms” through “evaluating others”. We have established an anonymous peer review system. For this purpose, we designed a dedicated “Group Peer Review Rubric”, which includes core indicators such as “value and clarity of the research question”, “scientific rigor and appropriateness of research methods”, “rigor of data analysis and argumentation”, “innovation and practical significance of findings”, and “clarity and presentation skills”. During the review process, each group is required not only to assign scores but also to follow a “comments and suggestions” model, providing at least one “notable strength” and one “specific improvement suggestion”. This design compels students to engage in deep observation and reflection, transforming their reviews from simple “good/bad” judgments into constructive academic dialogue. To ensure fairness and consistency in evaluation, before the first peer review, the instructor organizes a “calibration meeting” in which all students collectively review one outstanding report from a previous cohort and one flawed report. Through group discussion, evaluation criteria are standardized, thereby enhancing the reliability of the assessment.

Ultimately, all of this serves the previously mentioned “iterative learning loop”. After receiving the first round of peer reviews and teacher feedback, the group had a valuable week to revise their report and optimize their plan. The final grade was calculated as the average of the two evaluations. This mechanism carries profound educational value: it clearly communicates to students a central concept—that excellent outcomes are achieved through iteration, and knowledge is deepened through critique and reflection. It not only cultivates students’ dedication to quality but also hones their academic resilience when facing criticism and their metacognitive ability to learn and grow from feedback. These are invaluable qualities that will be indispensable throughout their future careers, particularly in the rap-

idly evolving field of AI.



**Figure 2.** Two-tier interactive teaching evaluation system caption.

### 3. Implementation Path: From Theoretical Design to Classroom Practice

Transforming advanced educational concepts into tangible educational outcomes requires a systematic and actionable implementation pathway. Based on the closed-loop management approach of “design-execute-evaluate-optimize”, we divide the entire teaching process into four interconnected and progressively advancing stages, ensuring that the reform plan is smoothly implemented and operates effectively.

#### Stage One: Preliminary Preparation and Mobilization—Laying a Solid Foundation for Educational Reform

Any successful educational reform begins with meticulous top-level planning and comprehensive ideological mobilization. In this phase, the primary task is to align and refine the curriculum objectives, precisely mapping the core knowledge units in the syllabus to the expected AI literacy competencies of students, ensuring that all subsequent teaching activities are closely centered around these core goals. Next comes the systematic development of resources and environment, which involves not only preparing a project question bank and evaluation rubrics but also constructing a complete support system. Finally, the crucial communication of 理念 (concepts and principles) formally begins in the first class of the term. Teachers need to thoroughly and vividly explain to students the theoretical value, operational processes, and anticipated impact on personal skill development of project-based learning and dual-layer assessment. They should candidly discuss potential challenges and available support measures, aiming to earn students’ deep recognition and active participation, transforming the mindset from “I have to do it” to “I want to do it”, thereby building consensus and accumulating momentum

for the subsequent practice.

### **Phase Two: Group Initiation and Project Establishment—Igniting the Spark of Team Exploration**

This phase marks the transition from “preparation” to “action”, with the core objective of forming an efficient team and establishing a valuable starting point for research. Random grouping and team building are conducted through online tools to ensure fairness and transparency in the process. Ice-breaking activities are immediately organized to guide the group in quickly selecting leaders, assigning roles, and establishing a regular internal communication mechanism, aiming to rapidly transform a collection of individuals into a cohesive learning community with aligned goals and clearly defined responsibilities. Subsequently, project topic selection and planning become critical. Guided by a structured question bank provided by instructors, students brainstorm and conduct preliminary research based on their own interests, ultimately consolidating their work into a “Project Research Plan” that includes core research questions, expected outcomes, technical approaches, member responsibilities, and a progress schedule. Instructors review these plans through project proposal defense sessions, functioning similarly to venture capitalists evaluating startup projects. This review process ensures that each project is innovative, feasible, and closely aligned with course objectives, thereby safeguarding the quality and direction of the research from the outset.

### **Phase Three: Project Implementation and Process Guidance—Safeguarding the Journey of In-Depth Exploration**

This is the longest and most challenging core phase of project-based learning, emphasizing the balance between independent inquiry and timely intervention. Each group conducts in-depth autonomous research based on their approved project proposals, engaging in authentic research activities such as literature review, data collection, model construction, and analytical discussions, thereby deepening their understanding and application of knowledge through practice. At the same time, the teacher’s process-oriented intervention plays the role of both a “coach” and a “beacon”, with the mid-term review meeting serving as its key platform. This is not only a progress check but also an important teaching milestone. By listening to the reports collectively, teachers can sensitively identify common issues among groups and organize micro-workshops for focused guidance. Simultaneously, through individual questioning and mentorship, teachers provide personalized support to each group, helping them overcome bottlenecks and optimize their paths, ensuring that all projects “navigate” on the correct course—neither deviating from direction nor falling behind schedule.

### **Stage Four: Evaluation of Outcomes, Feedback, and Closure—Achieving the Sublimation of Learning Value**

This stage serves as a concentrated display, assessment, and refinement of learning outcomes, as well as the starting point for a new round of optimization. The final report presentation and interactive evaluation mimic the format of academic conferences, with a formal defense session held. At this point, the dual-

layer evaluation system is fully activated: anonymous peer reviews take place among groups, and bidirectional feedback occurs between teachers and students, making the evaluation itself a profound learning experience. The subsequent report iteration and grade assessment phase provides students with the opportunity to revise and enhance their reports based on valuable feedback. Final grades comprehensively consider process performance, the final version of the report, and peer evaluation results, resulting in a multidimensional and fair assessment. Finally, teaching reflection and course optimization constitute the feedback mechanism of the entire teaching loop. Teachers compile and analyze all evaluation data and student feedback, write reflective teaching reports, and accurately identify the strengths and areas for improvement in the current round of teaching, thereby providing data-driven decision-making foundations for the continuous iteration of the course, ensuring the enduring vitality of educational reform.

#### 4. Challenges and Countermeasures

This dual-layer evaluation system, through systematic rule design, tool support, and the restructuring of responsibilities and authority, transforms potential implementation challenges into opportunities for deepening educational reform. It does not merely add assessment procedures, but rather establishes a teaching management loop that can guide positive behaviors, cultivate core competencies, and ensure sustainability.

**1) Management of Teacher Workload.** To address the workload challenges brought by formative assessment, this model achieves “management relief” through the design of structured tools and clear rubrics. By automatically tracking process data via an online platform, making evaluation criteria accessible as actionable student guidelines, and transferring the main responsibility of team collaboration assessment to structured peer evaluation within groups, teachers can step away from labor-intensive daily evaluations. This allows them to focus their efforts on providing feedback, guidance, and review at critical points, facilitating a role shift from being a “hands-on judge” to a “coach who masters the rules”.

**2) Ensure the consistency of peer assessments (within-group evaluations).** To ensure fairness and effectiveness in peer evaluations within groups, this model enhances reliability through meticulous design and institutional calibration. Peer evaluation employs a behaviorally anchored multidimensional scale, guiding students to assess based on specific contributory actions rather than vague impressions. Instructors supervise the quality of evaluations by spot-checking anomalous scores, requiring factual justification, and making necessary adjustments. This design not only serves to obtain scores but also functions as an important instructional component for cultivating students’ abilities to evaluate objectively and communicate responsibly.

**3) Addressing Potential Team Conflicts.** Regarding the inherent conflict risks in team collaboration, this model emphasizes proactive prevention and process guidance through the design of an evaluation system. At the project initiation

stage, responsibilities are clarified through the review of a responsibility matrix; during the process, early warning and intervention are achieved using iterative logs and regular checks. Most importantly, the evaluation scheme assigns significant weight to both “process iteration” and “team collaboration”, clearly conveying to students that “collaboration skills are as important as problem-solving”. This actively motivates students to manage team dynamics proactively, transforming conflict resolution into an intrinsic driver for improving project performance and individual scores.

## 5. Conclusion

This study addresses the teaching challenges of the “Transportation Operations and Management” course in the era of AI and successfully designs and implements a comprehensive reform program centered on “project-based teaching integrated with AI literacy”, supported by a “dual-layer interactive evaluation system”. By placing students in real-world scenarios related to transportation operations and management, this program not only effectively imparts professional knowledge but also systematically cultivates essential AI literacy, collaborative spirit, and innovative potential. The dual-layer evaluation system, by reshaping teacher-student and student-student interactions, creates an equitable, interactive, and progressive teaching culture, providing a mechanism to ensure continual improvement in teaching quality. The program is not limited to transportation engineering majors; its core framework of “project-driven, dual-layer evaluation” offers valuable insights and has significant potential for adoption in other engineering and even social science courses that aim to integrate emerging technologies and cultivate students’ comprehensive competencies. In the future, we plan to further enrich the project library, introduce real-world enterprise projects, explore project-based teaching under university-industry collaboration, and utilize learning analytics to deeply analyze evaluation data, thereby providing more personalized and adaptive teaching support and continuously advancing the depth of curriculum reform.

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## Conflicts of Interest

The authors declare no conflicts of interest.

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