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Research on Project-Based Teaching Reform in Communication Engineering Enabled by Artificial Intelligence

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Abstract: *With the rapid advancement of next-generation information technologies—including 5G/6G, artificial intelligence (AI), cloud computing, the Internet of Things (IoT), industrial internet, and digital twins—talent cultivation in communication engineering is facing significant challenges, such as the accelerating pace of knowledge obsolescence, the increasing complexity of engineering scenarios, and a growing disconnect between industrial demands and university curricula. Traditional teaching models, primarily centered on knowledge dissemination and confirmatory experiments, struggle to effectively cultivate students' system design capabilities, engineering practice skills, collaborative innovation, and complex problem-solving abilities. Project-Based Learning (PBL), which utilizes real-world or high-fidelity engineering projects as a vehicle, integrates knowledge acquisition, skill training, and value cultivation throughout the entire project lifecycle, offering a vital pathway for developing applied and interdisciplinary talents in communication engineering. In light of the trend of AI-empowered education, this paper analyzes the practical background and core issues of implementing PBL reform in communication engineering. Furthermore, it proposes a three-tier progressive reform framework—"Project-based Curriculum, Engineering-oriented Graduation Design, and Entity-based Industrial College"—to construct a high-quality talent cultivation system aligned with industrial needs, thereby providing robust support for regional communication industry development and new infrastructure construction.*

Keywords: *AI-Empowered Education, Communication Engineering, Project-Based Teaching, Industry-Education Integration, Modern Industrial College*

1. Introduction

In recent years, the rapid evolution of technologies such as 5G mobile communications, satellite internet, edge computing, AI-native wireless networks, the Internet of Vehicles (IoV), the industrial internet, and digital twins has transformed communication systems from isolated network equipment and protocol stacks into complex systems integrating sensing, computing, control, and intelligent decision-making [1]. This industrial technological iteration imposes higher demands on communication engineering talent: students are expected not only to master fundamental theories—such as circuits, signals and systems, communication principles, digital signal processing, computer networks, and mobile communications—but also to possess competencies in network planning, system modeling, algorithm implementation, simulation testing, engineering deployment, data analysis, and teamwork.

However, traditional university instruction continues to suffer from a disconnect between theoretical teaching and engineering practice, a lack of coherence across curricula, relatively closed experimental content, and a weak alignment between graduation projects and actual industrial requirements. On one hand, while university faculty generally possess strong theoretical research capabilities, many lack long-term industrial experience, resulting in insufficient mastery of the latest industry technologies, engineering standards, project management workflows, and quality benchmarks. On the other hand, university evaluation systems tend to prioritize national-level research projects and academic publications, often undervaluing horizontal technical services, engineering practice, and outcomes of industry-education integration, which diminishes faculty motivation to engage in enterprise projects [2][3].

ISSN 2663-8169 Vol. 8, Issue 11: 15-22, DOI: 10.25236/IJNDE.2026.081103

Furthermore, local universities often lag in the construction of communication experimental platforms, engineering training centers, cloud platforms, and industrial practice bases, making it difficult to fully meet the pedagogical requirements of AI, 5G, network intelligence, and digital twins.

Project-Based Learning (PBL) emphasizes the use of real-world problems or comprehensive tasks as catalysts, guiding students to engage in active learning and collaborative practice throughout the processes of requirements analysis, scheme design, development, testing, verification, and project delivery [4][5][6]. Its essence lies not merely in increasing the number of experiments, but in restructuring teaching content, pedagogical workflows, teacher-student dynamics, and evaluation mechanisms, thereby transforming students from passive knowledge recipients into active problem solvers. The rapid advancement of artificial intelligence (AI) provides new technical conditions for PBL reform. Technologies such as generative AI, learning analytics, intelligent tutoring systems, knowledge graphs, and digital twins can support the hierarchical design of complex projects, personalized learning, and full-process assessment, driving education from "uniform pace and content" toward "data-driven, precision-supported, and continuous improvement" [7][8][9].

Based on this, this paper focuses on the communication engineering major and, by integrating the reform strategy of "project-based curricula, engineering-oriented graduation design, and entity-based industrial colleges," explores the overall framework, implementation mechanisms, and support systems for AI-empowered PBL. This study aims to provide a reference for the reform of talent cultivation models in communication engineering at applied-oriented universities.

2. Practical Background for the Project-Based Teaching Reform in Communication Engineering

The communication engineering industry is currently undergoing a stage of development characterized by network intelligence, cloud-based infrastructure, and ubiquitous application scenarios. Beyond supporting traditional mobile communication services, 5G networks are now widely applied in intelligent manufacturing, smart transportation, telemedicine, energy internet, and urban governance. At the same time, artificial intelligence is increasingly embedded in wireless resource management, network optimization, fault diagnosis, channel estimation, spectrum sensing, and user behavior prediction, thereby forming an interdisciplinary technological system of “communications + artificial intelligence.”

2.1 A Gap Exists Between Teachers’ Engineering Practice Competence and Industry Demands

Project-based teaching imposes requirements on teachers that differ significantly from those of traditional classroom instruction. In addition to delivering theoretical knowledge, teachers must be able to analyze engineering requirements, design project tasks, organize teamwork, guide system development, diagnose technical problems, and evaluate project outcomes. At present, however, many university teachers have primarily grown within academic research environments and lack sufficient enterprise experience and engineering project practice. As a result, they are not fully familiar with the R&D processes, product standards, testing specifications, and delivery requirements of the communication industry.

In addition, research-oriented faculty evaluation systems remain highly prominent. Horizontal technical services, enterprise practice, engineering outcome transformation, and teaching project development are relatively underweighted in promotion and performance assessment, which weakens teachers’ motivation to participate in real engineering projects. This issue directly affects the quality of project-based teaching: project topics may deviate from industrial reality, project implementation may lack engineering standards, and evaluation criteria may remain at the level of course assignments.

Therefore, the reform of project-based teaching must be accompanied by reforms in faculty development mechanisms. It is necessary to establish a “dual-mentor” system in which university teachers and enterprise engineers jointly participate, and to promote teachers’ transformation from “knowledge lecturers” to “technical mentors, project mentors, and learning designers” through enterprise practice, joint technical research, and collaborative curriculum development.

2.2 Insufficient Depth of University–Enterprise Cooperation Constrains the Supply of Authentic Project Resources

Real engineering projects are a crucial foundation of project-based teaching. At present, however, some university–enterprise cooperation remains limited to internship signings, short-term visits, and employment-oriented placements. Core technological needs, R&D tasks, and production processes of enterprises have not yet been fully integrated into the talent cultivation process, and there is a lack of

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stable mechanisms for joint project development between universities and enterprises.

To address this issue, modern industry colleges should be leveraged to establish enterprise technology demand lists and project databases, thereby transforming enterprise needs into project tasks suitable for teaching implementation. Such projects should not simply replicate enterprise production tasks; rather, they should undergo pedagogical adaptation, with clear definitions of project objectives, knowledge requirements, competency levels, implementation cycles, process milestones, deliverable formats, and evaluation criteria. Through a process of "enterprise demand identification—university instructional design—joint implementation by faculty and students—enterprise participation in evaluation—industrial application of outcomes," sustainable supply and effective transformation of project resources can be achieved.

2.3 Practice Conditions Are Difficult to Meet the Requirements of Frontline Technology Teaching

Practical teaching in communication engineering is characterized by high equipment investment, rapid technological iteration, and complex system structures. Traditional communication laboratories are often limited to standalone experiments, basic circuit experiments, and protocol verification experiments, making it difficult to fully reproduce engineering scenarios such as 5G core networks, network slicing, edge computing, intelligent operations and maintenance, digital twins, and large-scale network simulation.

Artificial intelligence can alleviate, to some extent, the limitations of practice conditions. Through cloud-based experimental platforms, software-defined radio, network simulators, digital twin systems, and virtual simulation experiments, students can complete tasks such as network planning, signal processing, protocol analysis, and intelligent optimization in a low-cost environment. AI can also dynamically recommend experimental resources, provide code-debugging guidance, and generate formative feedback according to students' knowledge base and project progress, thereby improving the accessibility and personalization of practical teaching.

3. Reform Strategies for Project-Based Teaching in Communication Engineering

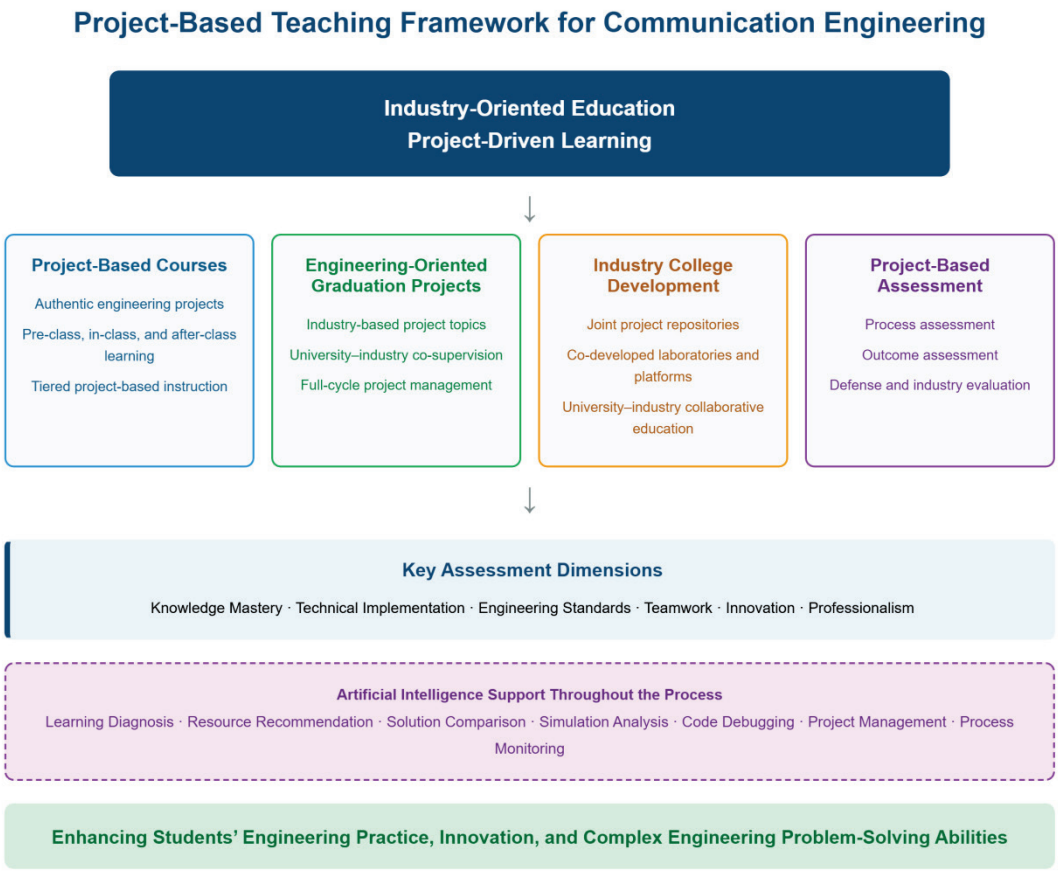

Figure 1 Three-level progressive framework

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Project-based learning typically begins with complex, open-ended, and meaningful real-world problems, through which students complete learning tasks via sustained inquiry, collaborative design, and outcome presentation. Its core features include authentic context, problem-driven learning, continuous inquiry, cooperative learning, outcome orientation, and reflective practice. Projects in communication engineering are often highly integrative. During project implementation, students no longer merely complete a set of independent experiments mechanically; instead, they actively select methods, decompose tasks, validate solutions, and optimize systems around an overall objective. Knowledge acquisition is thus embedded in the process of problem solving, forming a learning mode of "learning by doing, doing by learning, and innovating through application." Based on this, this paper constructs a three-level progressive reform framework of "curriculum Projectization—graduation design engineering orientation—industry college institutionalization," as shown in Figure 1.

3.1. Course Projectization

An AI-supported teaching model for communication engineering courses should be established. Curriculum Projectization does not simply mean breaking course content into several experiments; rather, it involves reorganizing knowledge modules according to engineering tasks. Based on course objectives, industry job competencies, and typical enterprise tasks, instructors should select comprehensive, open-ended, and implementable projects, integrating fundamental knowledge, specialized knowledge, tool training, and engineering standards into the project workflow. We propose a teaching process of "pre-class guidance—in-class support—post-class practice."

3.1.1 Pre-Class Guidance

Teachers release project background information, task descriptions, learning objectives, preview questions, micro-lecture videos, knowledge graphs, case materials, and self-assessment quizzes through an online learning platform. The AI system generates learning diagnostic reports based on students' responses and learning trajectories and recommends personalized resources.

Pre-class guidance should adhere to the principle that "AI provides support while students carry out thinking." Preview tasks should not degenerate into copying generative AI outputs; instead, they should include questions that require explanation, comparison, verification, and reflection. For example, students may be asked to explain the applicability of different propagation models or to verify AI-generated code through execution and identify potential errors.

3.1.2 In-Class Support

Classroom instruction follows a process of "problem introduction—group discussion—theoretical enhancement—solution design—phase verification." Teachers mainly undertake theoretical organization, methodological guidance, and instructional coordination, while enterprise engineers provide industry scenarios, engineering experience, standard requirements, and case-based feedback, thereby forming a "dual-instructor" model.

The classroom may include the following stages:

- The teacher introduces the project background, business requirements, and evaluation criteria;
- The enterprise engineer presents practical engineering cases and typical faults;
- Student teams analyze requirements and propose technical routes;
- AI tools assist with literature retrieval, solution comparison, and code debugging;
- The teacher conducts theoretical refinement for common problems;
- The enterprise engineer comments on feasibility, cost, reliability, and standard compliance;
- Groups complete staged outcomes and undergo peer review.

AI tools in the classroom may handle repetitive tasks such as format checking, basic code prompting, data visualization, and simulation parameter suggestions. However, key decisions concerning technical routes, engineering trade-offs, and solution justification should be made by students and reviewed by teachers and engineers.

3.1.3 Post-Class Practice

Post-class practice mainly includes on-campus experiments, virtual simulations, enterprise practice,

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open laboratories, and competition training. Students may choose software-defined radio platforms, network simulation environments, cloud experimental platforms, or enterprise practice bases for validation according to project requirements.

In communication engineering projects, post-class practice should strengthen the following engineering procedures:

- Data acquisition and data quality checking;
- System parameter configuration;
- Comparison between simulation and measured results;
- Fault localization and performance optimization;
- Technical documentation writing;
- Project presentation and defense.

AI can analyze logs, experimental data, and test results submitted by students and identify anomalies. For example, when an abnormal drop in throughput is detected in network simulation, the system may guide students to examine channel conditions, parameter settings, protocol overhead, and code logic, rather than directly giving the final conclusion, thereby fostering engineering diagnosis thinking.

At the same time, to accommodate differences in students' backgrounds, we have established a hierarchical mechanism for curriculum project design. Curriculum projects are categorized into three levels: basic, advanced, and innovative, as shown in Table 1.

Table 1: Tiered Project Mechanism

Level	Project Characteristics	Student Tasks	Forms of AI Support
Basic	Clearly defined objectives, well-structured procedures, and relatively fixed parameters	Complete module implementation and result verification	Concept explanations, code suggestions, and error diagnosis
Advanced	Open parameters, multiple solution options, and a need for comparative analysis	Complete solution design and performance optimization	Solution recommendations, simulation analysis, and data interpretation
Innovative	Complex scenarios, open-ended tasks, and a certain degree of research orientation	Develop innovative technical approaches and complete system integration	Literature assistance, model construction, and experimental-design recommendations

Hierarchical projects can avoid the problem that students with weak foundational knowledge are unable to complete the tasks while high-achieving students lack sufficient challenge, and they also facilitate personalized instruction.

3.2 Engineering-Oriented Graduation Design

Engineering-oriented graduation design integrates the graduation project into a real-world or high-fidelity engineering management system. By engaging students in requirements analysis, system design, development, testing, validation, delivery, and evaluation, this approach cultivates their ability to apply comprehensive knowledge to solve complex engineering problems.

3.2.1 Industry-Driven Topic Selection

Centered on "industry-education integration and project-driven learning," this model shifts graduation design from an academic-centric to an industry-demand-oriented paradigm. Industry-university collaborative projects serve as the primary source for topics. Enterprises define technical requirements, while AI recommends matching topics based on students' competency profiles, research interests, and knowledge mastery. Topics must span the full lifecycle—from requirements analysis to delivery and maintenance—to avoid the limitations of purely theoretical or simulation-based projects.

3.2.2 Dual-Mentor Guidance and Full-Lifecycle Management

A "university faculty + enterprise engineer" dual-mentor team is established to formulate design schemes and define system architectures. The project is managed through a full-lifecycle framework:

ISSN 2663-8169 Vol. 8, Issue 11: 15-22, DOI: 10.25236/IJNDE.2026.081103

Systematization decomposes the project into stages (analysis, design, development, testing, delivery); Modularization divides functions into independent sub-modules with clear interface standards to support team collaboration; and Standardization utilizes templates and quality evaluation protocols to ensure reproducibility and traceability. AI tools are employed for milestone monitoring, code review, test case generation, and documentation compliance checks.

3.2.3 Engineering Implementation Workflow

Students follow standard engineering workflows, progressing from conceptual design and detailed design to simulation, prototyping, and optimization. Each stage requires specific documentation and checkpoints. AI assists in communication link simulation, algorithm performance comparison, network topology optimization, and data visualization. For instance, in a "Digital Twin Network O&M" project, students build a network mirror using a five-dimensional digital twin model, utilizing AI to predict faults and generate operational strategies.

3.2.4 Credit Substitution and Multi-Dimensional Evaluation

Project outcomes can be substituted for elective course credits to incentivize student participation. Evaluation adopts a multi-faceted approach—combining enterprise acceptance, faculty assessment, AI-tracked process data, and peer review—focusing on requirements comprehension, design quality, teamwork, engineering standards, and practical performance rather than mere thesis writing.

3.3 Entity-Based Industrial Colleges

The industrial college serves as the primary vehicle for PBL reform. By co-building these colleges, universities and enterprises create project repositories, case libraries, and practice bases, ensuring a continuous supply of projects, curriculum updates, and faculty development. These colleges function as integrated platforms for joint training, R&D, and evaluation. Through this entity, industrial needs are translated into pedagogical tasks, research topics, and graduation projects, ensuring that talent cultivation remains aligned with industrial evolution.

3.3.1 Dynamic Project Repository Construction

To cultivate engineering talent for the "New Engineering" era, the university establishes a modern industrial college with close collaborative mechanisms. Both parties co-develop curricula and talent cultivation plans. The college manages a project repository, where AI provides dynamic tagging and ranking based on industrial urgency, knowledge coverage, difficulty, and commercial viability.

3.3.2 Interdisciplinary Centers and Co-built Laboratories

The college hosts interdisciplinary centers focusing on 5G/6G, AI, IoT, and digital twins. Enterprises participate by donating equipment and co-building laboratories, upgrading the university's infrastructure. AI-empowered digital twin platforms allow students to model complex scenarios, such as intelligent manufacturing lines and V2X (Vehicle-to-Everything) environments, providing a near-real engineering experience.

3.3.3 From "Resource Sharing" to "Co-Education"

Collaboration agreements explicitly define responsibilities regarding project management, faculty cross-hiring, equipment usage, data security, and intellectual property. The partnership evolves from simple internships to comprehensive cooperation: co-developing project-based courses, co-guiding graduation designs, co-providing technical services, and co-evaluating student competencies.

3.4 PBL Evaluation System

Given the complexity and open-ended nature of communication engineering projects, traditional examinations are insufficient. Evaluation must encompass knowledge mastery, technical implementation, engineering standards, teamwork, innovation, and professional ethics. The "Process + Outcome + Defense + Enterprise" evaluation model is detailed in Table 2.

Table 2: PBL Evaluation System

Evaluation Dimension	Weight	Key Content
Project Process	30%	Task completion, process logs, progress reports, problem-solving
Technical Outcome	30%	Functionality, performance metrics, stability,

ISSN 2663-8169 Vol. 8, Issue 11: 15-22, DOI: 10.25236/IJNDE.2026.081103

		innovation
Engineering Documentation	15%	Requirements, design specs, test reports, user manuals
Teamwork	10%	Division of labor, communication, individual contribution
Comprehensive Defense	10%	Technical presentation, live demo, Q&A
Enterprise/Industry Feedback	5%	Engineering standards, application value, feasibility

This evaluation system breaks away from the single-exam model, providing a comprehensive and objective reflection of students' engineering practice capabilities and professional literacy.

4. Conclusion

Communication Engineering as a discipline is characterized by a complex knowledge system, rapid technological updating, high practical requirements, and close ties with industry. The traditional teaching model, which is dominated by teacher-delivered instruction and verification-oriented experiments, can no longer satisfy the demand of the new-generation information technology industry for engineering-oriented and interdisciplinary professionals. Driven by real-world problems and engineering tasks, project-based teaching can effectively integrate curriculum knowledge, practical skills, and professional qualities, making it an important pathway for deepening the reform of application-oriented talent cultivation in Communication Engineering.

This paper proposes a three-tier reform framework comprising “curriculum projectization—engineering-oriented graduation design—substantiation of industrial colleges.” At the curriculum level, a project-based teaching process is constructed through “pre-class guided learning—in-class assisted learning—post-class practice-based learning,” with artificial intelligence used to support resource recommendation, learning diagnosis, code assistance, and process support. At the graduation design level, authentic enterprise needs are adopted as the source of topic selection; full lifecycle management is implemented across requirements analysis, system design, development and implementation, testing and optimization, and deliverable delivery; and a joint guidance mechanism involving university faculty and enterprise engineers is established. At the college level, relying on modern industrial colleges and project centers, enterprise technical demand lists and project repositories are established to promote joint formulation of talent cultivation plans, joint course development, joint project guidance, and joint evaluation of talent by universities and enterprises.

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References

[1] Wei M M, Xia Y Q, Song X W, et al. Research-oriented teaching reform for cultivating new engineering innovative talents in communication engineering [J]. Higher Education Journal, 2025, 11(35): 113-117.
[2] Sun X M, Huang Z X, Fu Y F. A new mode of practice teaching “integration of competition and teaching” to improve the engineering ability of young teachers under the new engineering background [J]. Guide of Science & Education, 2024, (17): 81-83.
[3] Lu Y, Li J, Chen W D, et al. Research on approaches to improving engineering ability of engineering teachers in ethnic minority regions [J]. China Educational Technology & Equipment, 2022, (13): 15-24.
[4] Zhao S W, Zhang P, Fan Z Y. Reform and research of project course under background of engineering education professional accreditation [J]. Laboratory Science, 2018, 21(6): 125-129.
[5] Yang P, Liu W. Teaching innovation and practice driven by project-based application practice of communication engineering [J]. Education and Teaching Forum, 2026, (10): 10-14.
[6] Feng W. The application of project scenario-based teaching method in communication engineering curriculum—A case study of the application of the North Great Wilderness Agricultural Reclamation Communication Project [J]. Modern Agricultural Research, 2024, 30(7): 75-79.

ISSN 2663-8169 Vol. 8, Issue 11: 15-22, DOI: 10.25236/IJNDE.2026.081103

[7] Sun R, Fan Z G. Design and practice of communication engineering teaching cases integrating artificial intelligence [J]. Higher Education Journal, 2024, 10(25): 103-106.
[8] Wang W, Li M, Hu H J, et al. Curriculum reform and talent cultivation practice for electronic information majors in the era of artificial intelligence [J]. Industry and Information Technology Education, 2026, (7): 1-7.
[9] Xi Z H, Li Y Y, Wang X J, et al. Reform and exploration of talent cultivation in 5G+Electronic Information Industry [J]. Journal of Electrical and Electronic Education, 2026, 48(2): 56-59.