Research on Dual-Drive Reform of the “Wireless Network Technology” Course under the New Engineering Paradigm

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Abstract: In response to the urgent demand for high-quality applied talents in the construction of new engineering disciplines, as well as the problems such as outdated teaching content, weak practical teaching, and lack of value guidance in the traditional "Wireless Network Technology" course, this study carried out a comprehensive teaching reform driven by real industrial demands and centered on the integration of course practice. The reform established a "three-level connection" content update mechanism, a "three-stage progressive" practical ability cultivation path, and a "three-dimensional penetration" course integration model. It innovatively adopted the "CDIO-PBL" hybrid teaching mode, forming a teaching loop of "demand analysis - scheme design - engineering implementation - value internalization"; it systematically designed a "technology - ethics - family and country" three-line integrated course implementation path. After one round of teaching practice, students' engineering practical ability, industry certification pass rate, and academic competition results have significantly improved, and a set of practical and promotable engineering curriculum reform plan has been formed.

Keywords: New Engineering; Wireless Network Technology; Curriculum Reform; Industry Demand; Engineering Competency Development

1. Introduction

With the rapid advancement and deep industrial integration of next-generation information technologies such as fifth-generation mobile communications (5G), the Internet of Things (IoT), and the Industrial Internet, wireless network technology has become a cornerstone of national digital economy strategy [1]. The industrial deployment of 5G/6G, IoT, and IIoT technologies has imposed unprecedented demands on the pace of knowledge renewal, engineering practice capabilities, and professional ethics within the wireless networking field [2]. However, traditional Wireless Network Technology course delivery commonly faces three challenges: Firstly, textbook content lags behind technological iteration, failing to reflect cutting-edge developments such as 5G-A, Wi-Fi 7, and network-embedded security; Secondly, teaching methods predominantly rely on theoretical lectures, with fragmented and verification-focused laboratory components, resulting in students' tendency to engage in theoretical discussions without practical application and insufficient capability to resolve complex engineering problems; Thirdly, course instruction remains disconnected from value formation, failing to organically integrate elements such as national strategy, engineering ethics, and innovative spirit into professional teaching. These issues constrain the achievement of new engineering talent cultivation objectives.

Consequently, this study takes the Wireless Network Technology course as its reform vehicle, proposing and implementing a dual-core "demand-ideological" driving philosophy. This approach transcends the mere juxtaposition of industry case studies and ideological slogans, instead striving to establish a complete closed-loop system spanning course objective setting, content restructuring, methodological innovation, and evaluation feedback. Its aim is to cultivate high-calibre engineers who are not only proficient in modern wireless network technologies but also possess a sense of national responsibility and professional accountability.

2. Reform Philosophy and Overall Design: Constructing a "Dual-Core Closed-Loop" Educational System

This paper proposes the core reform concept of "dual-wheel drive by industrial demand and course-based ethical and professional values education". Centred on this concept, it implements a "four-dimensional reconstruction" of course objectives, content, methodology, and assessment to create a bidirectionally empowering educational closed-loop system, as illustrated in Figure 1.

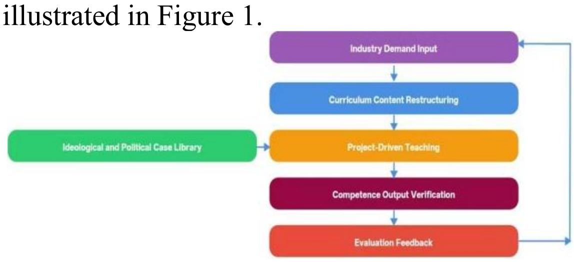

Figure 1. Overall Reform Framework Diagram

Industrial Demand: Functions as input. Through regular corporate research (with partners like Huawei and ZTE), analysis of industry standards (e.g., HCIA-WLAN certification syllabus), and graduate feedback, it continuously and dynamically translates real-world job competency requirements, typical technical challenges, and cutting-edge application scenarios into specific course learning objectives, project-based learning (PBL) tasks [3], and assessment criteria.

Ethical and Professional Values: Its function lies in shaping character· By systematically reviewing the history of wireless network technology, pivotal events (such as the 5G standards race), legal frameworks, and ethical dilemmas in engineering practice, corresponding elements—craftsmanship ethos, innovative confidence, rule-of-law consciousness, and patriotic sentiment—are distilled[4]. Driven by this dual-engine approach, the course achieves a fundamental shift from teacher-centred knowledge transmission to a student-centred model emphasising both competency and ethical cultivation.

Dual-Core Closed-Loop Operation: The two cores do not operate independently but intertwine and mutually reinforce each other through the "course implementation" phase. For instance, when undertaking an industrial project like "High-Density Wi-Fi Deployment in Campus Areas," students simultaneously confront dual tasks: optimising technical selections (demand-driven core) and evaluating cost-benefit and social impact assessments (value-driven core).This reform ensures the dual-core energy is effectively channelled into every teaching phase through a four-dimensional restructuring of learning objectives, content, methodology, and assessment. Ultimately, it cultivates high-calibre talent meeting the requirements of the new engineering discipline.

3. Core Implementation Framework: The "Three - Tier, Three - Stage, Three - Dimensional" System

Based on the dual-core concept, the reform establishes a three-dimensional implementation framework centred on "three-tier content alignment, three-stage progressive competency development, and three-dimensional ethical and professional values".

3.1 Dynamic Course Content Update Mechanism via "Three-Tier Alignment"

The first layer: Align with industry technical standards and establish a teaching benchmark

Based on authoritative certification systems such as Huawei's HCIA/ICP and the technical evolution routes of international standard organizations like 3GPP[5], conduct reverse course design. By deconstructing the certification capability matrix and standard protocol clusters, extract the core knowledge units and skill requirements that support current industrial practices, ensuring that the basic theoretical teaching is synchronized with the mainstream technical track, and laying a professional knowledge foundation that meets industry certification requirements for students.

The second layer: Extract typical application scenarios and construct comprehensive teaching modules

Closely focusing on emerging industrialization scenarios such as "Smart Park", "Industrial Internet of Things", and "Vehicular Networking", deeply analyze the common technical challenges in their wireless network deployments, such as seamless roaming switching, high-density terminal access, and low-latency guarantee for services. Transform these real technical problems into a series of modularized teaching topics, guiding students to learn beyond isolated knowledge points, and train their systematic analysis and solution design capabilities in simulated scenarios.

The third layer: Introduce real enterprise cases and promote problem-oriented teaching

Transform real project segments from cooperating enterprises (such as network renovation requirements documents, fault troubleshooting reports, etc.) or typical technical problems into classroom discussion cases and course design topics. Through "real problem real practice" or "real problem virtual practice" methods, shift the teaching content from "knowledge logic-driven" to "problem logic-driven", cultivating students' understanding, judgment, and innovation capabilities in facing complex engineering realities.

This mechanism not only ensures the advancement and practicality of the teaching content, but also systematically promotes the structural transformation of course teaching from theoretical imparting to the generation of practical abilities.

3.2 Three-Stage Progression Pathway for Engineering Practice Competency Development

To overcome the drawback of the traditional curriculum where "theoretical teaching" and "verification experiments" are disconnected from each other, this teaching reform system has designed a three-stage progressive and progressively deepening practical teaching chain of "cognition - simulation - practical operation", aiming to gradually enhance students' comprehensive ability to solve complex engineering problems.

Stage 1: Virtual simulation and principle cognition: Utilizing simulation platforms such as Huawei eNSP [6], conduct visual simulation teaching on network protocol interaction and topology networking. Through dynamic simulation and interactive operations, convert abstract theories into intuitive scenarios, significantly reducing the learning threshold and helping students establish system-level principle cognition and framework understanding.

Stage 2: Hardware experiments and system integration: Using low-cost hardware devices such as AP/AC from Huawei, complete integrated experiments such as wireless network configuration, security policy deployment, and fault troubleshooting. This stage focuses on cultivating students' practical equipment operation skills, system debugging techniques, and preliminary engineering implementation literacy.

Stage 3: Project-based learning and comprehensive innovation: In a group of 4-6 students, introduce comprehensive PBL projects derived from real industrial demands (such as "Wireless Network Planning and Optimization Scheme for Small Science and Technology Park"). Students need to fully experience the entire process from requirement analysis, scheme design, equipment selection, deployment simulation, testing and acceptance, and project defense. In tasks that closely resemble actual engineering scenarios, they can hone teamwork, innovative design, and engineering management skills, achieving a leap from learning and practice to comprehensive innovation.

3.3 The "Three-Dimensional Infusion" Model for Integrating Ethical and Professional Values". Education into Curriculum

First, the time dimension: Throughout the entire teaching process, a closed loop of ethical and professional values education is formed.

Thought-based education is deeply integrated into all aspects of the course teaching, including before, during and after class: Before class, value preheating: Through the course platform, push "Huawei's breakthrough in 5G[7] patents" and "the construction history of the Beidou system" and other technological information, guiding students to pay attention to the strategic significance of the country's self-reliance and strength in science and technology, and stimulating their sense of learning responsibility. During class, natural connection: Integrate value guidance appropriately during the explanation of professional knowledge, for example, when analyzing the WPA3 [8] security protocol, combine the "Prism Gate" incident to explain the practical necessity of the "Cybersecurity Law", strengthening the bottom-line thinking and legal awareness of technical personnel. After class reflection deepening: Set special reflection questions on "technical ethics and social impact" in experimental reports, project summaries, etc. requiring students to examine the technical solutions from dimensions such as sustainable development, information security, and social equity, promoting the internalization of values.

Second, spatial dimension: Covering both online and offline scenarios, expanding the field of ethical and professional education Construct a virtual-real integrated ethical and professional teaching environment, ensuring that value guidance is omnipresent:

Offline classroom interaction infiltration: Organize classroom activities such as "autonomous debate on technical standards" and "argumentation meetings on technical routes", allowing students to understand the strategic value of the national policy of independently controlling key core technologies through the exchange of viewpoints [9].

Online platform extension of discussion: Set up discussion areas such as "Science and Technology Frontiers and National Strategy" and "Engineer's Social Responsibility" on platforms like Superstar Learning Platform, encouraging students to pay attention to macro issues such as industrial policies and technical ethics, and creating a continuous atmosphere of value thinking.

Third, subject dimension: Promoting dual-line participation of teachers and students, activating the driving force of ethical and professional education

Change the one-way teaching mode of teachers, and build a value growth community where teachers and students jointly create and understand: Teacher level: Deeply explore by conducting collective lesson planning and teaching research activities to systematically sort out the ethical and professional integration points in the course content, forming a "professional knowledge - value element" mapping table to enhance the systematicness and consciousness of integration.

Student level: Actively construct in PBL project practices, guiding students to become the main body of value experience and meaning construction. For example, when designing a wireless coverage solution for remote areas, students need to consider cost, efficiency, and accessibility, naturally experiencing the social equity carried by "information equality" and the responsibility of engineers.

Through the "three-dimensional penetration" integration mechanism, course ethical and professional education can break free from the predicament of formalism and superficiality, truly achieving the organic unity of professional knowledge transmission, ability cultivation, and value guidance, and cultivating new era engineering talents with superb skills and patriotism.

3.4 Construction, Implementation Outcomes, and Reflections on the Diversified Assessment System

Course evaluation serves as the "commander" and "benchmark" for promoting teaching reforms and optimizing educational outcomes. To comprehensively, objectively and scientifically assess the internalization of students' knowledge, the development of their abilities and the enhancement of their qualities under the dual-core-driven reform of "demand - ethical and professional education", this project has systematically reformed the traditional evaluation model that overly relied on final written tests in the past. A diversified comprehensive evaluation system oriented towards abilities, emphasizing both process and result, and integrating both internal and external evaluations has been constructed and implemented.

This system breaks through the limitations of single quantitative scoring, emphasizing the educational, developmental and integrated nature of the evaluation. In terms of evaluation content, it not only focuses on students' mastery of theoretical knowledge, but also attaches great importance to their comprehensive ability to analyze and solve problems in real situations, as well as their core competencies demonstrated in social practice, teamwork, value judgment, etc. In terms of evaluation methods, it pays attention to the organic combination of process evaluation and terminal evaluation, and comprehensively uses various forms such as classroom performance, project assignments, stage tests, practice reports, group discussions, result presentations, reflection, etc., to dynamically track students' learning trajectories and growth processes. In terms of evaluation subjects, it promotes the combination of teacher evaluation, student self-evaluation, and peer mutual evaluation, and builds a multi-party participation evaluation community to enhance the comprehensiveness and credibility of the evaluation.

This reform aims to truly achieve the goals of promoting learning, teaching and improvement through the evaluation system. It strives to facilitate a profound transformation in course teaching from "knowledge imparting" to "development of skills and qualities", thereby providing a solid guarantee for cultivating high-quality talents that meet the demands of the times.

4. Construction and Implementation of a Diversified Assessment System

To verify the “dual-core-driven” reform outcomes, Chapter 4 systematically designs and implements a tripartite diversified assessment system - formative, summative, and value-added - capability-oriented, balancing process and product, and integrating internal and external evaluation to comprehensively trace students' knowledge internalization, ability growth, and value formation, providing scientific evidence for continuous course improvement.

4.1 Construction and Implementation of the Diversified Evaluation System

This evaluation framework comprises three modules: "Formative Assessment," "Summative Assessment," and "Value-Added Assessment," collectively focusing on the development of students' engineering practice capabilities and comprehensive competencies.

(1) Formative Assessment: Tracking Developmental Trajectories. This module comprehensively documents and evaluates student performance and progress throughout the learning journey, specifically including: PBL Project Performance: Based on project briefs and assessment rubrics, evaluations combine group and individual assessments across four dimensions: "Rationality and Innovation of Technical Solutions," "Project Implementation Outcomes and Documentation Quality," "Team Collaboration and Communication Skills," and "Depth of Project Reflection (including ethical and professional reflection)."

(2) Summative Assessment: Evaluating integrated application. The end-of-term assessment abandons rote memorisation of isolated knowledge points, employing exclusively comprehensive, application-oriented, and open-ended questions. Examples include: "Given the application scenario and performance metrics of a smart factory, select and justify the appropriate wireless network architecture and technologies"; "Analyse an abnormal capture file of WLAN network traffic [10], diagnose potential security threats, and propose solutions." Examination questions are closely aligned with real-world industry challenges and core competency requirements of the programme.

(3) Value-Added Assessment: Incentivising Excellence

To encourage students to pursue excellence and personalised development, an "ability enhancement" pathway is established. During this course, students who achieve provincial-level or higher awards in designated subject competitions (e.g., Huawei ICT Competition) or obtain industry certifications (e.g., HCIA-WLAN) may receive corresponding bonus points in their overall course assessment. This initiative aims to achieve "competition-driven learning and certification-driven teaching," explicitly linking course study with career development pathways.

4.2 Implementation Analysis of the Assessment System

After one academic year of operation, this assessment system has effectively fulfilled its guiding, motivational, and diagnostic functions. Key outcomes include: More Comprehensive and Balanced Student Competency Development: The emphasis on formative assessment has prompted students to place greater importance on every project phase and experimental process, shifting away from previous "cramming before exams" study habits. PBL project rubrics guided students to focus not only on technical implementation but also on teamwork, documentation, and value reflection, fostering more integrated skill development. Performance analysis revealed a more reasonable differentiation in student grade distributions, better reflecting actual learning effort and ability disparities.

Workload and fairness concerns in formative assessment: Detailed process evaluation generates substantial marking workloads, while assessing individual contributions in group projects occasionally sparks internal disputes over fairness among students. Future exploration should include introducing rubric-based peer assessment and developing semi-automated online learning behaviour analysis tools to enhance evaluation efficiency and objectivity. Boundaries and standardisation of value-added assessment: To prevent utilitarian participation or "certificate farming" driven by bonus point policies, the scope and level of awardable bonuses and certifications require further clarification and restriction. Guidance on student motivation must be strengthened, emphasising the intrinsic value of skill enhancement.

5. Conclusion and Outlook

The established and implemented diversified evaluation system serves not only as a tool for assessing student learning outcomes but has itself become a pivotal lever for advancing the implementation of the "dual-core driven" teaching reform. It successfully translates industry competency requirements literacy indicators into observable, measurable teaching components, achieving consistency between teaching objectives, processes, and evaluations. In addressing implementation challenges, ongoing optimisation will focus on making evaluations more scientific, efficient, and developmental, thereby better serving the sustained enhancement of new engineering talent cultivation quality.

This study addressed the pedagogical challenges of the Wireless Network Technology course by implementing a systemic reform driven by the dual cores of "industry demands" and education". Practice demonstrates that through "3+1+1" content restructuring, "CDIO-PBL" model innovation, and diversified assessment guidance, student learning engagement has been effectively stimulated. This has significantly enhanced students' engineering practice capabilities, innovative awareness, and professional ethics, achieving an organic unity in the cultivation of knowledge, skills, and values.

Future refinement directions include: firstly, deepening university-industry collaboration to co-develop dual-qualified instructor classrooms, inviting corporate engineers for intensive project guidance and assessment; secondly, developing a series of virtual simulation experiments to address hardware limitations and complex network scenario construction challenges; thirdly, continuously tracking graduate development to establish a long-term feedback-based course improvement mechanism, whilst exploring the extension of this reform model to other core course clusters within the Network Engineering programme.

Funding Project

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