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Hierarchical-Synergistic PDCA Closed-Loop: Construction and Optimization of University Teaching Supervision System—A Case Study of Zhengzhou University

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ABSTRACT

This research aims to address the long-standing problems existing in traditional university teaching supervision, such as hierarchical division, delayed feedback, and insufficient rectification efforts. These issues have hindered the high-quality development of university education and failed to meet the requirements of domestic education accreditation. To tackle these challenges, an improvement-oriented supervision model is established. This research adopted a case study of the School of Electrical and Information Engineering, Zhengzhou University, during 2023–2025, integrating hierarchical collaboration and closed-loop management to construct a multi-dimensional supervision system featuring vertical coordination among university, school, and department levels and horizontal synergy across teaching management, teacher development, experimental teaching, and other related departments. Operated through the PDCA (Plan-Do-Check-Act) cycle and specialized feedback protocols (including immediate, regular, and specialized feedback), the system effectively breaks down "information silos" in traditional supervision, accelerates problem response, and strengthens rectification constraints. Tangible results were achieved: 1) the rectification completion rate of teaching problems rose from 85% to 96%, with core teaching issues fundamentally resolved; 2) national/provincial student competition awards increased from 22 to 35, reflecting enhanced practical and innovative abilities. Additionally, the model optimized curriculum systems, improved teachers' teaching capabilities, and boosted student satisfaction. By aligning with engineering education norms and focusing

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on continuous improvement, this model enhances institutional standardization and provides a replicable, feasible paradigm for teaching supervision reform in similar engineering institutions.

Keywords: Hierarchical Collaboration; Teaching Supervision System; Closed-Loop Construction; Practical Optimization

1. Introduction

Aiming to focus on high-quality development in higher education, teaching quality has become a core competitive advantage for universities[1–3]. Key elements of ensuring teaching quality include improving outcome evaluations, strengthening process management, exploring value-added exercises, and establishing comprehensive evaluation systems[4–7]. Additionally, Engineering Education Accreditation has raised the bar for teaching quality assurance systems, emphasizing a student-centered, output-oriented approach with continuous improvement[8–11]. However, traditional "more inspection, less improvement" teaching supervision models exhibit significant shortcomings, making them inadequate for current teaching needs.

In the current teaching supervision work of colleges under universities, there have long been three major pain points[12–16]: "hierarchical fragmentation, delayed feedback, and weak rectification". From the perspective of hierarchical division, the three-level supervision at the university, college, and department levels often operates independently: The university-level supervision focuses on the inspection of macro teaching norms, mainly through random classroom observations and spot checks of teaching plans, lacking a deep understanding of the professional characteristics of each college (such as experimental teaching and project-based training in engineering). Although college-level supervisors are familiar with the curriculum system of their own colleges, due to the limitations of limited staffing and authority, they find it a challenge to coordinate the university-level resources to solve common problems across colleges. Department-level supervisors directly connect with teachers and students, but often, due to the lack of smooth communication channels, problems in grassroots teaching cannot be promptly fed back upwards. As a result, the three-level supervision system becomes an "information island", making it difficult to form a joint force for quality control. The problem of delayed feedback directly affects the efficiency of teaching improvement: In the traditional supervision process, supervision experts need to first sort out the class observation records, summarize the problems, and then pass them on to teachers layer by layer through the college's academic affairs department. The entire process often takes 1 to 2 months. For engineering courses that are dynamically updated (such as those related to artificial intelligence and intelligent manufacturing), teachers may have completed the teaching of the chapter by the time they receive feedback, thus missing the opportunity to promptly adjust teaching methods and supplement cutting-edge cases. Some young teachers, unable to obtain targeted advice in a timely manner, still follow the traditional teaching mode, which is difficult to meet the needs of engineering students for the cultivation of practical abilities. The lack of effective rectification is a key factor restricting the improvement of teaching quality; on the one hand, traditional supervision only focuses on "problem identification" without formulating a corresponding rectification plan. When teachers face feedback such as "insufficient teaching interaction" and "insufficiently detailed experimental guidance", they lack specific improvement paths. On the other hand, the rectification effect lacks follow-up evaluation. Although some teachers have ostensibly adjusted their teaching methods, they have not fundamentally changed their concepts, resulting in the recurrence of the same problems in subsequent supervision, such as inadequate explanations of safety norms in engineering experimental courses and insufficient practical operation guidance for students. These issues are difficult to fundamentally resolve in the long term[17–21].

From the practice of the School of Electrical and Information Engineering of Zhengzhou University, it can be seen that the new teaching supervision system has effectively solved the above-mentioned problems through a three-level linkage mechanism[22–24]. The college has established "supervisor-teacher" liaison officers at the departmental level to ensure that any teaching issues at the grassroots level are fed back to the college-level supervisors within 24 h. The college-level supervisors, in collaboration with university-level experts and enterprise mentors (such as engineers in the fields of power systems and electronic information), formulate

a closed-loop plan of "problem–rectification–verification" based on the characteristics of engineering courses. The university-level supervisors regularly spot-check the effectiveness of rectification, and link the assessment results with the evaluation of teachers' professional titles and the funds for course construction, thereby strengthening the binding force of the process. This targeted design makes supervision no longer a formality but a true core driving force for the iteration of engineering teaching quality. This experience is highly replicable for similar institutions.

2. Hierarchical Structure of Supervision System

2.1. Vertical Level Management

The entire teaching supervision system includes three vertical levels (**Figure 1**): university, school, and department, which are functionally differentiated in decision-making, execution, and operational levels. Each level has clear responsibilities and collaborative roles.

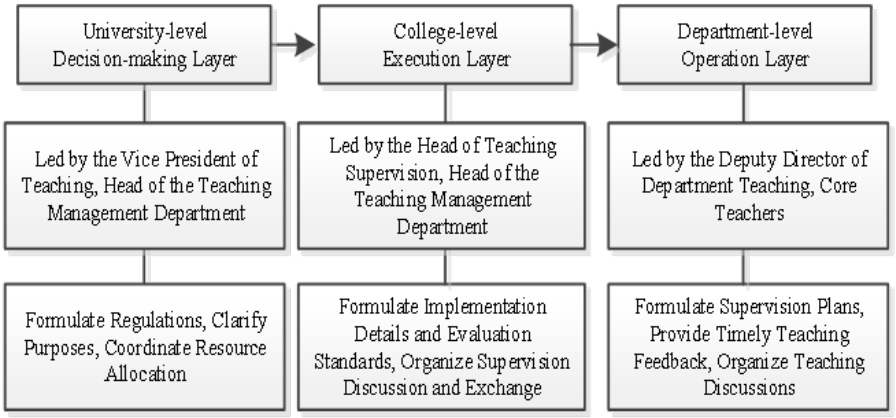


Figure 1. Diagram of Vertical Level Management.

As the core decision-making level, Zhengzhou University, the teaching Supervision Committee, led by the vice-president for teaching of the university, includes leaders of the teaching management department and academic experts. From the perspective of the university's strategy and the overall situation of talent cultivation, this committee, guided by deep learning theories, makes "Teaching Supervision Regulations," clarifying principles and goals. During the advancement of the "Double First-Class" discipline initiative, in response to the talent cultivation objectives of the School of Electrical and Information Engineering, the committee instructed the teaching supervision team to place particular emphasis on courses in cutting-edge fields such as smart grids, and resources should be strategically allocated to support teaching reform and innovation. For instance, in the construction of the smart grid course cluster, the committee provided guidance to the school to integrate real-world data case studies and implement project-based learning approaches, thereby promoting deep learning among students. During the implementation of the "Double First-Class" discipline development initiative and in alignment with the talent development goals of the School of Electrical and Information Engineering, the committee directed the teaching supervision team to prioritize courses in emerging fields such as smart grids and to allocate resources strategically to support teaching reform and innovation. For example, in developing the smart grid course cluster, the committee guided the school to incorporate real-world data cases and adopt project-based learning methods, thereby fostering deeper student learning.

At the operational level, the School Teaching Supervision Committee, led by the committee chair, is composed of senior professors, industry experts, and management personnel. Guided by the latest theories in higher education teaching, and based on the university-level regulations and the school's disciplinary characteristics, the school formulates detailed documents, such as Classroom Teaching Quality Evaluation Standards. For example, the College of Electrical and Information Engineering incorporates new teaching methods into the core curriculum evaluation indicators, and conducts overall supervision of the quality of the curriculum.

The implementation layer links the preceding and the following, refines the macro policy into operational standards, strengthens the evaluation of practical teaching, supervises the whole process of the course, guides and supervises the supervision work at the department level, organizes the discussion and exchange of experience, and ensures the standardization and efficiency of the teaching supervision of the college. At the same time, it provides oversight and guidance to departmental-level supervision work, and organizes seminars to share experiences—ensuring that the school's teaching supervision operates in a standardized and efficient manner.

At the operational level, department supervisory work is carried out by associate deans of teaching affairs, professional heads, and key faculty. They ensure that teaching quality assurance documents are implemented at the grassroots level, conduct targeted supervision, and communicate with teachers for timely improvements. Department-level supervisors also provide feedback to the higher levels, supporting decision-making and enhancing overall teaching effectiveness.

2.2. Horizontal Collaborative Mechanism

To break down departmental barriers and achieve collaborative efficiency in teaching supervision work, the college has established a horizontal collaboration mechanism and built a multi-departmental linkage system centered on Supervise-Connect. It has carried out in-depth cooperation with multiple departments to form a comprehensive and multi-level teaching supervision collaboration network, as shown in **Figure 2**.

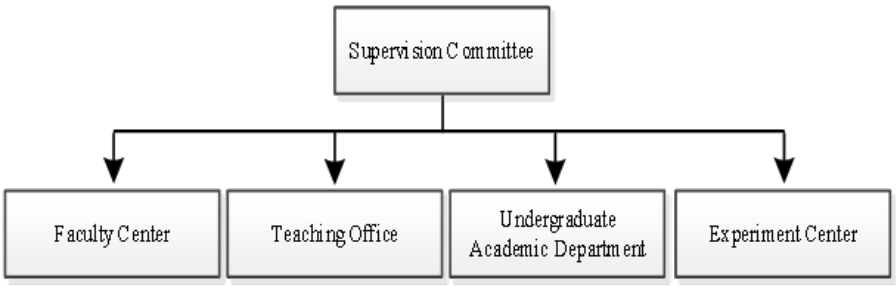


Figure 2. Diagram of Horizontal Collaborative Mechanism.

Establish a two-way "supervision–training" channel in collaboration with the Teacher Development Center. Shortcomings in teachers' teaching capabilities identified during teaching supervision can be promptly fed back to the Teacher Development Center, which then designs targeted training courses and activities accordingly. Meanwhile, the new concepts and methods that teachers acquire through training can be practically tested and evaluated for effectiveness through supervision work, forming a virtuous cycle where supervision and training mutually promote and jointly improve, effectively facilitating teachers' professional growth. This collaboration is not only reflected in the two-way flow of information, but also through regular joint activities such as "teaching ability improvement workshop" and "supervision and feedback case discussion". "The closed loop of 'finding problems-solving problems-verifying effects'" is implemented to support the continuous development of the teaching staff.

In cooperation with the teaching office of the college, the teaching office provides daily teaching information, and the courses and projects that need to be supervised, and the supervision committee conducts corresponding lectures and supervision work. The supervision committee will provide feedback on the problems found in the supervision process to the teaching office and relevant individuals, and the teaching office will cooperate with the relevant individuals to rectify the problems. Based on the feedback data of supervision, the teaching office will also make dynamic adjustments in the aspects of course scheduling, teacher allocation and teaching resource inclination. For example, for courses with low continuous supervision and evaluation, teachers with rich teaching experience will be given priority to help and teach, so as to provide a guarantee for the improvement of teaching quality from the management level.

Establish a 'classroom discipline-learning style construction' linkage mechanism with the student affairs depart-

ment. The teaching supervision pays attention to the quality of classroom teaching, and the learning department pays attention to the daily management of students and the construction of learning styles. The two sides combine the quality of classroom teaching with the management of students through regular communication and joint inspection. For example, for classes with classrooms with discipline issues, the Student Affairs Office intervenes in time to understand the students' ideological trends, carry out targeted education and guidance work, and jointly create a good teaching atmosphere. In addition, the two sides will also jointly carry out the 'style of study supervision month' activity, record the classroom attendance and interaction through the supervision committee, and the student work department will simultaneously track the students' after-school learning status, forming a 'classroom-extracurricular' integrated style of study construction pattern.

Collaborate with the Experimental Center to conduct supervision on experimental and practical teaching. Practical teaching for engineering majors features strong professionalism and complexity. The college fully leverages the resource advantages of the Experimental Center, integrating the teaching of experimental content with hands-on operation into the entire teaching supervision process. Supervision committee members comprehensively assess the effectiveness of practical teaching and put forward improvement suggestions by observing students' operational processes and hands-on abilities during experiments, thereby enhancing the quality of practical teaching. Based on evaluation feedback, the Experimental Center upgraded its equipment, updated the experimental project library, and jointly organized "demonstration observation classes for experimental teaching" with the supervision committee. These initiatives integrate cutting-edge industry technologies into practical teaching, promoting the continuous improvement of practical education quality.

3. Construct Closed-Loop Supervision Process

3.1. PDCA Cycle Implementation Path

PDCA (Plan-Do-Check-Act) cycle[5–7] is applied to the teaching supervision process of the School of Electrical and Information Engineering of Zhengzhou University, in order to form a complete closed-loop supervision process, as shown in **Figure 3**.

The path of PDCA is as follows:

1) **Planning Phase**: At the beginning of each semester, a "Supervision Task List" is created based on the university's teaching priorities, engineering education accreditation requirements, and the college's actual teaching situation. The list clearly defines the specific goals, tasks, time nodes and responsible persons of the supervision work, providing a clear action guide for the supervision work throughout the semester.
2) **Execution Phase**: Supervisors engage in "three checks and three listens" progress, including reviewing teaching plans, exam papers, and laboratory reports, as well as observing theory, lab, and practice courses. The supervisors delve into the sites of teaching, comprehensively understanding the teaching preparation of instructors, the implementation of the teaching process, and the learning outcomes of students by lots of methods, such as reviewing teaching materials and attending classes, thereby obtaining genuine and comprehensive teaching course information.
3) **Checking Phase**: A "Teaching Problem Classification Ledger" is established to document and categorize teaching problems for follow-up rectification. Classify problems into categories such as instructional design problems, teaching methodology issues, and teaching management concerns based on their nature, severity, and other dimensions, thereby providing an accurate basis for subsequent improvement efforts.
4) **Improvement Phase**: A "three-level feedback" rectification mechanism is implemented, where teachers, departments, and the college collaborate to address and solve teaching problems. At the faculty level, teachers engage in self-reflection and improvement regarding specific teaching issues; At the departmental level, teaching seminars are organized to analyze common challenges and propose solutions; At the college level, coordinated oversight is implemented to conduct targeted supervision and rectification for major teaching concerns. This tiered feedback mechanism ensures timely and effective resolution of teaching issues and establishes a closed-loop system for continuous teaching quality improvement.

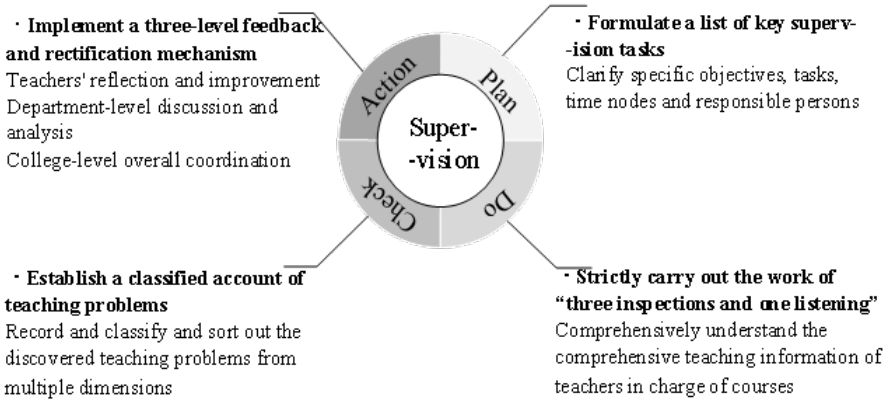


Figure 3. Diagram of the PDCA Closed-Loop Supervision Path.

3.2. Specialized Feedback Mechanism

In order to improve the timeliness and effectiveness of teaching supervision feedback, the college has established a characteristic feedback mechanism.

1) **Immediate Feedback**: After the class observation, the supervisor fills in the "classroom teaching schedule" on the spot, communicates directly with the teacher, and provides timely feedbacks the advantages and disadvantages found in the course of the lecture to the teacher. This instant feedback method enables teachers to understand their own teaching situation for the first time, adjust teaching strategies in time, and optimize the teaching process.
2) **Regular Feedback**: The monthly 'supervision briefing' is issued to comprehensively summarize the teaching supervision work of the month. The contents of the briefing include the display of teaching highlights, the analysis of existing problems and suggestions for improvement. It is released through the internal network platform of the college, teaching work conferences and other channels to promote the exchange and learning between teaching units, and also provide reference for the decision-making of teaching management in the college.
3) **Specialized Feedback**: The improvement stage: the implementation of the 'three-level feedback' rectification mechanism, that is, the teacher-level self-reflection and improvement of specific teaching problems; organize teaching seminars at the department and professional level, analyze common problems, and propose solutions; the college level is coordinated and coordinated, and special supervision and rectification are carried out on major teaching problems. Through this structured feedback mechanism, we can ensure that the teaching problems are solved in time and effectively, and form a closed-loop mechanism for continuous improvement of teaching quality.

3.3. Methods

This study adopted a case study design conducted at the School of Electrical and Information Engineering, Zhengzhou University, during 2023–2025. Participants included 86–105 course instructors (covering core engineering courses such as Power System Analysis and Circuit), three levels of supervisors (university, school, department), and undergraduate students from different grades and majors. Courses were sampled to cover theoretical, experimental, and practice-oriented types, with instructors including both junior and senior faculty, ensuring representation of engineering discipline characteristics. Research tools included the Classroom Teaching Observation Form (with rubrics for teaching content, methods, and interaction), Teaching Problem Classification Ledger, Supervision Situation Report, student feedback questionnaires, and teacher self-reflection records. Data sources encompassed supervision observation records, student questionnaires, teacher feedback forms, teaching competition results, and student academic competition awards over the three years (2023–2025). Quantitative data (e.g., rectification completion rates, award counts) were analyzed using descriptive statistics, while qualitative data (e.g., teacher-student feedback) were thematically coded to

identify key improvement areas. All student and teacher feedback data were anonymized to protect privacy. The study obtained approval from the school's academic ethics committee, and participants provided informed consent for data use.

4. Practical Optimization of Supervision Strategies

4.1. Quality Improvement "Dual Engines"

With standard construction and capacity building as the 'twin engines' of quality improvement, the college promotes the steady improvement of teaching quality and lays a solid foundation for talent training. In the dimension of quantity expansion and quality improvement, we will continue to make efforts to realize the in-depth reform of teaching supervision.

4.1.1. Standard Construction: Supervision-Driven Engineering Accreditation Evaluation System Reconstruction

Guided by engineering certification, the college uses a reverse design method to accurately decompose graduation requirements into curriculum objectives. For example, in the course "Power System Analysis," the fault handling ability is further refined into specific practical objectives such as short-circuit analysis. In terms of the supervision system, the focus is on the comprehensive coverage of school-enterprise cooperation courses. Taking the practice course of "Professional Innovation and Entrepreneurship Foundation" as an example, a special evaluation will be carried out on whether the enterprise tutors can effectively cultivate students' engineering innovation ability.

The college actively breaks through the traditional teaching mode, vigorously promotes project-based learning, and builds a multi-assessment system. In this process, the supervision committee is deeply involved in the teaching evaluation work throughout the whole process, and carefully constructs the process assessment indicators covering classroom performance, student feedback and other key dimensions. Through the weighted calculation of these indicators, a closed loop of the degree of achievement of curriculum objectives is formed, thereby ensuring that the quality of talent cultivation fully aligns with.

4.1.2. Capacity Building: Three-Dimensional Collaborative Development of New Teachers

Build a 'tutorial system' support system, select senior supervision experts to pair with young teachers, and implement the three-dimensional guidance of 'listening to and evaluating lessons, special guidance, project co-research'. The college establishes a "full-time teacher + enterprise mentor + graduate student teaching assistant" multi-dimensional supervision team: Full-time supervisors focus on teaching methods; Enterprise mentors (from large companies or research institutes) assess the industry relevance of course content, and graduate student assistants monitor student learning progress and outcomes. The college establishes "personalized diagnosis and improvement plans", where on-site course evaluations highlight areas for improvement in teaching content accuracy, method effectiveness, and other aspects, and provide full-process guidance for teaching reform projects application. Practical results show that this mechanism helps young teachers win teaching competition awards, forming a teaching ability development closed-loop with "supervision-led + practice reflection + ability enhancement."

4.2. Closed-Loop Management Innovation

To achieve full-process, refined management of teaching quality, the college boldly innovates in closed-loop management, constructing an all-encompassing management system that includes feed-forward control, process management, and post-effect tracking, while also refining quality enhancement strategies and optimizing the feedback mechanism, as shown in **Figure 4**.

4.2.1. Feed-forward Control: Strengthening the First Line of Course Offering

To guarantee the quality of talent cultivation, the college implements a "course introduction, trial teaching, supervision" pre-screening process for newly offered courses. In the process of lesson presentation, teachers need to clarify the orientation of the course in the professional system, the relationship with the graduation requirements and the organization logic of the teaching content; the trial teaching links simulate the real classroom and show the teaching process; finally, the supervision experts review from the teaching objectives, content, methods and other dimensions, and put

forward suggestions for improvement.

Taking the course of "Artificial Intelligence and Electrical Application" as an example, the instructor proposed the design idea of integrating an artificial intelligence algorithm into an electrical engineering application in the lecture. However, during the trial lecture, the peer evaluators pointed out that the teaching content emphasized theory and the practical cases were insufficient. Teachers adopt suggestions, supplement practical cases such as smart grid fault diagnosis, and optimize teaching methods. After the formal opening of the course, the students were praised by more reasonable design, which effectively avoided the defects of the course design and effectively improved the teaching quality of the new course.

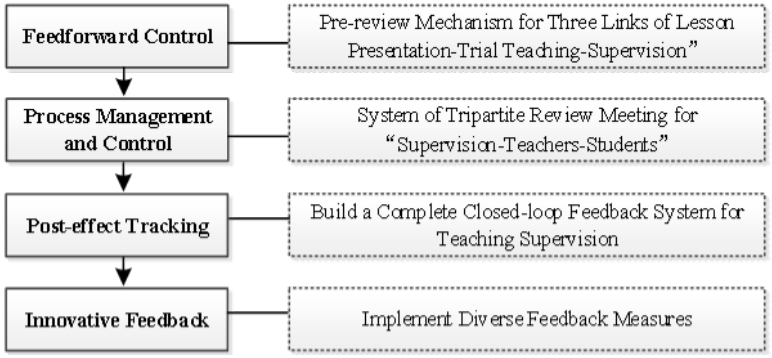


Figure 4. Diagram of the All-Round Management System for Closed-Loop Management Innovation.

4.2.2. Process Management: Multi-Party Collaboration for Dynamic Teaching Optimization

The teaching process is complex and dynamic, requiring multi-dimensional monitoring and feedback. The college constructs a "supervision-teacher-student" three-party evaluation meeting, organizing regular teaching discussions among the three parties and expanding the information collection channels. In addition to traditional methods, teachers are encouraged to write teaching logs to record pedagogical practices, conduct peer evaluations to share teaching experiences, gather career development feedback through alumni networks, and use big data analysis to understand learning behaviors for precise supervision.

In the three-party evaluation meeting, the supervisor puts forward suggestions on teaching norms, methods and effects from a professional perspective. Teachers share teaching experience and difficulties, and students provide feedback on the learning experience and needs. For example, in the 'Automatic Control Principle' course review meeting, students reflected that some of the theoretical derivations were difficult to understand. The supervisor recommended the case teaching method to combine the theory with the actual control system. Teachers adjust teaching accordingly, redesign cases, and significantly improve students' knowledge mastery. The tripartite committee facilitates the effective flow of instructional information, enables the timely resolution of teaching issues, and drives the continuous refinement of instruction. This process ultimately fosters a virtuous cycle that enhances both teaching and learning.

4.2.3. Post-Effect Tracking: Strengthening Rectification Constraints to Ensure Quality Improvement

Effective rectification of teaching problems is the core of improving teaching quality. The college links the rectification with teacher performance and professional title evaluation, and strictly tracks and evaluates the rectification of problems found in teaching supervision. Through the establishment of rectification ledgers, detailed records of problems, measures, responsible persons and deadlines, and regular inspection feedback. Teachers who have not been rectified or are overdue should be dealt with in the evaluation and employment of professional titles; teachers who actively rectify and improve their teaching quality should be given preference in the evaluation of professional titles.

At the same time, the college has established a complete closed-loop feedback system of teaching supervision. After the supervisor feedbacks the problem, a corrective action plan for the teacher is established to clarify the content, deadline and goal of the rectification, and the rectification effect

is reviewed by listening to the class again after one month. For teachers with good rectification results, they should be inclined in terms of teaching evaluation and professional title promotion; for teachers with inadequate improvement, in-depth analysis of the reasons, arrange the guidance of teaching tutors or organize training. Analyzing the closed-loop feedback data and summarizing the experience, it provides a basis for adjusting teaching policies and promotes the continuous improvement of teaching quality.

4.2.4. Innovative Feedback Forms

In order to improve the effectiveness of teaching feedback, the college breaks through the traditional mode and implements diversified feedback measures. In view of the complex problems, such as the teaching reform of the smart grid curriculum group, we organize teaching seminars, invite experts and teachers inside and outside the school, and explore the root causes and formulate plans in the form of case sharing and group discussion. For those with excellent teaching performance, experience sharing sessions and open classes are held. For example, excellent teachers of digital signal processing courses are invited to demonstrate the experience of the flipped classroom and play a leading role.

Relying on the recording and playback features of the online teaching platform, it provides teachers with classroom playback videos to help them reflect on teaching rhythm, interaction and other issues from a third-party perspective, and supports online annotation comments to facilitate communication and discussion. The supervisors strengthen accurate feedback, the pre-class research outline and standard clarify the teaching objectives, and after-class give accurate suggestions based on cases. At the same time, an instant communication mechanism is established to realize the real-time submission and tracking of problems with the help of the teaching supervision information platform, so as to ensure the efficient solution of teaching issues.

5. Results of Supervision

Through a series of measures such as teaching supervision, including Class Observation Record Table and Supervision Feedback Record Table as shown in **Figure 5**, the college has achieved remarkable results in teaching quality, students' learning effectiveness, teaching reform and innovation.

In terms of teaching quality, the core curriculum outline is optimized and cutting-edge technologies are integrated. For example, the proportion of actual cases in the course of "Power Electronics Technology" has increased to 35%; in terms of teaching method innovation, the application proportion of project-based teaching methods has increased to 85%, and students' participation and satisfaction have been greatly improved. The average score of teachers' teaching evaluation assisted by supervisors is more than 90 points, and teachers have achieved remarkable results in the teaching competition.

The students' learning effect is remarkable; the average score of each professional course is improved, and the failure rate has obviously decreased. In the past three years, it has won more than 30 national awards and more than 50 provincial awards in academic competitions. The survey of students' satisfaction shows that the satisfaction with teachers' teaching and curriculum setting has increased to 88% and 82%, respectively.

Teaching supervision has effectively promoted the teaching reform and promoted the application of new teaching methods. Many courses have carried out blended teaching, such as the "circuit" course, and its learning effect has been significantly improved. The ideological and political construction of the curriculum has achieved remarkable results. In the past two years, more than 10 courses have been awarded school-level and above ideological and political demonstration courses. Professional construction is optimized, new professional directions are added, the employment rate of graduates exceeds 80%, the evaluation of employers is improved, and the high-quality development of teaching is effectively promoted.

The annual effectiveness of teaching supervision can be seen in the increasing coverage of courses, the number of teaching observations conducted, the identification of problems, and the improvement in the rectification completion rate. As shown in **Table 1**, in 2023, 86 courses were covered, with 215 observations and 132 problems identified. The rectification completion rate for those problems was 85%. In 2024, the number of covered courses increased to 92, with 248 observations and 118 problems identified, and the rectification completion rate improved to 92%. In 2025, the number of covered courses further increased to 105, with 286 observations and 95 problems identified, achieving a 96% rectification completion rate. These statistics illustrate the

increasing effectiveness of the teaching supervision system over the years. The data of **Table 1** comes from the school's Teaching Supervision Committee, Teaching Management Section, and Teaching Management Section.

In addition, although the number of identified teaching problems has decreased by 30% compared to previous years, the rectification completion rate has risen to 95%, further confirming the effectiveness of the quality improvement mechanism. The number of specialized training sessions for supervisors has also increased by 100%, strongly supporting the construction and development of the "supervision-feedback-improvement" closed-loop management system.

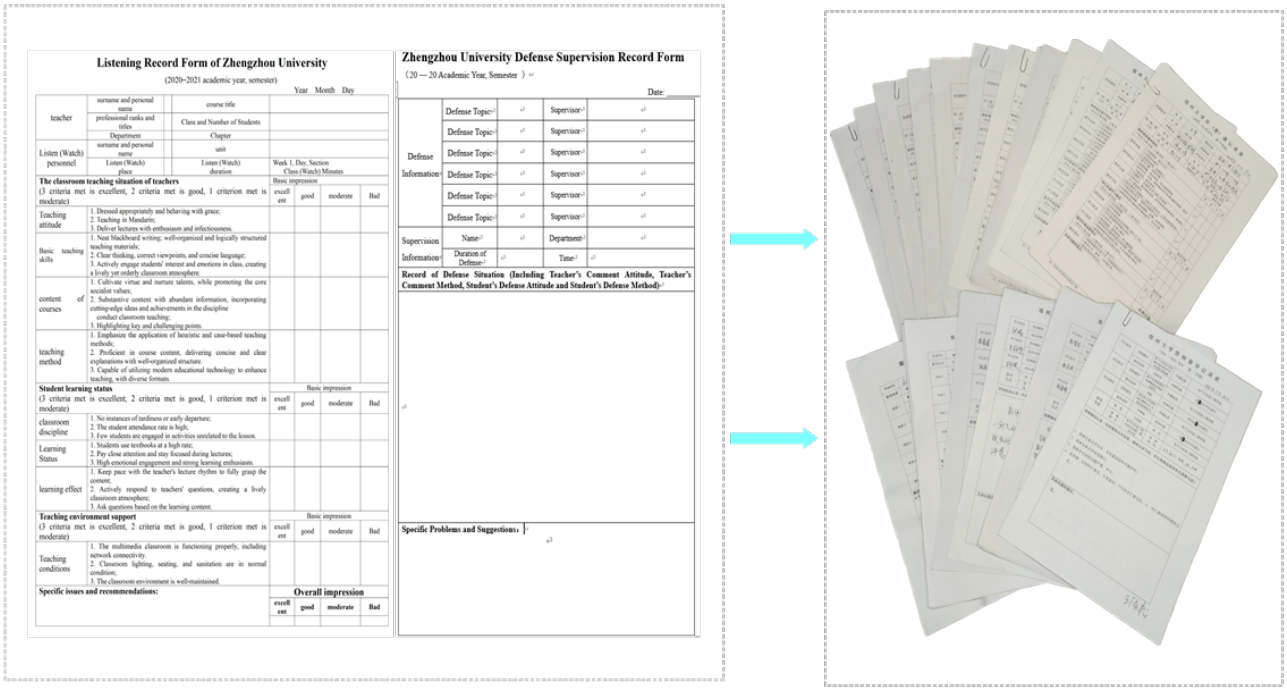


Figure 5. Class Observation Record Table and Supervision Feedback Record Table.

Table 1. Annual Review of Teaching Supervision Effectiveness.

Year	2023	2024	2025
Covered Course	86	92	105
Observations Number	215	248	286
Problems	132	118	95
Rectification Completion Rate	85%	92%	96%
Teaching Competition Award	8	11	14
Student Competition Awards	22	28	35

6. Conclusions

This study constructs a closed-loop teaching supervision system from a hierarchical-synergistic perspective at Zhengzhou University's School of Electrical and Information Engineering. Through vertical university-college-department coordination and horizontal multi-department collaboration, combined with the PDCA cycle and specialized feedback mechanisms, the system has successfully optimized course development, teacher development, and student learning outcomes, providing a replicable model for teaching supervision reform in engineering institutions.

Taking the School of Electrical Engineering and Information Engineering of Zhengzhou University as the case study, this paper constructs a closed-loop teaching supervision system from the perspective of hierarchical collaboration, based on the requirements of emerging engineering education development and engineering education accreditation. By breaking down the barriers of traditional supervision as the core, the system establishes a vertical three-level

linkage mechanism among the university, school, and department: the university level coordinates quality standards, the school level focuses on professional characteristics, and the department level addresses frontline needs, realizing a seamless quality control chain. Horizontally, it strengthens collaboration with multiple departments such as the Teaching Office, Teacher Development Center, and Experimental Center, closely integrating teaching supervision with teaching management, teacher training, and practical teaching.

Meanwhile, the system innovatively incorporates the PDCA cycle concept, forming a closed-loop process of "Plan-Do-Check-Act" and supporting it with a distinctive mechanism of "real-time feedback + follow-up evaluation". Eventually, it constructs a dual-engine model of "standard leadership (in line with accreditation norms) + capacity improvement (focusing on the core teaching and learning capabilities)". Practical verification shows that the system has effectively promoted the iteration of curriculum construction, the improvement of teachers' teaching capabilities, and the enhancement of students' learning outcomes in the school. It not only solves the problem of traditional supervision being "inspection-oriented rather than improvement-oriented" but also provides a scientific, feasible, and directly promotable practical paradigm for the reform of teaching supervision in similar engineering colleges and universities.

Author Contributions

Conceptualization, Y.L. (Yuefeng Liao) and Y.L. (Yong Luo); methodology, Y.L. (Yuefeng Liao) and Y.L. (Yong Luo); validation, Y.L. (Yuefeng Liao) and X.H.; investigation, Y.L. (Yuefeng Liao) and X.H.; resources, Y.L. (Yuefeng Liao) and X.H.; data curation, Y.L. (Yong Luo); writing—original draft preparation, Y.L. (Yuefeng Liao); writing—review and editing, X.H.; supervision, Y.L. (Yong Luo); project administration, Y.L. (Yuefeng Liao); funding acquisition, Y.L. (Yong Luo). All authors have read and agreed to the final version of the manuscript.

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Institutional Review Board Statement

The study obtained approval from the academic ethics committee of Zhengzhou University.

Informed Consent Statement

Participants provided informed consent for data use.

Data Availability Statement

To protect the privacy of participants, all data will not be disclosed. Requests can be made to the corresponding author if necessary.

Conflicts of Interest

All the authors disclosed no relevant relationships. All the authors declared no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript; or in the decision to publish the results.

AI Use Statement

To improve the readability of this paper, an AI tool, ChatGPT, was used to polish the language of this paper to a certain extent.

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