Exploration of Practical Teaching Reform for Electrical Engineering and Automation Major under the Background of IEET Engineering Certification

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Abstract: This study explores reform and innovation pathways for practical teaching in the Electrical Engineering and Automation major within the framework of international engineering education accreditation, with a focus on IEET standards. Rapid advances in the Industrial Internet, Artificial Intelligence, and new-type power systems have exposed the limitations of traditional practical teaching models in meeting accreditation requirements for complex problem solving, innovation, and professional competence. Based on a systematic analysis of accreditation criteria and existing practices, this study adopts comparative analysis, curriculum restructuring, and industry–education integration to develop a reformed practical teaching model. A modular three-tier practical curriculum ("foundation–integration–innovation") is constructed, alongside strengthened industry–university collaboration through real engineering projects and a dual-mentor mechanism. Project-based learning supported by virtual simulation and case teaching is further promoted, and a diversified, competency-oriented evaluation system balancing process and outcomes is established. The results show that the proposed framework effectively addresses deficiencies in content, methodology, and assessment, significantly enhancing students' practical ability, interdisciplinary integration, and innovative capacity. Overall, this study provides a feasible pathway for aligning engineering education with international accreditation standards and improving talent cultivation quality.

Keywords: IEET; Electrical Engineering; Practical Teaching Reform; Competency-Oriented

1. Introduction

Amid profound transformation and rapid integration in global engineering education, accreditation has become a key mechanism for enhancing higher education quality and enabling international mutual recognition. As a leading accreditation body in the Asia–Pacific region, the Institute of Engineering Education Accreditation (IEET) has developed a framework aligned with the Washington Accord, grounded in the principles of Outcome-Based Education (OBE) and Continuous Quality Improvement (CQI) [1-3]. Its system architecture is shown in Figure 1. This framework emphasizes measurable and attainable learning outcomes, student-centered educational processes, and data-driven self-improvement mechanisms. For Electrical Engineering and Automation—a discipline central to national energy strategies and smart manufacturing—enhancing engineering practice and innovation capabilities is essential to respond effectively to rapid technological and industrial transformations. However, traditional practical teaching models, predominantly centered on verification experiments and on-campus training, are increasingly inadequate in addressing advances in the industrial internet, artificial intelligence, and new-type power systems [4]. Under IEET standards, systematic reform of practical teaching has therefore become a strategic imperative for cultivating engineers capable of solving complex, real-world engineering problems in a global context [5].

At present, practical teaching in Electrical Engineering and Automation faces several structural challenges in aligning with IEET requirements and evolving industrial demands. First, teaching content lags behind technological frontiers, as laboratory facilities and experimental projects are updated slowly and remain focused on conventional topics such as electric machines and relay protection, resulting in a mismatch between students' acquired competencies and emerging fields including renewable energy integration, power electronics-dominated systems, and digital twins [6-10]. Second, pedagogical approaches are largely teacher-led and procedure-oriented, which limits systematic training in problem formulation, iterative design, teamwork, and innovation; advanced methods such as project-based and design-based learning have not yet been widely implemented [11]. Third, industry-education collaboration remains relatively superficial, often confined to site visits or short-term internships, with limited enterprise participation in curriculum design, project development, and outcome evaluation [12-14]. Finally, existing evaluation systems place excessive emphasis on operational accuracy and report standardization, while lacking effective tools to assess higher-order competencies such as innovative thinking, systems integration, communication skills, and engineering ethics.

To overcome these challenges, practical teaching reform must evolve toward a student-outcome-centered, industry-informed, and continuously improved educational ecosystem. Key reform pathways include: (1) restructuring the practical curriculum into a progressive three-tier framework encompassing foundational, integrated, and innovative stages, with the incorporation of virtual simulation, hardware-in-the-loop technologies, and open-ended projects derived from industrial practice or research frontiers; (2)deepening university–enterprise cooperation through jointly constructed platforms, dual-mentor mechanisms, and the integration of real-world engineering projects into capstone design; and (3) advancing project-based and collaborative learning approaches, supported by a multidimensional evaluation system that tracks competency development through portfolios, peer assessment, and industry feedback.

Overall, this reform represents a comprehensive transformation in educational philosophy, resource allocation, and institutional culture. Its ultimate objective is to cultivate a new generation of electrical engineers with solid theoretical foundations, outstanding practical and innovative capabilities, strong teamwork skills, and a global perspective, thereby enabling meaningful contributions to energy transition and smart manufacturing and promoting a substantial enhancement in the quality of engineering education in China.

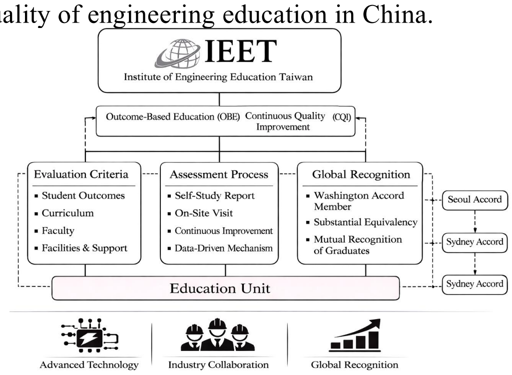

Figure 1. Framework of IEET International Engineering Education Accreditation

2. Current Status of Practical Teaching in Electrical Engineering and Its Automation

At present, practical teaching in Electrical Engineering and Automation has established a relatively systematic curriculum framework, covering multiple practice-oriented components from foundational to specialized levels, including circuit experiments, electrical machines and power electronics laboratories, automatic control experiments, and power system modeling and simulation. This framework provides students with a progressive pathway for engaging with core professional technologies. However, despite its structural completeness, significant deficiencies remain in teaching organization and implementation, resulting in a noticeable gap between students' engineering practice competencies and the evolving demands of industry and technological development.

First, the proportion of practical training within the overall curriculum remains insufficient, and the allocation of teaching resources is suboptimal. In most programs, theoretical instruction still dominates, while practical components play a supplementary role, limiting students' opportunities for hands-on practice and comprehensive engineering training. In particular, comprehensive and design-oriented experiments are often constrained by shortened schedules and simplified content, preventing students from experiencing the full engineering process from conceptual analysis and scheme design to debugging and performance evaluation. Moreover, practical teaching content is updated slowly and inadequately reflects recent advances in renewable energy, smart grids, power electronics, industrial internet, and artificial intelligence, leading to a disconnect between teaching cases and real engineering applications.

Second, practical teaching methods remain relatively homogeneous, and teaching resources are insufficient to support diversified and innovative learning. Instruction is still largely based on teacher-led, verification-type experiments, with limited implementation of open-ended, exploratory, and interdisciplinary projects. Advanced pedagogical approaches such as project-based learning, case-based teaching, and virtual–physical integrated simulation are not widely adopted, weakening students' active participation and innovation potential. In addition, outdated equipment, limited laboratory space, and shortages of advanced instruments—especially in emerging areas such as renewable energy integration and intelligent control—restrict students' exposure to cutting-edge technologies and team-based comprehensive training.

Finally, shortcomings in faculty structure and evaluation mechanisms further constrain teaching effectiveness. Many instructors possess strong theoretical backgrounds but lack sustained engineering practice experience, while the proportion of dual-qualified faculty with industry involvement remains low. Existing evaluation systems focus primarily on experimental reports and operational accuracy, lacking systematic and quantitative assessment of higher-level competencies such as design capability, innovation, teamwork, and engineering ethics.

In summary, despite the establishment of a basic practical teaching framework, Electrical Engineering and Automation programs require systematic reforms in content updating, pedagogical innovation, resource enhancement, faculty development, and evaluation system restructuring to achieve a shift from knowledge transmission to competency-oriented education.

3. Reform and Innovation Strategies in Practical Teaching

To address the reshaping demands of the capability structure for engineering talents brought by the new round of technological revolution and industrial transformation, practical teaching must transition from a traditional supplementary role focused primarily on knowledge verification to a systematic educational main channel centered on capacity cultivation. Currently, there is an urgent need to construct a modular and progressive interdisciplinary practical curriculum system and deepen the industry-education integration mechanism through collaborative university-enterprise partnerships. This includes jointly developing experimental projects incorporating cutting-edge technologies such as smart grids and industrial internet, co-establishing virtual-real integrated practical platforms, and systematically implementing project-based teaching driven by real-world engineering problems. Coupled with a comprehensive internship system spanning "cognitive-professional-graduation" stages and a process-oriented evaluation mechanism, these efforts will comprehensively promote innovation in teaching content, methods, and assessment models. By engaging in practices closely aligned with industrial realities, students will systematically develop complex problem-solving abilities, interdisciplinary integration competencies, and sustained innovative capacities. Ultimately, this will foster a new open and collaborative education ecosystem characterized by deep integration of the educational chain, talent chain, and industrial chain.

3.1 Optimization of the Practical Teaching Curriculum System

According to IEET accreditation standards, optimizing the practical teaching curriculum is a critical yet systematic process aimed at enhancing student learning outcomes and engineering practice competencies. Effective optimization requires a structured approach aligned with outcome-based education (OBE) principles.

First, explicit learning objectives for practical teaching should be clearly defined, specifying the knowledge, skills, and professional competencies students are expected to achieve. These objectives ensure alignment between theoretical instruction and practical training, while maintaining consistency with IEET and OBE requirements.

Second, curriculum content should be systematically integrated and optimized based on these objectives. Experimental modules, project-based practices, and engineering case studies should be organized into a coherent and progressive practical teaching framework.

Meanwhile, continuous updates are necessary to incorporate emerging technologies and evolving industrial demands, ensuring the curriculum remains relevant and application-oriented.

Third, diversified and student-centered instructional methods should be widely implemented. Practical teaching should integrate project-based learning, case-based instruction, virtual simulation, and competition-driven activities to form an engineering problem-oriented learning model. Through team-based projects, industry-oriented cases, and high-fidelity simulation platforms, students' abilities in system integration, teamwork, problem-solving, and innovation can be effectively strengthened.

Fourth, strengthening practical teaching infrastructure is essential. This includes upgrading laboratory facilities, developing industry-aligned comprehensive practice platforms, and expanding virtual simulation resources based on digital twins and VR/AR technologies. In addition, open innovation laboratories and maker spaces should be established to support student-led projects and interdisciplinary exploration.

Finally, universities should deepen industry–education collaboration and promote interdisciplinary integration by jointly developing experimental projects with enterprises and introducing cross-disciplinary practice courses. These measures enable students to address complex engineering problems from multiple perspectives.

Overall, practical curriculum optimization is a continuous and collaborative process that significantly enhances practical competence and innovative capacity in electrical engineering education.

3.2 Strengthen the Integration of Practical Teaching with Industry Enterprises

Strengthening deep collaboration between practical teaching and industry is a critical pathway for advancing engineering education reform and enhancing the alignment of talent cultivation with industrial needs. Universities should establish long-term, cooperative education mechanisms with power utilities, equipment manufacturers, and research institutes to jointly develop curricula, co-build practice platforms, and share teaching resources. By integrating real engineering projects from industry into teaching, comprehensive experimental modules covering frontier fields such as smart grids, renewable energy integration, and industrial internet of things can be designed, enabling students to engage directly with up-to-date technical standards, equipment, and engineering processes. In addition, stable university–enterprise practice bases should be leveraged to systematically organize cognitive, production, and capstone internships, allowing students to participate in real engineering tasks and thereby strengthen their problem-solving skills and professional competence. Furthermore, involving industry experts in practical instruction and outcome evaluation helps embed industrial requirements throughout the talent cultivation process, forming a virtuous cycle in which industry informs education and education, in turn, supports industry, thus effectively bridging the gap between academic training and practical engineering demands.

3.3 Offering Cutting-Edge Practical Courses and Teaching Methods

Considering the characteristics of the Electrical Engineering and Automation major, frontier-oriented practical courses such as Intelligent Control System Design and Practice and Industrial Robot Applications can be introduced. In parallel, advanced teaching approaches including virtual simulation and hardware-based simulation should be integrated into practical instruction. These methods enable students to engage in realistic engineering scenarios, thereby effectively enhancing their innovative thinking and complex problem-solving capabilities.

3.4 Strengthen the Design and Management of Internship Programs

Internships constitute a vital component of practical teaching. The effectiveness of this component can be enhanced by expanding internship opportunities and strengthening their systematic organization and supervision. Through well-structured guidance and management, students are better able to understand industry demands, apply theoretical knowledge in real engineering contexts, and develop practical skills and problem-solving capabilities.

3.5 Introduce Project-Based Learning with a Focus on Cultivating Problem-Solving Skills

Project-based learning is a student-centered pedagogical approach that emphasizes the development of innovation through engagement in real-world problem solving. In Electrical Engineering and Automation programs, incorporating project-based and case-based practical teaching formats encourages students to take an active role in learning and application. By participating in activities such as technological innovation competitions, enterprise internships, and team-based projects involving investigation, scheme design, and implementation, students can effectively address practical engineering problems, thereby strengthening their innovative awareness and engineering practice capabilities.

4. Implementation and Assurance of Practical Teaching Reform and Innovation

Based on the IEET accreditation philosophy, this study promotes the reform of the practical teaching system through Outcome-Based Education (OBE) and Continuous Quality Improvement (CQI), strengthens industry–academia integration and curriculum innovation, and establishes a progressive foundation-integration-innovation framework. This approach comprehensively enhances the practical competence, innovative capacity, and international competitiveness of electrical engineering talents. The reform framework is illustrated in Figure 2.

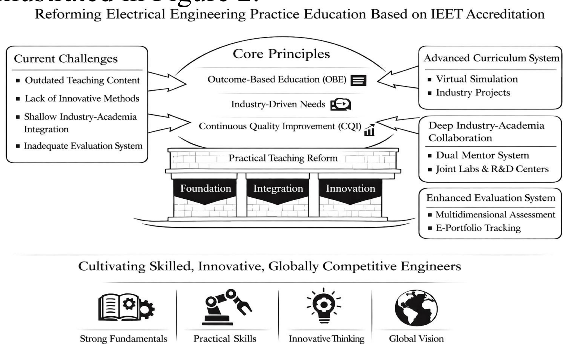

Figure 2. IEET-Based Framework for Electrical Engineering Practice Education Reform

4.1 Strengthen the Development of the Teaching Faculty

A high-quality faculty is fundamental to reforming and innovating practical teaching in Electrical Engineering. Strengthening the practical teaching workforce can be achieved through three key approaches: (1) recruiting and cultivating instructors with substantial engineering experience and strong innovative capacity to provide solid support for practice-oriented education; (2) enhancing teachers' engineering practice competencies by encouraging participation in industrial R&D projects, thereby improving their practical insight and applied expertise; and (3) establishing robust university–enterprise collaboration mechanisms by inviting industry experts to serve as guest professors or practice mentors, ensuring that instruction remains closely aligned with real engineering applications.

4.2 Enhance Practical Teaching Facilities and Conditions

Practical teaching facilities and conditions constitute the foundation for reform and innovation in practice-oriented education. Increased investment is therefore required to update and upgrade experimental equipment, ensuring high-quality hardware support for effective practical teaching and the cultivation of engineering competencies.

4.3 Establishing a Comprehensive Practical Teaching Evaluation System is Essential for Promoting the Improvement of Practical Teaching Quality

To ensure the quality and effectiveness of practical teaching, a comprehensive evaluation system should be established. This system should assess students' learning outcomes, process performance, and innovative capability, as well as teachers' instructional quality and professional engagement. Systematic analysis and feedback of evaluation results enable timely identification of deficiencies in practical teaching and support continuous improvement measures.

5. Conclusion

Against the background of the global transition of engineering education toward outcome-based and continuous improvement paradigms, systematic reform of practical teaching in Electrical Engineering and Automation based on the IEET accreditation framework is of significant theoretical and practical importance. Focusing on key deficiencies in current practice teaching—namely the lack of alignment with emerging technologies, limited innovation in teaching methods, insufficient depth of industry–education integration, and inadequacies in evaluation mechanisms—this study analyzes the gap between existing practices and internationally recognized standards of substantial equivalence. Guided by the principles of Outcome-Based Education (OBE) and Continuous Quality Improvement (CQI), a comprehensive framework for practical teaching reform and innovation is proposed.

The results indicate that establishing a progressive practice curriculum system spanning foundational, integrative, and innovative levels is essential for enhancing students' engineering practice competence and complex problem-solving abilities. The systematic adoption of project-based, case-based, and virtual–physical integrated teaching approaches effectively strengthens student engagement, systems thinking, and innovative capacity. Furthermore, deepening industry–university collaborative education by embedding real engineering projects, industrial standards, and enterprise-based evaluation throughout the practical teaching process is a critical guarantee for achieving close alignment between talent cultivation and industrial demand. The sustainable implementation of practical teaching reform also relies on the development of high-quality dual-qualified faculty, the continuous improvement of modern practice teaching facilities, and the establishment of multi-dimensional, process-oriented evaluation systems.

Overall, the practical teaching reform framework proposed in this study facilitates the transformation of Electrical Engineering and Automation education from a knowledge-transmission-oriented model to a competence-centered paradigm. It provides a feasible pathway for improving engineering education quality and enhancing graduates' engineering competence and international competitiveness. The findings may also serve as a valuable reference for other engineering disciplines seeking to align with IEET and similar international accreditation standards and to construct high-quality practical teaching systems.

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References

[1] Z. Tao and Z. Qiujing, "Discussion on the Reform of Electronic Information Engineering Graduation Design under the Background of IEET Engineering," 2020 International Conference on Information Science and Education (ICISE-IE), Sanya, China, 2020, 306-310.
[2] R. Liang, "Practical Teaching Reform of ARM Embedded Technology Based on OBE Concept for Applied Undergraduates," 2021 International Conference on Computers, Information Processing and Advanced Education (CIPAE), Ottawa, ON, Canada, 2021, 90-92.
[3] F. Yu, Y. Liu and F. Xiao, "Research on Construction and Practice of Precision Teaching Classroom for University Programming Courses," in IEEE Access, 2023(11), 9560-9576.
[4] W. Yuan, M. Wang, G. Liu, Z. Zhang and N. Liu, "Reform and Research on Online and Offline Hybrid Teaching of Operating System Focusing on Cultivating Students' Innovative and Practical Abilities," 2023 13th International Conference on Information Technology in Medicine and Education (ITME), Wuyishan, China, 2023, 755-759.
[5] Meng X, Guo Y .Technology Empowerment, Practice Foundation, and Ideological and Political Cultivation: Teaching Reform and Practice of the National First-Class Course "Electrical Machinery". Journal of Contemporary Educational Research, 2025, 9(12):132-139.
[6] P. Ling, "Research on the Teaching Reform of Interdisciplinary Courses under the Background of the Construction of New Liberal Arts: Taking "Data Visualization and Communication" as an Example," 2024 14th International Conference on Information Technology in Medicine and Education (ITME), Guiyang, China, 2024, 265-268.
[7] Z. Xu, H. Yuan and Q. Liu, "Student Performance Prediction Based on Blended Learning," in IEEE Transactions on Education, 2021(64) 1, 66-73.
[8] Li Y, Yu S, Zhang Y .Research on the Teaching Reform of Professional Practical Courses under the Background of Emerging

Engineering Education. Journal of Electronic Research and Application, 2025, 9(6):90-95.
[9] Li H, Feng X. Research on the Teaching Reform Practice of College Fundamentals of Computer Science Courses. Scientific Journal of Humanities and Social Sciences, 2025, 7(10):140-145.
[10]Xu M .Research on the Practice and Effectiveness of Project-based Teaching in E-commerce Curriculum Reform. International Education Forum, 2025, 3(7):166-172.
[11]Wen B .Research on the Teaching Reform of Pre-Primary Education Specialty Practice Course under the Demand Orientation. Education Reform and Development, 2024, 6(3):81-86.
[12]J. Jin and S. Jin, "Reforms to Teaching Practices in College Human Resource Management Courses Based on Integration with Regional Industries," 2022 10th International Conference on Information and Education Technology (ICIET), Matsue, Japan, 2022, pp. 330-335.
[13]Q. Lin and A. Wang, "Research on the Teaching Reform of Virtual Simulation Experiment of Tourism Management Major under the Background of Big Data," 2023 9th Annual International Conference on Network and Information Systems for Computers (ICNISC), Wuhan, China, 2023, pp. 520-523.
[14]S. Zhong, Y. Miao and X. Jiang, "Research on the Reform of Practice Teaching Based on OBE-CDIO," 2021 2nd International Conference on Information Science and Education (ICISE-IE), Chongqing, China, 2021, pp. 1499-1503.

