Journal of Education and Educational Research
ISSN: 2957-9465 | Vol. 21, No. 3, 2026

Exploration and Practice of Teaching Reform for the Course "Automation of Electric Power Systems" in the Power System Specialization

Yao Han *

Sichuan University Jinjiang College, Meishan, Sichuan, 620860, China
*** Corresponding author:** Yao Han

Abstract: "Automation of Electric Power Systems" is a core interdisciplinary course in the Electrical Engineering and Automation major. At present, the course faces prominent problems, including poor alignment with students' learning characteristics, abstract course content, and a single, lecture-dominated teaching method. To improve overall teaching quality, and considering the interdisciplinary and highly demanding nature of the course, this study carried out a systematic teaching reform based on the learner profile of students who possess relatively strong practical abilities but weak theoretical foundations. The reform first established three-dimensional teaching objectives integrating knowledge, competence, and values; incorporated frontier content on smart grids and a power-grid simulation environment into the course content; deeply integrated curriculum-based values education; adopted the BOPPPS teaching model; used case analysis and group discussion as major vehicles to construct interactive teaching scenarios; optimized the entire teaching process with modern information technology and AI technologies; and built a comprehensive assessment system combining continuous and summative assessment. Through an evidence-based teaching-reflection mechanism, the scheme was continuously refined. Ultimately, the reform achieved an organic integration of knowledge transmission, competence cultivation, and value guidance, and formed a new teaching model with potential for broader application and transfer, which may serve as a reference for teaching reform in similar engineering and technology courses.

Keywords: Automation of Electric Power Systems; Case Analysis; Interactive Teaching; Curriculum Integration; Curriculum-based Values Education; Smart Teaching.

1. Introduction

"Automation of Electric Power Systems" is an important course connecting power system theory with engineering practice. It covers multiple fields, including power systems, automation technology, electrical control, and information and communication, and helps students acquire foundational knowledge and skills in these areas[1]. The rapid evolution of smart grid and renewable energy grid-integration technologies is driving power systems toward deep transformation featuring digitalization, intelligent operation, and deep integration. This process imposes higher requirements on talents' professional competence, interdisciplinary transfer and application ability, and sustainable-development awareness[2]. According to the China Business Industry Research Institute (CBIRI), China's smart grid market reached approximately RMB 107.72 billion in 2023, with an average annual compound growth rate of 10.31% over the previous five years; the market size was approximately RMB 116 billion in 2024 and is expected to exceed RMB 120 billion in 2025[3]. Under the traditional teaching mode, however, course content cannot keep pace with industrial development; classroom teaching remains dominated by one-way lecturing and lacks effective interaction; and theoretical instruction has long been disconnected from engineering practice[4]. As a result, although students accumulate a certain amount of hands-on experience, they find it difficult to translate it into systematic theoretical understanding. When facing emerging technologies such as intelligent dispatching and virtual simulation, their ability to transfer knowledge is insufficient, leading to a mismatch between talent cultivation and actual industrial needs[5]. Therefore, teaching reform of the course is imperative.

Current engineering curriculum reform in universities places greater emphasis on the concept of "fostering virtue through education" (lide shuren) and Outcome-Based Education (OBE), highlighting the deep integration of professional teaching with values education and the organic combination of the teaching process with information technology[6]. To this end, scholars at home and abroad have conducted extensive exploration and practice in teaching-model innovation.

In international research, Syeed et al. explained that the OBE concept can be used to teach, measure, and track all engineering skills critical to students' professional development. Through OBE, teachers can use evidence to measure students' strengths and weaknesses and design academic interventions to enhance their learning [7]. Lavado-Anguera et al. examined Project-Based Learning (PjBL) in engineering and showed that this model has great potential for improving students' skills and generating added value for the overall teaching model [8]. The New Engineering Education Transformation (NEET) program launched by the Massachusetts Institute of Technology (MIT) in 2017 is a representative attempt of this kind. Organized around interdisciplinary project groups, the program's teaching outcome evaluation showed substantial improvement in students' innovative behavior and engineering judgment [9]. Based on OBE-BOPPPS teaching theory, Wang et al. constructed a coordinated teaching model for course groups, achieved dynamic optimization and targeted feedback in the

teaching process, and effectively promoted the systematic transfer of knowledge and the comprehensive development of students' innovative practice ability [10].

In domestic research, the integrated model of project-based learning and university–industry collaboration has been widely applied in electrical engineering education. Studies show that this model can stimulate students' learning interest and significantly improve their theoretical and practical performance[11]. Li Shasha et al. introduced the BOPPPS model into the teaching reform of the course "Relay Protection and Automatic Devices," applying it to all links of the teaching process and improving students' learning effect and engineering thinking ability within limited classroom time[12]. Cui Xiao et al. constructed a SPOC+BOPPPS blended model, took students as the center, and realized the combination of teaching, learning, and practicing, achieving good teaching results[13]. In addition, interactive teaching methods such as case analysis and group discussion can cultivate students' innovative thinking and interdisciplinary competence and strengthen their ability to transfer cross-cutting knowledge[14].

Regarding the construction of curriculum-based values education, the Guidelines for Ideological and Political Education Construction in Higher Education Courses issued by the Ministry of Education in 2020 clearly require that all universities, all teachers, and all courses assume the responsibility of fostering virtue through education, so that various courses and ideological-political courses work in the same direction and create synergy[15]. As a typical engineering course, "Automation of Electric Power Systems" contains abundant values-education elements, such as scientific spirit, engineering ethics, patriotism, and the concept of sustainable development, providing a sound basis for curriculum-based values education.

Focusing on the difficulties in the course "Automation of Electric Power Systems"—namely, teaching content not synchronized with industrial development, theoretical teaching disconnected from engineering contexts, and value guidance separated from knowledge transmission—this study integrates frontier content in smart grids, virtual simulation teaching resources, and modern educational technologies, incorporates interactive teaching methods, and constructs a practical system combining virtual and real components. The objective is to achieve synergistic enhancement of knowledge transmission, competence cultivation, and value guidance, improve course teaching quality, strengthen talent-training effectiveness, and provide replicable practical experience for teaching reform in similar engineering courses.

2. Analysis of Existing Teaching Problems

2.1. Analysis of Student Learning Profiles

The college has already developed a certain foundation in terms of laboratory facilities. Existing professional laboratories and innovation laboratories can provide hardware support for cultivating students' engineering practice ability. Students who have long been exposed to practical training show relatively strong hands-on engineering skills and abilities in solving concrete technical problems, and they possess strong practical application thinking and execution ability. However, because students devote more energy to practical-skill training, their theoretical knowledge system is not systematically developed; their grasp of abstract concepts is relatively weak; and their ability to transfer and integrate interdisciplinary knowledge remains to be improved. Specifically, this is reflected in the following aspects:

(1) Students have a weak mathematical foundation and encounter difficulties with differential equations, matrix operations, and complex-number arithmetic involved in power system analysis;

(2) Their understanding of physical concepts is unclear, and they have not firmly mastered core concepts in prerequisite courses such as electromagnetic field theory and circuit principles;

(3) They have insufficient knowledge of control theory and find it difficult to understand abstract contents such as automatic regulation systems and optimal control.

2.2. Analysis of Course Attributes

"Automation of Electric Power Systems" is a typical interdisciplinary course. Its knowledge system spans multiple disciplinary fields, including power systems, control theory, and information and communication, and is highly comprehensive and interrelated. The course content involves not only the basic principles of power systems and the working mechanisms of automation devices, but also professional modules such as control algorithms and communication protocols. The concepts are closely interlinked and the logical structure is complex, making the course demanding overall. To systematically master the core content of the course, students need multidisciplinary knowledge reserves and cross-domain thinking patterns.

In addition, the lag between course content and current industry practice has become increasingly prominent. Traditional textbooks mostly focus on classical theories and mature technologies, with an obvious insufficiency in absorbing emerging fields such as smart grids, the energy internet, and the power internet of things. Taking the dispatching-automation section as an example, existing textbooks mainly teach the architecture of centralized SCADA/EMS systems, while frontier topics such as cloud-computing-based dispatching and control systems, big-data analytics in power grid operation, and AI-assisted decision-making are not systematically covered. This content lag creates a gap between talent-training requirements and industry technical needs, and graduates need a relatively long adjustment period after starting work before they can meet actual job requirements.

2.3. Analysis of the Teaching Model

Under the traditional teaching model, course content is delivered in a relatively monotonous form, dominated by theoretical explanation and text-based instruction, with insufficient intuitiveness and concreteness. The equipment structures, operating mechanisms, and control logics involved in power system automation are relatively abstract. Moreover, due to limitations of physical space and equipment scale, large substation equipment and complex distribution-network systems are difficult to bring into the classroom. As a result, students find it difficult to build a clear knowledge framework and tend to perceive the course content as "overly abstract and disconnected from engineering practice," which negatively affects their learning motivation and knowledge internalization.

In the course-evaluation link, traditional assessment relies mainly on a final closed-book examination, which usually

accounts for 70% of the total grade. Its proposition orientation emphasizes memorization and primary application of theoretical knowledge, while insufficiently measuring engineering practice ability, innovative thinking, and teamwork skills. This "one final exam determines the grade" approach tends to encourage strategic learning behavior: students put in little effort during the semester and cram for the final examination, making it difficult to guarantee the stability of learning quality. It also contradicts the ability-oriented concept emphasized in engineering education.

In summary, the core contradictions currently facing the course are as follows: students have relatively ample practical-skill reserves but weak theoretical foundations; the course content is abstract and complex but is delivered in a monotonous form; and industry technology is evolving rapidly while teaching content updating lags behind. To resolve these contradictions, systematic teaching reform must be carried out, with coordinated advancement in teaching objectives, content, methods, evaluation, and other dimensions.

3. Solutions to the Teaching Problems

3.1. Reorientation of Teaching Objectives

In response to the above problems, the reform first established a three-dimensional teaching objective system integrating "Knowledge–Competence–Value," realizing the transformation of course orientation from single knowledge transmission to comprehensive competence cultivation and value guidance.

(1) Knowledge objectives. Students should systematically master the basic principles of power system automation, core technologies, and the working mechanisms of key equipment; keep abreast of technological advances in frontier fields such as smart grids, renewable energy grid integration, and energy storage technology; and be familiar with mandatory requirements in power industry standards, technical specifications, and relevant regulations.

(2) Competence objectives. Students should be able to use theoretical knowledge to analyze complex engineering problems in power system automation; develop interdisciplinary thinking, teamwork skills, and innovative problem-solving ability; and, through participatory teaching activities, improve academic expression, logical reasoning, and professional communication skills.

(3) Value objectives. Students should establish engineering-ethics awareness, recognize the fundamental supporting role of safe and stable power system operation in the national economy and social life, cultivate a rigorous academic attitude and a truth-seeking and pragmatic engineering spirit, enhance industry identity and professional mission, internalize sustainable development as a guiding principle in engineering practice, and foster national identity and patriotism, thereby encouraging students to take initiative in contributing to innovative development of the power industry.

3.2. Deep Integration of Curriculum-Based Values Education

The construction of curriculum-based values education is not a simple superposition of professional content and values elements; rather, it pursues deep coupling between the two and achieves subtle integration, often described as "salt dissolved in water." This course constructs a values-education system from four dimensions:

(1) Engineering-case dimension. Typical engineering contexts in power system automation are selected, such as complex power grid fault diagnosis and the development of high-precision automation devices, to highlight the basic constraints of data accuracy and process standardization. Major accident cases such as the August 14, 2003 North American blackout and the 2012 India blackout are introduced to conduct accident-attribution analysis from multiple factors, including human error, equipment defects, and management loopholes, thereby cultivating students' rigorous academic attitude and sense of engineering responsibility.

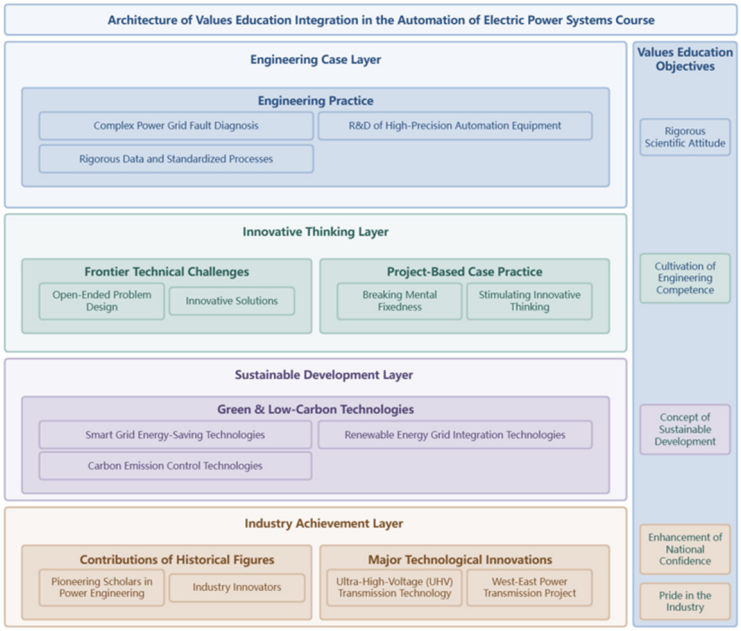

Figure 1. Architecture of Values Education Integration in the Automation of Electric Power Systems Course

(2) Innovative-thinking dimension. Relying on frontier technical problems in the industry and innovative project cases, open propositions are set to guide students to break through traditional thinking patterns, attempt unconventional

solutions, and stimulate their problem awareness and innovative initiative.

(3) Sustainable-development dimension. Around contents such as energy-saving technologies in smart grids, renewable energy grid integration, and carbon-emission control, students are guided to pay attention to sustainable energy development as a major challenge for humanity, encouraging them to consider how to promote sustainable development through technological innovation and to generate new ideas and theories.

(4) Industry-achievement dimension. The course introduces historical figures in China's power industry development who made innovative contributions, such as pioneering scholars in power engineering, major innovative technologies such as ultra-high-voltage transmission technology, and landmark projects such as the West-East Power Transmission Project, so as to showcase China's achievements in the power industry and enhance students' national confidence and pride in the industry.

In this architecture, professional knowledge serves as the carrier, while values-based elements serve as the soul. Through case teaching, project-driven learning, and cultural infiltration, the unity of knowledge transmission and value guidance is achieved.

3.3. Reconstruction and Optimization of Teaching Content

The course knowledge system was reconstructed to fully integrate smart grid-related content into the entire teaching process, keeping course content aligned with industry development trends. Specific measures include:

(1)Condensing traditional content while retaining the essentials. Classical theories were streamlined by retaining basic concepts and core principles and removing outdated technologies and redundant content.

(2)Adding frontier-technology modules to respond to industrial evolution demands. A module entitled "Smart Grids and Power System Automation" was added. Its content architecture focuses on core technical blocks such as intelligent dispatching systems, intelligent distribution networks, and intelligent inspection systems, and presents the technological evolution and latest research progress in this field.

(3)Strengthening interdisciplinary integration and breaking down disciplinary barriers. Attention is paid to the cross-integration of disciplines such as power systems, control theory, and information and communication, helping students establish a systematic knowledge framework.

3.4. Teaching Process and Methods

3.4.1. Systematic Application of the BOPPPS Teaching Model

The BOPPPS classroom teaching model was adopted to construct a complete teaching closed loop. The specific application of its six links in this course is as follows.

Bridge-in. Materials such as power industry news reports, film and video clips, and typical engineering cases are used to create teaching contexts close to engineering practice. Examples include the launch of new smart grid projects, major power supply assurance operations, documentary clips about the power industry, and automation retrofit cases for complex substations, so as to stimulate students' learning interest and inquiry desire.

Objective. The knowledge, competence, and value objectives of each lesson are clearly communicated to students so that they form clear learning expectations. At the same time, these objectives are related to engineering application scenarios, revealing the functional positioning of the content in industrial practice.

Pre-assessment. Diagnostic tools such as classroom questioning, mini-quizzes, or online voting are used to assess students' existing knowledge base and provide evidence for teaching decisions. Pre-assessment content covers core concepts of prerequisite courses and preparatory knowledge for the current lesson. Based on the results, teachers can judge whether foundational content needs to be supplemented and adjust teaching progress and depth accordingly.

Participatory Learning. As the core module of the BOPPPS model, this link uses questioning interaction, case-based seminars, and group collaboration to encourage students to actively participate in classroom processes and conduct in-depth thinking and viewpoint exchange. Specific strategies include:

(1) Case teaching method. Typical engineering contexts are selected, such as "cause analysis of a low-frequency oscillation accident in a certain power grid" and "frequency-control problems after large-scale renewable energy grid integration." Students are organized to conduct group seminars: analyzing the case background, identifying the causes of the problem, and presenting solutions. Each group then presents in class, followed by teacher comments and theoretical enhancement.

(2)Problem-Based Learning (PBL). A graded and progressive sequence of questions is designed to guide students to deepen cognition step by step. For example, when teaching the knowledge point of "voltage-regulation measures," the teacher asks in sequence: Why is voltage regulation necessary? What adverse effects does low voltage have on the power grid? What means can be used to regulate voltage? What are the advantages, disadvantages, and applicable scenarios of each means? How should multiple regulation means be coordinated? Through continuous questioning, students are prompted to move from phenomenon description to mechanism explanation.

(3) Scenario simulation and role-play. A simulated scenario of "power system fault troubleshooting" is created. Students are divided into groups and assume functional roles such as dispatchers, operation-and-maintenance personnel, and maintenance personnel to work through the coordinated response process after a power grid fault. Contextualized learning improves students' participation and learning experience.

Post-assessment. Formative assessment tools such as classroom exercises, group presentations, or online tests are used to assess students' level of knowledge mastery, identify gaps in understanding, and conduct targeted intervention. Post-assessment content covers the core concepts of the current lesson, with difficulty connected to the pre-assessment. Through longitudinal comparison of pre- and post-assessment scores, learning effects can be evaluated. For common problems exposed in post-assessment, teachers should provide supplementary explanations in time; individual problems can be solved through after-class tutoring.

Summary. The core concepts, key difficulties, and engineering application scenarios of the lesson are systematically sorted out to help students construct a knowledge framework. The summary follows a two-way structure: the teacher provides a mind map or knowledge-

framework diagram to present logical relationships among concepts; meanwhile, students are encouraged to review the learning process and share cognitive gains and remaining questions, promoting reflection at the metacognitive level.

3.4.2. Deep Integration of Modern Information Technology and AI Technologies

Modern information technology and AI technologies are fully used to enhance teaching and create an intelligent and personalized teaching environment.

(1)Application of online teaching platforms. Smart teaching platforms such as Rain Classroom and Chaoxing Learning Pass are used to release teaching resources, assign homework, and organize discussions. The platforms automatically record students' learning-behavior data, such as video-viewing duration, resource-download frequency, homework-submission time, and the number of discussion posts, providing a data basis for learning analytics.

(2)Application of AI data-analysis technology. Machine learning algorithms are used to model students' learning behavior from multiple dimensions, including behavioral patterns, homework completion, and classroom interaction performance, constructing individual learning profiles. Cluster analysis identifies groups with different learning styles and provides a classification basis for differentiated teaching; prediction models identify students at risk of academic failure, enabling early warning and targeted intervention; and association rule mining extracts key variables affecting learning effectiveness, providing data support for teaching decisions.

The teaching process after integrating the BOPPPS model is shown in Figure 2.

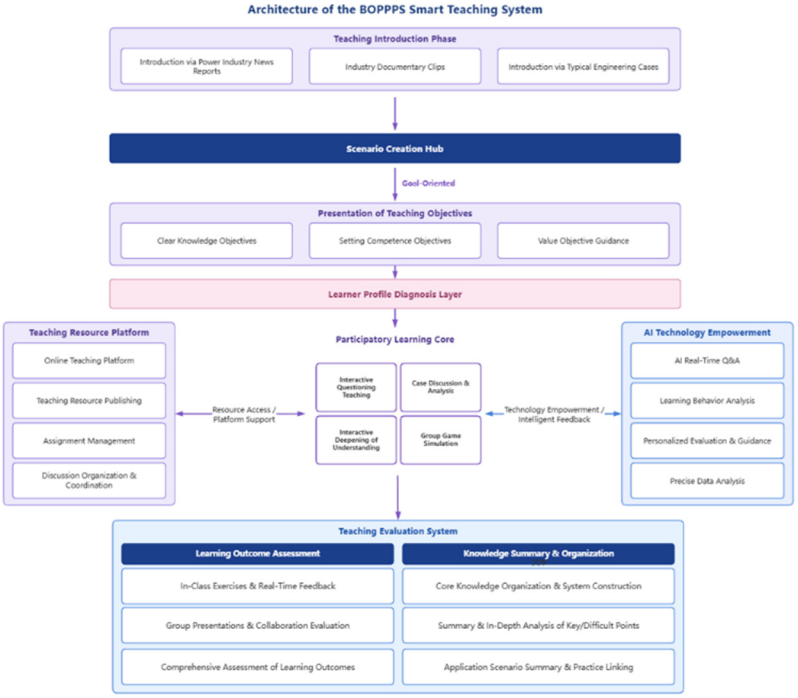

Figure 2. Course teaching process based on the BOPPPS model

4. Course Assessment

Table 1. Composition of process-based assessment grades.

Course grade composition	Specific item	Weight
Continuous assessment (100 points)	Class attendance	4%
	Individual assignments and group assignments	20%
	Class participation (case discussion, questioning and answering, group presentation, etc.)	16%
Final examination (100 points)	Final examination	60%
Total		100%

According to the attributes of the course, a comprehensive evaluation method combining continuous assessment and summative assessment is adopted to measure students' knowledge mastery, skill-transfer level, innovation potential, and professional literacy from multiple dimensions, present their learning outcomes more completely, and promote their all-round development. Under this assessment method, the final course grade is calculated as follows:

Final course grade (100%) = Continuous assessment (40%) + Final examination (60%).

The specific composition is shown in Table 1.

The specific design of continuous assessment is as follows:

(1) Class attendance (4%). Multiple methods are used, including random roll calls, QR code check-in, and in-class interaction responses, which both ensure attendance and avoid wasting class time.

(2) Assignments (20%). Assignments include individual assignments and group assignments. Individual assignments focus on consolidating basic concepts and training calculation skills, while group assignments focus on comprehensive knowledge transfer and the cultivation of teamwork skills. The evaluation considers not only the correctness of results but also process standardization and the originality of students' thought processes.

(3) Class participation (16%). Smart teaching platforms are used to collect students' classroom-interaction data, covering behavioral indicators such as question response, discussion participation, question initiation, and group presentation. A

"classroom contribution" indicator is included to encourage active participation.

The summative assessment consists of the final examination, which accounts for 60%. It focuses on testing students' mastery of core course concepts and their comprehensive application ability. The design of test questions emphasizes the combination of theory and engineering practice and increases the proportion of comprehensive questions such as case analysis and design tasks.

5. Teaching Practice Results

The results of teaching practice after the course reform are shown in Figure 3 and Table 2.

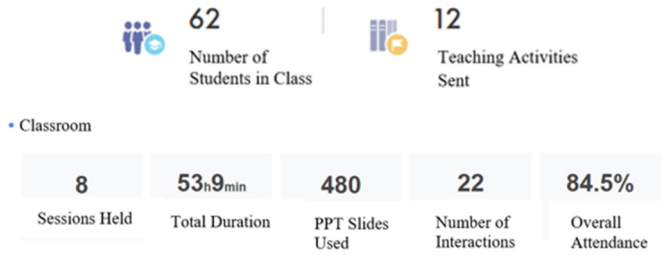

Figure 3. Learning records from Rain Classroom

Table 2. Final-examination analysis (total number of students in the taught class: 62).

Score band (full mark: 100)	Number of students	Percentage
90 and above	10	16.13%
80–89	29	46.77%
70–79	23	37.10%
60–69	0	0.00%
45–59	0	0.00%
Below 45	0	0.00%
Highest score	94	
Lowest score	71	
Average score	82.4	
Pass rate	100.00%	

As shown in the Rain Classroom learning records in Figure 3, when the number of class sessions reached eight, teacher–student interactions reached 22, averaging two to three interactions per session, indicating a relatively high level of classroom engagement. Table 2 shows that all students taught under the new teaching and assessment methods passed the final examination, and the average score reached 82.4. Therefore, in the course "Automation of Electric Power Systems," it is feasible and effective to integrate smart grid content and a simulation environment into the course, adopt the BOPPPS teaching model, construct interactive teaching scenarios with case analysis and group discussion as the core carriers, and optimize the teaching process by combining modern information technology and AI technologies. The practice can provide a practical reference for teaching reform in similar engineering and technology courses.

However, the reform also exposed some problems. For example, in group discussions, a small number of students participated little and discussions sometimes lacked focus. In the future, the grouping and evaluation mechanisms will be optimized, student feedback will be obtained in a timely manner, teaching schemes will be dynamically adjusted, and the teaching model will be continuously improved to enhance the precision and effectiveness of the reform.

6. In-Depth Reflection on Teaching Effect and Value for Broader Application

Through systematic exploration, this teaching reform of the course "Automation of Electric Power Systems" has accumulated certain experience. At the level of teaching implementation, closely following the learner profile of students who have relatively ample practical-skill reserves but weak theoretical foundations, frontier technical content in smart grids and virtual simulation environments were integrated into the teaching process, which, to a certain extent, made up for the shortcomings of traditional course content that lagged behind industrial development and was overly abstract. The combination of the BOPPPS teaching model with interactive methods such as case analysis and group discussion, supplemented by modern educational technology and intelligent tools, significantly improved classroom interactivity and teaching pertinence, prompting students to establish effective connections between theoretical knowledge and engineering contexts. The deep integration of curriculum-based values education, relying on typical industry situations and major national engineering achievements, realized the resonance of value guidance and professional education and achieved coordinated cultivation of "knowledge–competence–value."

The new teaching methods and model developed in this reform have strong potential for broader application and transfer:

(1) The constructed teaching-content system combining virtual and real components provides an effective way to make abstract knowledge more concrete in highly interdisciplinary and practice-oriented engineering courses;

(2) The experience of integrating the BOPPPS model with modern information technology and AI technologies can be widely applied to teaching in related majors such as power engineering, automation, and control science;

(3) The comprehensive assessment method of "continuous + summative" and the evidence-based teaching-reflection mechanism provide reliable support for assessment reform and quality improvement in engineering courses;

(4) The practical path for deeply integrating curriculum-based values education with professional teaching also provides a directly referable operational case for universities to implement the fundamental task of fostering virtue through education and can be widely applied in related professional fields.

7. Conclusion

Aiming at the problems of poor alignment with students' learning characteristics, abstract course content, and a single teaching method in the teaching of "Automation of Electric Power Systems," this study carried out systematic exploration of teaching reform. A three-dimensional teaching objective of "knowledge–competence–value" was established; the course knowledge architecture was reconstructed to integrate frontier smart grid technologies; the BOPPPS teaching model was used to construct interactive teaching scenarios; modern educational technology and intelligent technology were applied to optimize the teaching process; a comprehensive evaluation system of "continuous + summative" assessment was established; and curriculum-based values elements were deeply integrated. As a result, teaching quality was significantly improved.

Practice shows that after the reform, students' learning effectiveness and comprehensive abilities were enhanced, and the educational function of curriculum-based values education was initially demonstrated. The formed teaching model and methods possess a certain degree of transferability and can provide a practical reference for reform in similar engineering and technology courses. Future research will continue along the dimensions of intelligent teaching, virtual–real integrated experiments, and industry–education collaborative education, further improve course teaching quality, and contribute to cultivating power engineering talents in the new era.

Acknowledgments

The authors gratefully acknowledge the financial support from Sichuan University Jinjiang College (QNJJ-2026-B18).

References

[1] Li, Y. S. (2023). Automation of electric power systems (2nd ed.). China Electric Power Press.

[2] Hu, K., & Deng, X. M. (2022). Exploration of the talent cultivation model for electrical engineering and automation under the "dual carbon" goal. Coal Higher Education, 40(2), 128–132.

[3] China Business Industry Research Institute. (2022). Market outlook and future investment strategy analysis report of China's smart grid industry, 2024–2029 [Report].

[4] Zhou, L., & Pan, C. (2025). Research on the optimization of curriculum system and teaching content for electrical engineering majors under the background of engineering education professional certification and emerging engineering education. Education Reform and Development, 7(7), 120–127.

[5] Li, W. J., Fu, M., Zhang, Y., et al. (2024). A new teaching paradigm for electrical engineering under the CDIO-OBE concept. China Modern Educational Equipment, (1), 104–106, 110.

[6] Department of Higher Education, Ministry of Education. (2020, May). Guidelines for ideological and political education construction in higher education courses [Regulatory document].

[7] Syeed, M. M., Shihavuddin, A., Uddin, M. F., et al. (2022). Outcome-based education (OBE): Defining the process and practice for engineering education. IEEE Access, 10, 119170–119192.

[8] Lavado-Anguera, S., Velasco-Quintana, P. J., & Terrón-López, M. J. (2024). Project-based learning (PBL) as an experiential pedagogical methodology in engineering education: A review of the literature. Education Sciences, 14(6), 617.

[9] MIT NEET Program. (2017). New engineering education transformation: Program overview [Report]. Massachusetts Institute of Technology.

[10] Wang, Y., Liu, M., Xia, R., et al. (2026). A study on the teaching model for hydraulic engineering curricula based on the OBE-BOPPPS theory. Water, 18(6), 685.

[11] Fang, M., Ma, Y. X., Fan, P., et al. (2024). Reform and practice of the training model for future technology leaders. Research in Higher Education of Engineering, (6), 74–78.

[12] Li, S. S., Wang, D. X., & Xu, Q. (2022). Application of BOPPPS in the teaching of relay protection and automatic devices under the background of emerging engineering education. Scientific Consultation, (6), 82–84.

[13] Cui, X., Su, K. Y., Zhou, B. L., et al. (2023). Teaching reform and innovation of the SPOC+BOPPPS blended model: Taking power system relay protection as an example. Theory and Practice of Innovation and Entrepreneurship, 6(22), 158–160, 171.

[14] Fan, K., Li, J., Sun, B., et al. (2025). Research on curriculum teaching model reform adapted to individualized development. Journal of Shanxi Institute of Energy, 38(1), 79–82.

[15] Ministry of Education. (2020, May 28). Notice of the Ministry of Education on printing and distributing the Guidelines for Ideological and Political Education Construction in Higher Education Courses (Jiaogao [2020] No. 3) [Online notice]. Retrieved April 28, 2026.