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Empowering University Curriculum System Development with China's New Quality Productive Forces: A Case Study of Power Electronics Technology Course

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Abstract
In response to the national strategic demand for cultivating talent aligned with New Quality Productive Forces (NQPF), this study aims to reform the educational paradigm of the “Power Electronics Technology” course in higher engineering education. A progressive ideological and pedagogical integration model termed the “Three Teaching Objective, Five Measures, Five Assessments methods, and A calculation method for objective attainment degree.” is designed and implemented. This reform was applied to the 2023 grade students of the course, with the 2022 grade serving as a comparison group. The intervention involved restructuring course content, innovating teaching methods, and overhauling the assessment system. The key finding was a 24% increase in the average course attainment degree for the 2023 grsde compared to the 2022 grade, demonstrating the model's effectiveness in enhancing learning outcomes. This study provides a replicable, data-driven reform framework that successfully translates the macro-concept of NQPF into micro-level curricular practice, offering a valuable solution for engineering education innovation in the context of technological and strategic transformation.

Keywords: New quality productive forces, Power Electronics Course, Reform Measures, Teaching Methods, Assessments methods

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Introduction

In September 2023, during a symposium on promoting the full revitalization of Northeast China in the new era, General Secretary Xi Jinping first proposed accelerating the formation of new quality productive forces (NQPF) to enhance new drivers of growth. The Chinese 2024 National Two Sessions placed special emphasis on NQPF, with the conference characterized by an enthusiastic atmosphere and active discussions (Yang, 2024). The essence of NQPF lies in knowledge-driven production, reflecting the output efficiency and level of new production methods (Hongdi, 2025; Xuan, 2025). It is prominently demonstrated in transforming the advantages of scientific and technological innovation resources into developmental strengths (Guozhen, 2024; Pan et al., 2025), which in turn enhances society's capacity to reshape the world and create social wealth (Xing, 2025). Such transformation encompasses the entire society's capability system in constructing new forms of capital, featuring disruptive, integrative, and co-creative attributes. Scientific and technological innovation serves as the core element of NQPF, capable of catalyzing new industries, models, and momentum. Cultivating and developing NQPF requires comprehensively deepening reforms to establish new relations of production that align with it. Simultaneously, it demands strengthening scientific and technological innovation—particularly original and disruptive innovation—to accelerate the achievement of greater self-reliance and strength in science and technology. Additionally, it necessitates optimizing the virtuous cycle of education, science and technology, and talent, while refining mechanisms for talent cultivation, recruitment, utilization, and rational mobility (Boquan et al, 2025). Against this backdrop, NQPF impose higher demands on engineering education.

Power Electronics Technology is a fundamental course for Motor and Electric Drive Control Systems, Variable Frequency Control Technology, Photovoltaic Power Generation Technology, and Wind Power Generation Technology. It serves as both a specialized foundational course for electrical engineering disciplines and an engineering technology extensively applied in nearly all fields related to electrical energy. Notably, its applications in renewable energy generation and electric vehicles have expanded significantly in recent years (Rui et al, 2025). This course plays a crucial role in cultivating application-oriented talents focused on practical skills, and holds significant importance for advancing NQPF (innovation-driven productivity) in intelligent and green manufacturing.

Analysis of Curriculum System Based on Practice-Based Teaching Reflection

Based on practice-based teaching reflection and using graduates from the New Energy Science and Engineering program at Lanzhou City University as a case study, surveys reveal that the core pain points in the current "Power Electronics Technology" curriculum system lie in: the conflict between "rapid technology iteration" and "slow teaching updates," as well as the imbalance between "deep interdisciplinary integration" and "surface-level knowledge delivery." Traditional Power Electronics courses suffer from outdated content, monotonous teaching methods, weak practical integration, and falling short in cross-disciplinary convergence. Specifically, the "Power Electronics Technology" course exhibits the following critical issues:

Outdated Course Content. The existing teaching materials lag behind technological advancements. The curriculum remains centered on traditional silicon-based devices, with inadequate coverage of the principles, characteristics, and application cases of wide-bandgap semiconductor devices (e.g., silicon carbide (SiC) and gallium nitride (GaN)), which have become the mainstream choice in fields like renewable energy and fast charging. Additionally, textbooks lack in-depth analysis of advanced topologies such as multilevel converters and matrix converters, resulting in a disconnect from industrial demands.

Monotonous Teaching Methods. Current teaching primarily relies on theoretical lectures, with outdated case studies and a lack of interactive models such as flipped classrooms. This passive knowledge acquisition restricts students' innovative thinking. Additionally, there is an absence of diverse teaching forms, including industry expert seminars and corporate field visits, leading to students' vague understanding of technological trends. Under the context of NQPF, teaching methodologies must prioritize ideological education goals and hybrid teaching models integrating multiple approaches.

Insufficient Practical Innovation Capacity. Experimental setups focus predominantly on analog circuit verification, lacking digital validation platforms (e.g., MATLAB/PLECS simulations). Student engagement in innovation competitions remains low, and the curriculum fails to delve into advanced topologies like multilevel converters and matrix converters, resulting in a disconnect from industrial demands.

Teaching resources face multiple challenges: slow updates of textbook content, restricted access and integration of new resources, severe shortage of experimental resources, underutilization of virtual simulation tools despite their potential for complex system modeling.

Currently, research on the reform of Power Electronics Technology courses primarily focuses on the innovation of teaching methods (Muhammad & Theresa, 2019; Wei, 2023) and practical teaching (Mingxin Xiao, 2024; Vijaychandra Joddumahanthi, Łukasz Knypiński, Yatindra Gopal, et al., 2025). These studies do not consider the impact of NQPF, lack quantitative validation of comprehensive teaching paradigms, and are deficient in the supervision of quality education objectives within their evaluation methods.

Thoughts on the construction of the curriculum system

The development of NQPF represents a new height in national competitiveness. At its foundation lies the qualitative transformation of laborers, means of labor, and objects of labor, along with their optimized integration; its core is scientific and technological innovation, particularly breakthroughs in original and disruptive technologies. New quality productive forces are not only a direct manifestation of technological innovation but also the core driving force behind high-quality economic development. They emphasize the deep integration of technological innovation, knowledge creation, talent-driven initiatives, and information flow, highlighting the decisive impact of innovative capabilities and comprehensive competencies on national competitiveness. The development of NQPF, represented by artificial intelligence, new energy, and advanced materials, provides value guidance, practice-driven impetus, global perspectives, and technical leverage for cultivating innovative talent. Starting from the "Power Electronics Technology" course, we closely track innovations in the new energy industry and the knowledge advancements in New Energy Science and Engineering, while addressing industry demands for professional competencies in this field.

The development of NQPF imposes higher and more comprehensive requirements on the cultivation of innovative talent in applied universities. The core attributes and curriculum system development must revolve around technological innovation, industrial demands, and interdisciplinary integration. First, it is essential to shape the values of innovative talent. Innovators should possess ideological and ethical literacy centered on correct worldviews, life perspectives, and values. This manifests as deep-rooted patriotism, the spirit of innovation to scale new heights, a truth-seeking attitude, and a selfless dedication to contributions over personal gain. Designing the ideological module in the Power Electronics Technology course must therefore emphasize scientific rigor, commitment to serving national strategic needs, and integrating personal aspirations into the great cause of national rejuvenation. Simultaneously, students must develop a sense of global responsibility and international perspective. Second, interdisciplinary training is crucial to cultivate comprehensive innovative abilities. Amid the rise of new quality productive forces, applied talents with multi-dimensional innovative capabilities—through technological breakthroughs, resource integration, and industrial alignment—become pivotal engines for accelerating scientific achievement translation and leading high-end industrial transformation. They embody the core momentum for building national strategic scientific strength and achieving global competitiveness (Shengchi Liu, Shuangyue Xiao, et al., 2022). Thus, it is necessary to reconstruct the theoretical framework of courses, enabling students to tackle complex problems through multidisciplinary collaboration and deepen their subject-matter expertise. Third, it is imperative to equip students with the capability to solve real-world social problems (Beibei, Yutong, et al., 2024). Practical instruction is a highly effective approach in innovative talent cultivation; it moves beyond theoretical concepts learned in class and applies them to hands-on challenges—enhancing both comprehension and applied skills (Wu Chan, 2022). For this purpose, the practical component of courses must be redefined. Activities such as innovation competitions and entrepreneurship projects spark innovative passion and creativity, ultimately nurturing top-tier applied talents with integrated innovative capabilities. Finally, intelligent methodologies must revolutionize talent cultivation pathways. Generative artificial intelligence, represented by DeepSeek, is triggering a paradigm shift in education (Xi Zhu, 2021). As an advanced smart education platform, generative AI leverages unique technological advantages to: integrate knowledge efficiently, assist instruction dynamically, build cohesive collaborative learning ecosystems, and implement intelligent evaluation mechanisms. This creates powerful support for fostering innovative talent.

We aim to establish an application-oriented teaching system for "Power Electronics Technology" in universities, centered on student outcome capabilities and ultimately focused on enhancing students' practical skills. Under the context of building application-oriented universities, empowered by NQPF, we conduct comprehensive research on the ideological and political framework, curriculum content, teaching methodologies, educational resources, and assessment methods for the "Power Electronics Technology" course within the New Energy Science and Engineering program.

Thus, we adopt the Power Electronics Technology course as a case study to investigate measures for curriculum system development empowered by new quality productive forces. Based on the cyclical path of "practice-reflection teaching → proposing reform measures → quantitative verification → teaching reflection," we have developed the "Three Teaching Objective, Five Measures, Five Assessments" educational paradigm for the Power Electronics Technology course.

Three Teaching Objective

"Power Electronics Technology" is a core specialized course in Electrical Engineering and New Energy Science and Engineering programs (Sun & Tang, 2022). The teaching objectives include:

(1) Teaching Objective I (TO I): Master the characteristics of power electronic devices, principles of power conversion circuits, and control strategies after completing the course.

(2) Teaching Objective II (TO II): Acquire practical abilities in wiring, testing power conversion circuits, and designing/debugging renewable energy generation systems.

(3) Teaching Objective III (TO III): Cultivate a belief in serving the nation through technology, dedicating themselves to the "dual carbon strategy" (carbon peak and carbon neutrality goals) with a craftsman spirit.

Five Measures for the construction of the curriculum system

Reconstruct the structure of ideological and political education in the curriculum

The cultivation of innovative talents in the new era requires not only solid academic competence and innovative capabilities but also broad international perspectives and a strong sense of social responsibility (Yuhan Xu, Zhiqiang Jin & Rui Zhang, 2025; Huanhuan Xu, Xiaoqing Hu, Quping Zhu, et al., 2025). Under the context of new quality productive forces, the Power Electronics Technology course can integrate theoretical, experimental, and practical education with ideological and moral development. This integration may support students in: grasp the characteristics of power electronic devices; master the working principles, functions, and applications of four types of power conversion circuits; enhance hands-on practical skills to improve employability; atriotic dedication, global perspectives, innovative thinking, and craftsman spirit; Scientific methodologies, critical thinking, and engineering ethics.

This paper establishes "patriotic dedication, ethical responsibility, craftsman spirit, and serving the nation through technology" as core objectives. Aligned with China's national strategic demands for "carbon peak and carbon neutrality" and student cognitive development patterns, it designs a progressive pathway for integrating ideological and political elements. The pathway follows a logical progression: emotional foundation → cognitive deepening → value internalization → practical transformation → belief sublimation. It identifies key themes, including: national pride and scientific curiosity; awareness of technological self-reliance; recognition of national strategies; engineering safety consciousness; responsibility for technological contribution to national development; materialist dialectics; integrity mindset; innovative thinking; scientific rigor; spirit of scientific inquiry; community with a shared future for mankind.

These themes are embedded into course content through online guided learning, case studies, group discussions, summary analysis, extended study, experimental work, simulation design, and project-driven teaching. It anchors the scientist's spirit and employs real-world cases to guide students: from "knowing the nation" to "loving the nation"; from "willingness to act" to "capacity to act". Ultimately cultivating new-era youth with vision, pursuit, responsibility, and capability.

Optimize the teaching content of the courses

The current teaching content lags behind technological advancements, as courses remain centered on traditional silicon-based devices (such as IGBTs) while inadequately covering the principles, characteristics, and application cases of wide-bandgap semiconductor devices like silicon carbide (SiC) and gallium nitride (GaN)—the latter having become prevailing options in fields like renewable energy and fast-charging technologies. Moreover, the curriculum lacks in-depth analysis of emerging topologies, including multilevel converters and matrix converters, resulting in a divergence from actual industrial requirements and practices.

Under the context of NQPF, curriculum content development must strengthen the integration of cutting-edge technologies, focus on new energy and energy storage applications, and align with intelligent manufacturing. Through this course, students will: master rectification and inversion technologies widely applied in wind and solar power generation systems；acquire fundamental power supply design methodologies; Understand frontier application fields related to power electronics technology. Consequently, the teaching content for "Power Electronics Technology" should be selectively optimized: move away from rigid adherence to a single textbook and avoid exhaustive coverage of all textbook content. adopt a targeted approach by prioritizing topics highly relevant to New Energy Science and Engineering, especially widely adopted industrial practices; incorporate content related to academic competitions and adjust laboratory hours to enhance hands-on training.

In the generation of renewable energy, inversion, DC chopping, and AC frequency modulation are crucial technologies. The use of switches and PWM control techniques is also widely prevalent. Furthermore, these topics often appear as subjects in renewable energy engineering competitions. Therefore, it is essential to enhance theoretical knowledge in these areas.

Adjust the credit hours for the experimental component. As students majoring in New Energy Science and Engineering, they should not focus heavily on the internal structures and operating principles of power electronic devices but rather prioritize their practical applications. Therefore, experiments on power electronic devices will be reduced, while experiments on multilevel converters and matrix converters will be added. Additionally, the three-phase semi-controlled rectification experiment will be replaced with a PWM rectifier circuit experiment.

To enhance students′ innovative practical skills and motivate them to actively contribute to the national strategy of rejuvenating China through science and education, we guide students to align their innovative passion with the needs of national energy development strategies. This supports green and low-carbon energy transition, advances new energy development, and fosters the construction of a Beautiful China, thereby continuously promoting technological innovation among university students. In alignment with our university's training program for the New Energy Science and Engineering major, we organize students to participate in national competitions such as the National Undergraduate Electronic Design Contest, the National Renewable Energy Science and Technology Competition, and the National Energy Conservation and Emission Reduction Social Practice & Technology Competition. Consequently, 8 credit hours of practical content have been added to the Power Electronics Technology curriculum.

To fully mobilize students' enthusiasm and bridge the gap between theoretical knowledge and real-world applications, the practical component integrates cutting-edge case studies:

(1) Rectifier circuits: principles applied in new energy vehicle charging piles, converting AC to DC for EV batteries.

(2) Inversion circuits: technologies used in high-speed train onboard power systems, converting DC to AC for diverse loads.

(3) DC chopper circuits: core mechanisms for EV speed regulation via voltage adjustment.

(4) AC voltage regulation circuits: contactless voltage regulation methods for energy-efficient street lighting.
PWM control techniques: switching regulators for precision dimming applications.

Innovate multi-mode blended teaching methods

The current teaching methodology remains predominantly lecture-based, with outdated case studies and a lack of interactive models like flipped classrooms. Students passively receive knowledge, and their innovative capacity development is constrained. There is also an absence of diverse teaching formats, such as inviting industry experts to lectures or organizing field visits to enterprises, leaving students with a vague understanding of technological trends. Against the backdrop of new quality productive forces, the development of teaching methods should place high emphasis on integrating moral education goals through curriculum-based ideological and political education and adopting multimodal blended teaching approaches.

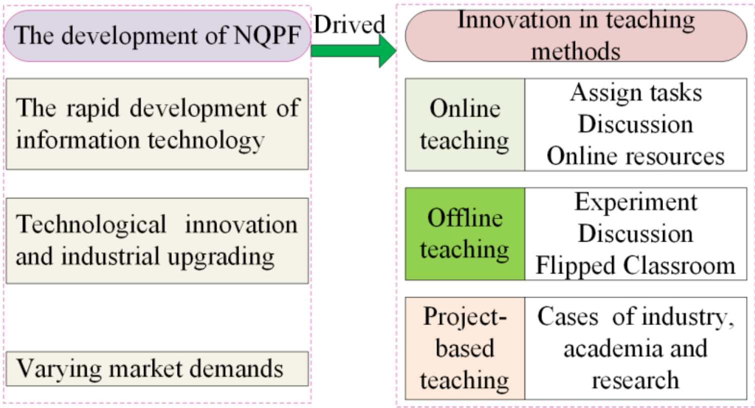

Figure 1. The framework of multi-mode blended teaching

Driven by the development of NQPF, the curriculum integrates cutting-edge case studies, online teaching platforms, and software simulations to establish a multi-modal blended teaching model (Muhammad & Theresa, 2019; Wei, 2023). This model combines online-offline hybrid instruction with integrated theory-practice pedagogy, specifically tailored for students in New Energy Science and Engineering. As illustrated in Figure 1, the redesigned teaching framework is oriented toward ideological and moral education objectives, emphasizing the integration of online and offline learning and the synergy of industry-academia-research collaboration.

Online components includes live-streamed lectures, video courses, and online discussions, providing students with flexible learning time and abundant learning resources; offline components, on the other hand, enhances students' practical abilities and teamwork spirit through classroom lectures, practical activities and seminars. Besides, the flipped classroom is incorporated to enable students to master knowledge through self-study and deepen the interactive sessions in class.

Power electronics is a highly interdisciplinary field that encompasses power conversion, control, and the application of various power electronic devices. To cultivate students' practical skills and innovative thinking, industry-academia-research collaboration is leveraged to integrate real-world case studies into power electronics courses (Huimin Shen & Kangming Liu, 2024). Through the analysis and practical application of real-world cases, students gain intuitive insights into complex theoretical concepts and enhance their problem-solving capabilities (Ke Wang, Fei Li, Shengying Yang et al. ,2024). This paper incorporates case studies closely tied to new energy technologies, such as photovoltaic power generation systems, electric vehicle drive systems, and smart grid control systems, into specific teaching practices.

By selecting photovoltaic power generation systems as a case study, students will learn about the design and optimization methods of PV systems through explanations of their basic structure, operational principles, and control strategies. Through simulation and experimentation, the performance of different control strategies will be validated, enhancing students' comprehension and mastery of photovoltaic power generation systems. Select the electric drive system of electric vehicles as a case study to explain technologies such as motor drive, battery management, and energy regeneration. Through practical case analysis, enable students to understand the design requirements and optimization methodologies for electric vehicle drive systems, and validate the performance of the drive system through experimental or simulation-based approaches. Select the distributed energy management system (DEMS) in smart grids as a case study to explain its structure, functions, and control strategies. Through case analysis and experiments, students will gain insights into the application of power electronics technology in smart grids and enhance their mastery of smart grid technologies.

The application of case-based teaching methods in Power Electronics courses can effectively enhance students' theoretical knowledge and practical skills. By analyzing real-world cases and conducting experimental operations, students gain a more intuitive understanding of complex theoretical concepts, while cultivating their problem-solving abilities and innovative mindset. In future teaching practices, it is essential to continuously refine and optimize case-based teaching approaches, integrating the latest technological advancements and practical engineering applications. This will lay a solid foundation for cultivating high-caliber professionals in the field of Power Electronics Technology

Through this new multi-modal blended teaching, utilizing comprehensive educational approaches, we aim to meet the diverse learning needs of students, cultivate their innovative capabilities and technological literacy, and focus on their all-round development. This approach helps students achieve comprehensive growth in five dimensions: knowledge, skills, health, practical abilities, and ideological development, enabling them to become outstanding talents with well-rounded moral, intellectual, physical, aesthetic, and labor development, thereby laying a solid foundation for advancing NQPF.

Enrich curriculum resources

The development of teaching resources for the Power Electronics course plays a critical role in the teaching process. The Power Electronics course suffers from textbook content detached from practical applications, outdated experimental equipment, and rigid, unchanging experimental content and teaching cases. Systematic and modernized teaching resources facilitate students' in-depth understanding of theoretical knowledge and enhance their practical capabilities. Under the context of NQPF, to meet the rapidly evolving demands of power electronics technology, a scientific and comprehensive teaching resource system must be established (Doni et al, 2023). This paper explores the development of teaching resources for the Power Electronics course from four aspects: teaching materials, experimental equipment, digital resources, and faculty teams. Building upon existing course materials, experimental equipment (Xin & Yanhui 2020), and digital resources, efforts should focus on strengthening three core libraries: ideological education case library, simulation case library, project-based teaching case library, integrated experimental platform and advanced experimental equipment.

The development of teaching materials encompasses foundational textbooks, specialized textbooks, and supplementary resources. Foundational textbooks serve as the core of teaching resource development, providing systematic and fundamental theoretical knowledge. Priority should be given to texts that comprehensively cover core components, principles of power electronics technology, and their applications—such as Power Electronics Technology, Fundamentals of Power Electronics, and Modern Power Electronics. These resources, characterized by scientific rigor, systematic structure, and cutting-edge relevance, help students establish a solid theoretical foundation. Specialized textbooks focus on in-depth research and applications within specific domains, including renewable energy generation systems, electric vehicle drive technologies, and smart grids. Academic teams may author subject-specific texts (e.g., New Energy Power Electronics Technology or Power Electronics for Electric Vehicles) that integrate the latest technological advancements, enabling students to master advanced knowledge in specialized fields. Supplementary resources encompass practical case repositories, experimental guidebooks, and technical application references, such as Power Electronics Experiment Manuals and Case Studies in Power Electronics Applications. These materials deliver rich practical resources to familiarize students with experimental operations and real-world applications of power electronics technology.

The construction of experimental facilities includes basic experimental equipment, comprehensive experimental platforms and advanced experimental equipment. Basic experimental equipment is used for fundamental experiments and theoretical verification, including power electronic device testers, circuit workbenches, and basic testing instruments (such as oscilloscopes, ammeters, and voltmeters). These devices support the design, construction, and testing of fundamental power electronic circuits, helping students master essential experimental skills. Strengthen the construction of comprehensive experimental platforms and advanced experimental equipment. The comprehensive experimental platform is used for comprehensive experiments and system design, equipped with power converters, inverters, rectifiers, DC converters and corresponding control systems, which support the experiments and debugging of complex power electronic systems and cultivate students' comprehensive design abilities. The advanced experimental equipment is used for the research of cutting-edge technologies and new applications, including new energy power generation simulation devices, smart grid experimental platforms and electric vehicle power system experimental platforms. Through these devices, students can conduct experiments related to new energy and smart grids, simulate actual application scenarios, and enhance their understanding and mastery of cutting-edge technologies.

The development of digital resources should also encompass online courses, virtual simulation experiments, digital textbooks, and resource databases. Online courses provide flexible and diverse learning pathways for students through MOOC platforms and university-owned online learning platforms. They cover foundational courses, specialized curricula, and cutting-edge technical topics in Power Electronics Technology. Online courses facilitate self-directed learning and knowledge consolidation. Virtual simulation experiments offer safe and repeatable experimental environments using simulation software such as MATLAB/Simulink, PSIM, and PSpice. They support the modeling, simulation, and analysis of power electronic circuits and systems. Through virtual experiments, students can design and debug complex systems in simulated settings. Digital textbooks and resource databases enable students to access learning materials anytime, anywhere, including e-books, courseware, video tutorials, lab manuals, and relevant research papers. Such resources are delivered via university digital libraries and academic resource databases, providing students with rich learning materials. This integrated approach ensures resource development meets evolving educational demands while fostering innovation and practical competency in power electronics education.

Teacher team development encompasses the construction of professional faculty, dual-qualified teachers, and teaching teams. Professional faculty development focuses on advancing subject-matter expertise through specialized training and academic collaborations (Jiajia Yuan, Sike Wang & Jingsi Gao, 2025). Dual-qualified teachers combines theoretical proficiency with practical industry experience. Teachers engage in enterprise internships, obtain vocational certifications, and participate in industry-academia projects to bridge theory-practice gaps. Teams adopt modular teaching methods and competency-based assessments, improving student readiness for industry certifications.Teaching team development aims to enhance overall instructional quality and research capabilities. By regularly organizing teacher training, academic exchanges, and part-time positions in enterprises, educators stay abreast of cutting-edge technological trends and industry demands, thereby promoting the organic integration of teaching and research. Industry-driven projects lead to patents and curriculum upgrades. This integrated approach ensures teacher teams remain dynamic, industry-relevant, and pedagogically innovative.

Build cases of ideological and political education in courses. To address various ideological education themes, we have designed the following case studies for the "Power Electronics Technology" course: applications in renewable energy, CRRC's high-power IGBT, west-east electricity transfer project, charger design innovations, ultra-high voltage transmission projects, comparative analysis of chopper circuit characteristics, voltage-regulated motor speed control systems, cumulative nature of technological breakthroughs, rigorous experimental processes, simulation designs for cutting-edge challenges, and renewable energy's role in global climate governance. These ideological and political cases should be subtly integrated into the course content through methods such as pre-class online guidance, classroom case introduction, classroom case discussion, classroom summary analysis, post-class extension learning, post-class experiments, post-class simulation design, and project-driven teaching.

Enrich simulation cases. Although tools like MATLAB/Simulink can compensate for the limitations of physical experiments, the current simulation case library remains underdeveloped and loosely integrated with the curriculum. Building upon existing simple circuit simulation cases, we propose incorporating practical application systems—such as smartphone chargers and electric vehicle charging stations—through interdisciplinary integration, and systematically embedding these into the core teaching framework.

To construct project-based teaching cases, we integrate hotspot industrial applications into project-based learning. For instance, in the rectification circuit, knowledge about new energy electric vehicle charging stations is introduced to convert alternating current into the direct current required by the batteries of new energy vehicles; in the inverter circuit, knowledge about the on-board power supply for high-speed rail is incorporated to convert direct current into alternating current of different amplitudes needed by various loads; in the DC chopping circuit, core knowledge of electric vehicle speed regulation, namely the adjustment of power supply voltage magnitude, is introduced; in the AC voltage regulation circuit, the contactless voltage regulation method of energy-saving street lamps in practice is introduced; in the PWM control technology section, a switch regulator is introduced for dimming.

Five Assessments methods

To evaluate students' learning outcomes and competencies, diversified and scientifically sound performance assessment methods should be established (Zhao, 2021). Under the context of NQPF, this study adopts multidimensional evaluation methods to comprehensively and objectively assess students' integrated competencies and skill levels. Aligned with the restructured curriculum goals and generative AI technology (Jia, 2025), we shift toward a talent cultivation-oriented evaluation philosophy, promoting cultivation through evaluation, and leveraging comprehensive competency assessment to drive innovative talent development. The evaluation framework encompasses multiple dimensions: knowledge mastery, practical skills, innovative capabilities, interdisciplinary competence, team collaboration, ethical and social responsibility, global perspectives.

This paper has established an intelligent evaluation index system. The proportions of knowledge goals, ability goals, and quality goals are 50%, 30%, and 20% respectively. The more detailed process-based assessment methods encompass five key aspects: class discussions, specialized reports, simulation experiments, hands-on laboratory experiments, and theoretical examinations. The objectives, format, content requirements, percentages, and supported teaching objectives of each assessment method are shown in Table 1.

Table 1. Diversified assessment methods

Assessment methods	Objectives	Format	Content requirements	Percentage	Supported teaching objectives
Class discussions	By discussing hot topics, cultivate students' conviction in serving the country through science and technology.	Classroom discussions and study notes.	This includes the students' interaction during class, their contributions in group discussions, and the completion of class assignments.	20%	TO III
Specialized reports	Assessing students' topic engagement and teamwork spirit.	Production and presentation of the special report PPT.	Self-study content, division of labor details, writing of special reports, and creation of PPTs.	10%	TO II
Simulation experiments	Assess students' understanding and design capabilities for power electronic systems through computer simulation software.	Simulation model presentation, simulation result analysis and reports	Using simulation tools such as MATLAB/Simulink, the working process of the actual power electronic system can be simulated.	10%	TO II
Hands-on experiments	Assess students' hands-on skills, experimental design ability, and analysis skills of experimental results.	Experimental reports, experimental operation examinations, experimental design plans.	Experimental principles, experimental procedures, data processing, and analysis of experimental results, etc.	10%	TO II
Theoretical examinations	Assess students' mastery of fundamental concepts, principles, and theoretical knowledge.	Test paper	Basic knowledge, formula derivation, short-answer questions, drawing questions and calculation questions.	50%	TO I

The scores for classroom discussions are derived from observation and note-taking scores, those for specialized reports and simulation experiments come from document analysis, scores for hands-on laboratory experiments are based on observation, and scores for theoretical examinations are derived from achievement scores. Assume that a student's grades for the theoretical examination, hands-on experiment, simulation experiment, thematic report, and class discussion are A1, B1, B2, B3, and C1 respectively. The achievement degree of each teaching objective for this student can be calculated using the mathematical expression below.

$$r_1 = \frac{A1 \times 0.5}{50} \tag{1}$$

$$r_2 = \frac{B1 \times 0.1 + B2 \times 0.1 + B3 \times 0.1}{30} \tag{2}$$

$$r_3 = \frac{C1 \times 0.2}{20} \tag{3}$$

Where r_1 is the achievement degree of TO I, r_2 is the achievement degree of TO II, and r_3 is the achievement degree of TO III. The overall objective achievement degree can be calculated using Equation (4). The value of r determines the achievement degree of students regarding the teaching objectives. A value closer to 1 indicates better fulfillment, while a value less than 0.6 signifies failure to meet the target.

$$r = r_1 \times 0.5 + r_2 \times 0.3 + r_1 \times 0.2 \tag{4}$$

The main feature is that generative AI is incorporated in the evaluation of students' abilities. AI is used to record learning trajectories and quantify non-cognitive indicators such as classroom participation and cooperation ability. Especially in the evaluation of quality abilities, the use of generative AI can more objectively evaluate students' teamwork, ethical and social responsibility, and international perspective. Through this measure, the key abilities that students should possess can be comprehensively understood and evaluated, providing solid support for innovative talents for their career development and the continuous progress of the industry. Meanwhile, this research adopts a prudent, innovative, and responsible approach to the application of generative AI, firmly keeping the steering wheel of assessment and the initiative of value judgment in the hands of teachers. It strives to leverage cutting-edge technological achievements while upholding the educational essence of evaluation and the integrity baseline of academic research.

Analysis of the effectiveness of curriculum construction

The students from both 2022 and 2023 grades of the New Energy Science and Engineering program at Lanzhou City University are labelled as example, the effective of the newly proposed curriculum system is analyzed in this study. Class 221 (2022 grade, 50 students) adopted the old curriculum system, while Class 231 (2023 grade, 45 students) adopted the proposed curriculum system in this paper, while all other conditions remained consistent. Classes 221 and 231 were taught by the same teacher. For the five assessment components, the overall objective achievement degree of each student was calculated using Eqs. (1)~(4). The objective achievement degrees for Classes 221 and 231 are illustreated in Figure 2 and Figure 3, respectively.

The average objective achievement degree of each class was calculated. It was found that the average achievement degree of Class 231 increased by approximately 24% compared to that of Class 221. As shown in Figure 3, over 94% of the 2023 cohort achieved strong objective attainment, while 6% attained moderate results. The distribution points of individual attainment in Figure 3 are densely clustered, indicating that after the curriculum system construction of "Power Electronics Technology" was empowered by NQPF, students have a better grasp of the overall course content, and students' overall capabilities have been enhanced.

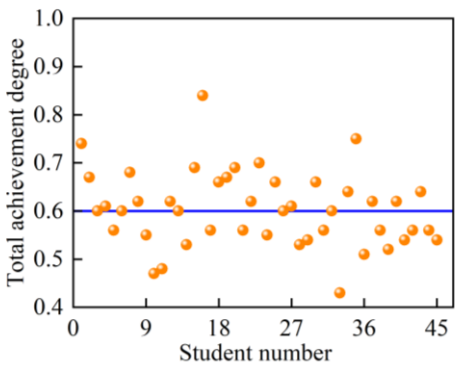

Figure 2. Course total attainment degrees for the 2022 grade

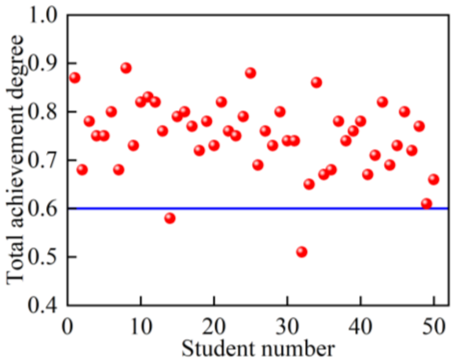

Figure 3. Course total attainment degrees for the 2023 grade

Through the implementation of curriculum-based ideological and political education, the class engagement and competition award rates of the 2023 grade have improved. The penetration rate of renewable energy-related topics in self-study reports has also increased. Survey results indicate that 90% of students expressed willingness to pursue careers in national key fields such as new energy and power grids within their capabilities. This demonstrates that, by aligning with the development of China's NQPF and through measures such as restructuring teaching content, innovating teaching methods, enhancing teaching resources, and improving assessment methods, the quality of student cultivation has been effectively enhanced.

The implementation of this project have enhanced students' proficiency in using simulation software and potentially stimulated their active engagement in disciplinary competitions and practical projects. This engagement correlated with the development of diverse technology-driven works aligned with course objectives. Throughout this process, students demonstrated solid professional knowledge and strong ideological-political literacy. Their participation in competitions may have contributed to both outstanding outcomes and a deeper understanding of specialized knowledge, while also reinforcing their commitment to ideological education. These accomplishments may be interpreted as an indicator of students' individual capabilities, offering preliminary support for the role of new quality productive forces in empowering the Power Electronics Technology curriculum system.

Conclusion

The course "Power Electronics Technology" plays a crucial role in cultivating talent for the new energy sector. In alignment with the development of China's NQPF, this paper aims to reconstruct the educational paradigm of the "Power Electronics Technology" course. Building upon three teaching objectives, it proposes five teaching reform measures, five assessment methods, and a calculation method for objective attainment. Through anchoring industrial demands, driving with digital and intelligent technologies, and promoting interdisciplinary integration, it achieves comprehensive innovation across the entire chain from course content to evaluation methods.

We implemented the new curriculum system for the 2023 grade of students. Compared to the 2022 grade, which used the old curriculum system, the average course attainment degree for the 2023 grade increased by 24%. Through the implementation of curriculum-based ideological and political education, the class engagement and competition award rates of the 2023 grade have improved. The penetration rate of renewable energy-related topics in self-study reports has also increased. Survey results indicate that 90% of students expressed willingness to pursue careers in national key fields such as new energy and power grids within their capabilities. This demonstrates that, by aligning with the development of China's NQPF and through measures such as restructuring teaching content, innovating teaching methods, enhancing teaching resources, and improving assessment methods, the quality of student cultivation has been effectively enhanced.

In future teaching practices, we will continuously optimize the teaching content of the "Power Electronics Technology" course and explore innovative pedagogical approaches aligned with technological development needs. Simultaneously, we will refine and innovate the teaching resource system to provide robust support for cultivating power electronics professionals. Furthermore, we will integrate cutting-edge technologies and educational philosophies to enhance course evaluation methods, deepen the application of AI large models in teaching, dynamically update cutting-edge cases such as "energy transition" and "intelligent manufacturing," and drive the continuous improvement and innovation of the course evaluation system. This reform paradigm can be extended to more universities, offering a replicable Chinese solution for engineering education.

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Author (s) Contribution Rate

The first author contributed 80%, the second author 10%, and the third author 10%.

Ethical Approval

For this study, approval was received from the Lanzhou City University Educational Sciences Ethics Committee with the decision numbered 2025/1 and dated 06/03/2025.

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