Research on an OBE-Based Project and Ideological-Political Teaching Model for Power Electronics Technology Courses

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Abstract: To achieve the overall goal of cultivating application-oriented engineering and technical talents with patriotism, social responsibility, and professional ethics through the Power Electronics Technology course, this study carries out a teaching reform based on an outcome-oriented and project-driven engineering education concept, with the organic integration of ideological and political education. It explores a teaching reform approach for the Power Electronics Technology course driven by project-based thinking and ideological-political elements under the guidance of Outcome-Based Education (OBE). Reform practices have been implemented in terms of teaching content, teaching methods, and instructional design. Guided by OBE and the principles of engineering education, teaching objectives are constructed and the teaching model is designed in a backward manner. With projects as the main thread, teaching is implemented through a blended instructional design that combines laboratory work, virtual simulation, and both online and offline learning. Practice has shown that the implementation of this teaching reform, driven by project thinking and ideological-political elements under the OBE framework, not only enriches the teaching content of the Power Electronics Technology course, but also effectively stimulates students' interest in learning power electronics technology, enhances their practical abilities and overall competence, and provides a useful reference for further curriculum reform of the Power Electronics Technology course.

Keywords: OBE; Ideological and Political Education; Project-Based Thinking

1. Introduction

Power Electronics Technology is a core course of the Electrical Engineering and Automation major, mainly teaching power electronic devices, the four basic power conversion technologies, PWM control technology, soft-switching technology, and other related contents [1,2]. Power electronics technology has been widely applied in various fields of industrial production, including UPS power supplies for data centers, motor speed control systems, high-voltage direct current (HVDC) transmission in the power industry, active power filters, and reactive power compensators [3].

In the entire new energy industry, including photovoltaic power generation, wind power, and the related equipment manufacturing sector, there is an urgent demand for innovative and application-oriented talents who possess and master power electronics technology. Therefore, how to carry out curriculum reform for the Power Electronics Technology course, strengthen students' overall quality education, enhance their practical engineering application ability, and cultivate professionals with patriotism, a sense of social responsibility, professional ethics, innovative capability, and professional skills that meet enterprise needs has become a key focus of universities [4].

2. The Necessity of Curriculum Reform in Power Electronics Technology

The traditional Power Electronics Technology course mainly adopts a one-way, cramming-style teaching model in which classroom lecturing dominates and students passively receive knowledge, supplemented only by experimental teaching and course design. The course involves a wide variety of circuit topologies, complex waveforms, and difficult calculations. If students have a weak foundation in courses such as Advanced Mathematics, Analog Electronics, and Circuit Fundamentals, a cramming-style teaching approach in class will cause teachers to lack targeted guidance in the explanation, analysis, and application of key knowledge points. As a result, it is difficult for students to improve their enthusiasm for learning and their initiative in self-study, and their willingness to actively participate in classroom teaching is low.

At the same time, students only have a superficial understanding of how to apply what they have learned. During experiments, they merely follow the procedural steps to wire circuits and mechanically record data, which does little to deepen their practical application ability [3].

The OBE concept is oriented toward students' learning outcomes, and project-based teaching is student-centered with teachers playing a supporting role. By integrating real engineering projects with virtual simulation, it can fully stimulate students' initiative, enthusiasm, and creativity, ultimately enabling them to reconstruct knowledge and fostering in them a spirit of continuous exploration and innovation.

Replacing independent ideological and political theory courses with "curriculum-based ideological and political education" is a key initiative that meets the needs of national and local economic development and is crucial for cultivating high-quality, application-oriented engineering and technical talents.

Therefore, based on the OBE concept, using project-based teaching carriers, life-oriented examples, and practical circuits, this reform integrates real engineering projects with virtual simulation and incorporates ideological and political education. It actively explores teaching reform of the Power Electronics Technology course, emphasizes project practice, and organically combines theoretical knowledge with engineering applications to build a curriculum system featuring "outcome orientation, student-centeredness, and continuous improvement." This is a necessary means to cultivate high-quality talents with application ability and innovative spirit, who also possess patriotism, a sense of social responsibility, and professional ethics [3].

3. Teaching Design of Power Electronics Technology Based on OBE Concept, Project Thinking, and Ideological and Political Elements

3.1 Selection and Design of Teaching Projects

Our university's Power Electronics Technology course reform has shifted from traditional teaching to project-based teaching. The knowledge points are explained in modules, based on an engineering education model and project-oriented teaching. The course utilizes a blended teaching approach, combining online and offline methods, and adopts reverse design for course objectives and content[5]. The course has designed a series of teaching projects closely aligned with the core content of the course (as shown in Figure 1), which is the key to the teaching reform[6].

The selection of teaching projects for the "Power Electronics Technology" course begins at the macro level, first clarifying the teaching mission and overall objectives of the course. Then, the key knowledge is broken down into several independent, implementable modules. For each module, real-world power engineering cases with matching difficulty levels are selected, and demand analysis and theoretical support systems are designed around the cases .

Project resources are integrated into classroom practice, with continuous iteration and optimization of project content and teaching strategies based on real-time feedback on teaching effectiveness[5]. Meanwhile, power supply projects have a certain degree of comprehensiveness and design complexity, so MATLAB simulation projects are added. Based on different circuit topologies, a series of classic beginner circuits are selected for progressive simulation training, starting from simple to more complex[6].

Once the virtual-real integrated power supply projects are determined, learning groups of 5–6 people are formed to explore different project themes[7]. The tasks within each group are broken down into individual responsibilities, with contribution weights assigned according to the difficulty gradient. After completing their tasks according to project specifications, students present their results, and teachers assess the grades based on the project completion level and individual contribution ratio[8].

3.2 Ideological and Political Education Design

Ideological and political education (IPE) has gradually replaced the standalone ideological and political courses, becoming the mainstream approach to education. In the Power Electronics Technology classroom, teachers need to deeply explore the ideological and political elements within the professional content and seamlessly integrate value guidance into knowledge delivery. This aims to achieve the simultaneous advancement of ideological and political education and technical skill development, which has become a new challenge for teachers in the engineering field.

Taking the "Power Electronics Technology" course as an example, teachers can embed ideological and political goals throughout the entire teaching process, from project-based tasks and life-related cases to circuits with engineering value. The ideological and political integration teaching design framework is shown in Figure 2. Currently, the ideological and political development in Power Electronics Technology courses is still in its early stages, and there is no unified model to follow, which leads to fragmented educational chains and unclear themes. Teachers must align with the professional training plan and course standards, embedding ideological and political elements throughout the entire course cycle, ensuring they are implemented in every teaching segment. Additionally, this should span across the classroom, online and offline, as well as campus and society, to create a multidimensional, collaborative educational framework. Based on this, a systematic design framework for ideological and political education in Power Electronics Technology courses is proposed, as shown in Figure 3 [9].

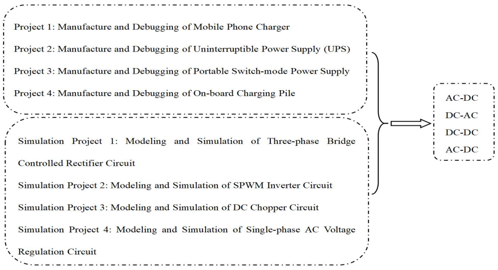

Figure 1. Project-Based Teaching Case for Power Electronics Technology

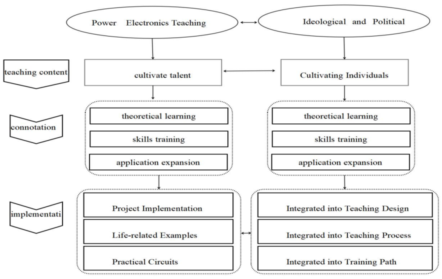

Figure 2. Teaching Design Framework for Power Electronics Technology Course Integrated with Ideological and Political Elements

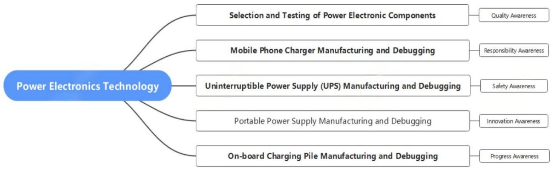

Figure 3. Systematic Framework of Ideological and Political Education for the Power Electronics Technology Course

4. Classroom Teaching and Management of Power Electronics Technology Integrating Project Thinking and Ideological and Political Elements under the OBE Concept

To align with our university's goal of cultivating application-oriented talents, the original teaching content has been adjusted. The course now adopts a project-based teaching model integrating ideological and political elements, together with a blended teaching design that combines online and offline instruction. Emphasis is placed on project practice and outcome production, so that theoretical knowledge is organically integrated with engineering applications. The project-based teaching model with embedded ideological and political education is implemented in three stages.

4.1 Before Class: Task-Driven, Self-Directed Preview

At the beginning of the semester, teachers design several "progressive" engineering projects according to the course objectives and chapter structure, and release task sheets, micro-videos and reading lists via platforms such as Xuexitong. Students form groups of 5–6 members, select projects online, independently search device manuals and ideological-political materials, and complete knowledge preview and preliminary scheme conception. The platform automatically records their preview trajectories and discussion intensity, providing teachers with accurate learning analytics.

4.2 During Class: Group Discussion with Teacher–Student and Student–Student Interaction

The classroom is the main front for education and teaching. Teachers not only need to impart professional knowledge and cultivate professional skills, but also need to instill the spirit of craftsmanship. In class, teachers explain key knowledge points around the cases and guide students in solving difficult problems in the projects. At the same time, students are guided to conduct group discussions and begin detailed scheme design. This fully stimulates students' learning interest and initiative, thereby improving their ability to analyze and solve problems. Meanwhile, the process statistics on Xuexitong help teachers complete course evaluation and assessment in a scientific and effective way, and further improve the teaching design [10].

4.3 After Class: Integration of Virtual and Real, Outcome Assessment

Offline: Students book open laboratories and use oscilloscopes, power analyzers and other equipment to complete hardware debugging; teachers answer questions and emphasize safety norms and the spirit of craftsmanship pursuing perfection.

Online: Group members who cannot be present conduct simulation verification with simulation software to ensure that all members participate deeply.

Assessment: A three-dimensional assessment system of "product + defense + reflection" is adopted—product accounts for 60% (function, efficiency, innovation), defense 20% (teamwork, integration of ideological and political elements), and individual reflection report 20%.

5. Implementation Effects and Promotion Value

5.1 Teaching Implementation Effect Analysis

To verify the effectiveness of the teaching model driven by project-based thinking and ideological and political elements under the OBE (Outcome-Based Education) philosophy, this study selected two programs for comparison: the 2021 Automation major in the Power Electronics Technology course as the control group, and the 2021 Electrical Engineering and Automation major with the reformed Power Electronics Technology course as the experimental group. Through a multidimensional data analysis, including course grades, student interest and classroom participation, and achievement of OBE graduation requirement indicators, the teaching effectiveness was quantitatively assessed [11,12].

(1) Course Grades and Pass Rate

The statistical results show that the average course grade for students who did not undergo reform was 65.23 points, while the average grade for students in the reformed group was 68.73 points. The reform reduced the failure rate from 32.56% to 28%, and the excellent rate increased from 13.95% to 23.5%. This indicates that the project-driven and blended teaching model has a significant effect in helping students solidify their foundational knowledge and improve their comprehensive application abilities [11].

(2) Learning Interest and Classroom Participation

In this study, based on existing teaching practices and related research results, the new teaching model shows a clear advantage in enhancing student interest in learning and classroom participation. Literature analysis shows that project-based teaching under the OBE philosophy has been validated in multiple educational cases, demonstrating its effectiveness in motivating students' learning and engagement. For example, existing studies show that the reformed classroom teaching has significantly increased students' interest in the "Power Electronics Technology" course and promoted more active participation in classroom discussions and project presentations [11,12].

Moreover, with the introduction of project-driven teaching, students' practical operation skills and teamwork abilities have been strengthened, further stimulating their active participation in class. Based on existing practice results, the implementation of the new model is likely to show a significant improvement in student interest and classroom participation in future surveys.

(3) Achievement of OBE Indicators

Based on the course's alignment with graduation requirements, three indicators were selected for comparison: "Mastering the analysis and design methods of power electronic conversion circuits," "Possessing the ability to solve practical engineering problems in power electronics," and "Having professional ethics and social responsibility awareness." The results show that the achievement rate of these three indicators increased from the range of 0.8–0.89 under traditional teaching to the range of 0.90–0.99 under the reformed teaching. The overall achievement level has significantly improved, indicating that the outcome-based reverse design and project-driven implementation path better supports the achievement of the professional talent training goals [12,13].

5.2 Improvement in Students' Comprehensive Abilities and Competition Results

During the project-based teaching process, students are required to complete the entire engineering process, including requirement analysis, solution design, simulation verification, hardware construction, debugging and testing, and final presentation. Based on the comprehensive evaluation scores of project reports, class presentations, and process assessments, the proportion of students in the experimental group with project evaluations above the passing level increased from 88.37% (before the reform) to 96%. At the same time, students' abilities in problem analysis, teamwork, data retrieval, and technical expression have also significantly improved, which aligns with conclusions from related studies on the construction of practical teaching models based on the OBE engineering education philosophy [11,12].

Relying on course project training, students' enthusiasm for participating in subject competitions has been significantly enhanced. The number of students from the Electrical Engineering and Automation major participating in relevant academic competitions, such as the "Challenge Cup," "Electronic Design Competition," and "Siemens Cup," is significantly higher than that of the Automation major. Some of the course project results, after further optimization, were successfully transformed into competition works or university innovation and entrepreneurship training projects, reflecting a good connection between course teaching and innovation practice [12,13].

5.3 Promotion and Application Value of the Teaching Model

Practice has shown that the teaching reform of the Power Electronics Technology course, driven by project-based thinking and ideological and political elements under the OBE philosophy, not only significantly improved students' mastery of course knowledge and engineering practice abilities but also produced good results in cultivating patriotism, social responsibility, and professional ethics [13]. This model has strong replicability and applicability in aspects such as teaching goal design, project content organization, integration of ideological and political elements, and blended online-offline implementation.

Currently, the "OBE + Project-Based + Ideological and Political Education + Blended Teaching" framework has been attempted in other related courses such as "Electrical Control and PLC Technology," "Microcontroller Principles and Interface Technology," and "Power Drive and Automatic Control," gradually constructing an integrated training system for electrical courses that covers "basic courses—core professional courses—comprehensive practical training." This provides valuable experience for the future promotion of engineering education professional certification and the reform of applied talent cultivation models on a larger scale [11,13].

6. Conclusion

To address the issues of outdated teaching models, a disconnect between content and competency development, and insufficient student initiative in traditional "Power Electronics Technology" courses, this paper constructs a course teaching model based on the OBE (Outcome-Based Education) philosophy. This model integrates "outcome-driven, project-based, ideological and political guidance, and virtual-physical integration". By restructuring the course teaching objectives and content system, designing progressive engineering projects, and organically incorporating ideological and political elements throughout the teaching process, a three-stage implementation path has been formed: pre-class task-driven, in-class collaborative exploration, and post-class virtual-physical combined consolidation and enhancement.

Practice shows that this teaching model not only enriches the course content, effectively enhances students' interest in learning and classroom participation, but also significantly improves their circuit analysis skills, engineering practice abilities, and teamwork capabilities. It helps students gradually develop a sense of patriotism, social responsibility, and professional ethics, achieving the coordinated integration of professional knowledge learning and value formation. This provides valuable experience for the cultivation of applied engineering talents .

However, there are still certain shortcomings in this study, such as the need for further refinement of the course evaluation indicator system and the deepening of coordination with the OBE talent cultivation system at the course group and program levels. In the next step, continuous tracking and closed-loop improvement of teaching effectiveness will be carried out by incorporating data from more student cohorts. The project content and integration of ideological and political elements will be further optimized, and this teaching model will be explored and promoted in other core courses of electrical and related majors, aiming to form an integrated engineering education curriculum system that covers "basic courses—core professional courses—comprehensive practice" .

Acknowledgments

This study is a phased achievement of the teaching reform project of Guangdong University of Science and Technology, titled “Exploration and Practice of a Teaching Model for the Power Electronics Technology Course Driven by Project-Based Thinking and Ideological-Political Elements under the OBE Concept” (Project No. GKZLGC2023040). The authors would like to express their sincere gratitude to Guangdong University of Science and Technology for its generous support of this project.

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