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Innovation and Exploration of Teaching Mode for Energy and Power Engineering Driven by the OBE Concept

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Abstract: Outcome-based education (OBE) takes students' learning outcomes as the core, emphasizing goal-oriented design and continuous improvement, so as to enhance students' learning and practical abilities. The OBE concept has injected vitality into the teaching reform of energy and power engineering, advocating employment-oriented orientation, optimizing teaching objectives, continuously improving teaching modes, perfecting teaching evaluation systems, and comprehensively improving curriculum teaching quality. This paper analyzes the construction principles of the teaching mode for energy and power engineering under the OBE concept, dissects the current teaching situation, and explores innovative paths for the teaching mode. It elaborates from four aspects: accurately positioning talent training objectives, optimizing teaching content, carrying out project-based teaching, and continuously improving teaching and evaluation systems, aiming to improve the teaching and talent training quality of energy and power engineering.

Keywords: OBE education concept; Energy and power engineering; Teaching mode; Construction path

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1. Introduction

At present, China is in a critical period of energy structure transformation. The proposal of the "dual carbon" goal has promoted the rapid development of the energy industry toward cleanliness, low-carbon, and intelligence. Against this background, new energy industries such as wind power, photovoltaic power generation, and hydrogen energy have risen rapidly, putting forward higher requirements for energy and power talents. As an important cradle for cultivating energy and power talents, energy and power engineering should not only consolidate students' professional knowledge, but also cultivate their practical ability, innovation ability, ability to solve complex engineering problems, and interdisciplinary learning ability, so as to lay a solid talent foundation for the development of the new energy industry. Therefore, colleges and universities should integrate the outcome-based education (OBE) education concept into the teaching of energy and power engineering, promote the precise docking of curriculum teaching, talent training and industry demand, build a teaching mode with learning outcomes as the core, promote interdisciplinary integration, actively carry out interdisciplinary teaching, improve students' engineering practice ability, craftsmanship spirit and innovation ability, and achieve a win-win situation for curriculum teaching and talent training.

2. Construction principles of teaching mode for energy and power engineering under OBE concept

The core of the OBE concept is "outcome-oriented." The focus of teaching shifts from "what teachers teach" to "what students learn and what they can do," focusing on improving students' independent thinking ability, practical ability, and problem-solving ability [1]. The most prominent feature of OBE is goal orientation: all teaching activities are carried out around students' expected learning outcomes. Teaching methods are continuously improved according to students' learning status and knowledge mastery, teaching content and methods are dynamically adjusted, and a closed-loop mechanism of "evaluation–feedback–improvement–promotion" is formed to enhance students' comprehensive abilities.

2.1. Focus on students' learning outcomes

Teachers should define the learning outcomes to be achieved by students based on the characteristics of energy and power engineering and talent demand, formulate teaching objectives, methods, and evaluation around the outcomes, ensure that each teaching link is closely integrated with learning outcomes, guide students in deep learning, and improve their thinking, practical, and innovation abilities. Under the OBE concept, teachers should adhere to employment orientation, clarify expected learning outcomes, consolidate professional foundations, and improve post practical ability from theoretical and practical modules to help students complete learning goals [2].

2.2. Reverse design principle

Different from traditional teaching, OBE takes students' final learning outcomes as the starting point to reverse-deduce teaching objectives, content, methods, and evaluation, reflecting the reverse teaching principle. It is more conducive to implementing individualized education and student-centered concepts, stimulating learning interest and encouraging active participation, thus improving autonomous learning ability. For example, teachers formulate teaching objectives based on the development trend of new energy industry and cutting-edge research results of energy storage technology, optimize teaching content according to industry talent demand, clarify the professional skills that students should have after graduation, and design teaching cases reversely to promote the docking of talent training objectives with expected learning outcomes, so as to improve teaching and training quality [3].

3. Analysis of current teaching situation of energy and power engineering in universities

3.1. Disconnection between talent training objectives and industry demand

Many colleges and universities have vague talent training objectives for energy and power engineering. They fail to adjust objectives according to the transformation and upgrading of the energy industry under the "dual carbon" goal, and insufficiently reflect the professional skill requirements of new energy and energy storage. This leads to the disconnection between training objectives and industrial and enterprise demands, affecting teaching and talent quality [4]. In addition, some objectives lack outcome orientation and do not include new energy technologies such as wind power and photovoltaic power generation, making graduates unable to adapt to new energy enterprises quickly and reducing employment quality.

3.2. Imperfect curriculum system

The current curriculum system is incomplete. On the one hand, the class hours of theoretical and practical courses are unreasonably arranged, with emphasis on theory and neglect of practice. Practical courses are mostly verification experiments, lacking interdisciplinary, innovative, and comprehensive experiments, leading to a disconnection between practice and industrial development, which is not conducive to the development of scientific research spirit and practical ability [5]. On the other hand, curriculum content is updated slowly, with little explanation of new technologies such as hydrogen energy storage and transportation, virtual power plants, and digital twin, affecting students' understanding of new technologies. Poor connection between courses makes it difficult to form a complete knowledge system, reducing teaching quality.

3.3. Inadequate school-enterprise collaborative education mechanisms

The depth of school-enterprise cooperation in energy and power engineering is insufficient, limited to post internships and special lectures. There is a lack of in-depth cooperation in curriculum system construction, training base construction, and faculty team building, making it difficult to achieve the talent training goal of "integration of industry and education, unity of knowledge and practice," and restricting the development of practical ability [6]. In addition, enterprises do not participate in practical teaching, so it is difficult to guide students in engineering design and construction practice, limiting engineering practice ability and preventing students from achieving expected learning outcomes.

3.4. Lack of continuous improvement mechanisms in teaching evaluation system

The teaching evaluation indicators and methods are relatively single, mainly based on written examination scores and experimental assessment, with little evaluation of practical ability, innovation ability, and professional literacy. Process evaluation using big data and artificial intelligence is neglected, making it difficult to accurately analyze problems in learning and affecting personalized teaching quality. In addition, students and enterprise experts rarely participate in teaching evaluation, so problems cannot be found in time. The lack of a continuous improvement mechanism makes it impossible to form a closed loop of "evaluation–feedback–improvement," reducing teaching quality.

4. Construction path of teaching mode for energy and power engineering driven by OBE concept

4.1. Employment-oriented, accurate positioning of talent training objectives

OBE emphasizes "outcome orientation." It is necessary to clarify students' expected learning outcomes, reconstruct talent training objectives, focus on comprehensive ability cultivation, and further optimize teaching content and objectives to improve teaching and training quality. First, colleges should adhere to employment orientation, based on the "dual carbon" goal and energy industry transformation, clarify the professional skills and learning outcomes that students should achieve, and realize the "seamless connection" between training objectives and industry demand. They can investigate talent demand in emerging fields such as new energy power generation, carbon capture, and hydrogen storage to define professional knowledge, practical ability, and professional literacy [7]. For the new energy power generation industry, students should master core technologies and equipment operation and maintenance of wind power and photovoltaic power generation; for the energy storage industry, students should have skills in energy storage system design, equipment commissioning and maintenance. Second, refine training objectives and clarify expected learning outcomes from three dimensions: professional knowledge, practical ability, and professional literacy. In professional knowledge, students should master engineering thermodynamics, fluid mechanics, heat transfer, energy conversion and utilization, new energy technology, and energy storage technology. In professional skills, students should master energy engineering design, construction management, interdisciplinary practice, and teamwork. In professional literacy, students should have dedication, low-carbon awareness, craftsmanship, and innovation spirit [8].

4.2. Goal-led, careful optimization of curriculum teaching content

Teachers should adhere to goal guidance, based on learning outcome objectives, continuously optimize teaching content, promote the connection between teaching content and industrial development, let students timely understand new processes, technologies, and concepts in the energy industry, and help them achieve learning goals [9]. Taking the course *Thermal Measurement Technology* as an example, teachers can integrate the teaching content of two class hours: error analysis of different temperature measurement methods and layout and error analysis for different temperature requirements, present the relationship between knowledge points through mind maps, guide students to explore the characteristics, advantages, and disadvantages of different measurement methods, and analyze applicable measurement methods in different scenarios. In addition, teachers should break the barriers between courses, promote interdisciplinary integration, combine artificial intelligence, materials science, environmental science with energy and power courses, offer courses such as *Hydrogen Energy Storage*, *Virtual Power Plant*, and *Digital Twin Technology in Energy Industry*, guide students in interdisciplinary learning, and use artificial intelligence and digital twin technology to design engineering and construction schemes, so as to improve their ability to solve complex engineering problems and give play to the value of OBE [10].

4.3. Carrying out project-based teaching to improve students' comprehensive ability

Based on students' expected learning outcomes, teachers should invite enterprise experts to design project-based teaching plans, let students participate in the whole process of project design, implementation, acceptance, and evaluation, so as to promote the development of comprehensive abilities. Taking photovoltaic power generation technology as an example, enterprise experts and supervisors can design the installation and commissioning project of household photovoltaic power generation equipment in rural areas, encourage students to form groups freely, and cooperate to complete design drawings and construction schemes [11]. First, each group can analyze rural terrain and climate, reasonably select the installation position and inclination angle of solar panels, design construction schemes based on household income, control project costs, focus on optimizing equipment installation and commissioning schemes, improve operation stability, and reduce failure rate. During this process, groups can assemble and debug solar panels on campus, predict possible faults and formulate maintenance plans, master photovoltaic knowledge in practice, and improve practical ability and teamwork spirit [12]. Second, teachers can encourage mutual Q&A and evaluation among groups to cultivate modesty, pragmatism, and teamwork spirit. Finally, enterprise experts and teachers comment on each group's performance, point out problems, and give revision suggestions to help students optimize project schemes and achieve learning goals [13].

4.4. Continuously improving teaching methods and perfecting teaching evaluation system

Continuous improvement is a major feature of OBE, which helps teachers improve teaching methods and evaluation systems and lay a foundation for teaching quality. First, OBE is student-centered, requiring teachers to respect individual differences, break the "one-size-fits-all" teaching mode, carry out personalized teaching, and design learning tasks of different difficulty to meet personalized needs and enable every student to achieve expected learning outcomes [14]. Teachers should implement OBE, teach according to differences in learning needs, thinking, and practical ability, continuously improve methods based on learning effects, stimulate autonomous learning enthusiasm, encourage students to explore new knowledge and pay attention to industrial development trends, and improve professional skills and scientific spirit. Second, teachers can invite enterprise experts to participate in teaching evaluation, assess students' professional knowledge, professional literacy, practical ability and professional ethics, and find problems in growth in time; organize students to participate in teaching evaluation, anonymously evaluate teaching content, methods and teachers' ethics, improve teaching mode and evaluation system based on feedback, improve teaching quality, promote students' all-round development and help them achieve high-quality employment [15].

5. Conclusion

In short, colleges and universities should fully implement the OBE education concept, conduct thorough market research on the energy industry, focus on industrial transformation and upgrading and enterprise talent demand, continuously optimize the talent training objectives, teaching mode, and curriculum system of energy and power engineering, so as to improve students' professional knowledge, professional skills, and literacy and help them achieve expected learning outcomes. Schools should deepen the integration of industry and education, invite enterprise experts to participate in project-based teaching and teaching evaluation, build an "evaluation–feedback–improvement" mode, and improve teaching and talent training quality. In the future, colleges and universities should try to use artificial intelligence and virtual simulation technology to optimize the teaching mode of energy and power engineering, accelerate the transformation of intelligent teaching, and deliver more outstanding energy talents to society.

Disclosure statement

The authors declare no conflict of interest.

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