Exploration and Practice of Online and Offline Mixed Teaching Mode in Heat Pump Technology

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Abstract. For the current energy and power engineering professional "heat pump technology" status quo and the existence of problems were analyzed, proposed from the teaching content, practice links, assessment and evaluation of online and offline combination of hybrid teaching mode, achieved better teaching results.

Keywords: PracticeBlended teaching model; Heat pump technology; Exploration; Practice

1 Introductory Remarks

For most of the energy and power engineering majors (hereinafter referred to as energy and dynamics majors) in domestic colleges and universities, the course of "heat pump technology" is not a core course, and the majors do not pay enough attention to this course, and the research on this course is relatively small. Under the background of "double-carbon", heat pump technology bears an indispensable responsibility and obligation in national energy conservation and emission reduction. The course "Heat Pump Technology" covers the study of air source, water source, ground source, waste heat and waste heat. Learning this course is of great significance to students in the subsequent graduation design, employment and social responsibility for energy saving and emission reduction.

2 Problems in Teaching Heat Pump Technology

The course "Heat Pump Technology" is a professional development elective course for the energy and dynamics majors in our university. Its main content covers the basic theory of heat pump, air source, water source and soil source heat pump air conditioning system energy conversion and utilization and other professional knowledge. Through the study of this course, students majoring in Energy and Dynamics will be able to master the basic theoretical knowledge of heat pump, the structure, composition, working principle and operating characteristics of air source, water source and soil source heat pump air conditioning system; be familiar with the basic methods and applications of its engineering design; understand the development trend of domestic and

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international heat pump technology, research hotspots, and cutting-edge application technology in this field. In addition, the course is also committed to cultivating students' engineering thinking literacy and patriotic sentiment.

The course of "heat pump technology" in our school, majoring in energy dynamics, consists of 32 hours, all of which are theoretical courses, and the course is set to start in the 4th semester. The common teaching method is based on classroom lectures, interspersed with some engineering cases.

The following problems exist with the original teaching methods for this course:

2.1 Single Mode of Teaching

The current teaching mode of the course "Heat Pump Technology" relies mainly on classroom lectures, and although the course content is extensive, the number of hours is small. This leads to the difficulty faced by students in mastering the course content. At present, the knowledge mastered by the students is mainly based on theory, and the combination with actual engineering projects is limited, which is not conducive to cultivating students' practical innovation ability.

2.2 Knowledge Points are Scattered

The existing "heat pump technology" course content chapters and scattered knowledge. For example, the water source heat pump content knowledge involved in the chapter 1 heat pump classification, chapter 5 water source heat pump air conditioning system, chapter 7 water loop heat pump air conditioning system, chapter 10 water source heat pump technology application analysis, analysis of geothermal energy tail water source heat pump program as well as analysis of the water loop heat pump air conditioning system technology program and so on, resulting in a reduction in the motivation of students to learn.

2.3 Disconnect Between Theory and Practice

The course "Heat Pump Technology" is highly practical. If the course is limited to theoretical knowledge, students will lack practical engineering experience. This will make it more difficult for them to understand and master the theoretical knowledge they have learned, thus reducing their interest in learning. Due to the lack of direct perception and understanding of actual engineering projects, the learning process of students may become boring. At the same time, it is difficult for students to understand and master this knowledge in depth, which makes teaching ineffective and is not conducive to the development of students' application ability.

2.4 Simple Appraisal and Evaluation Mechanism

The traditional "heat pump technology" teaching evaluation system usually overemphasizes the degree of mastery of theoretical knowledge, while ignoring the cultivation

of practical application ability. The shortcomings of this evaluation system are mainly manifested in the disconnection between theory and practice, single evaluation method and the lack of feedback and improvement mechanism.

Traditional evaluation methods generally use quantitative evaluation in the form of exams, assignments, etc. Although this method can quantitatively assess students' learning outcomes, it is too simple and lacks a comprehensive assessment of the students' learning process, and therefore cannot comprehensively reflect the comprehensive quality of students.

3 Teaching Reform Measures and Effectiveness

Based on the current problems of the heat pump technology course and the importance of the application ability training for the reform of the heat pump technology course, we can improve the course content, strengthen the practical aspects, innovative teaching methods, improve the evaluation system, and incorporate the elements of the course of the ideological and political elements, so as to better cultivate the application ability of the students. This is of great significance for improving the comprehensive quality of students, enhancing their employment competitiveness, promoting the development of the discipline of heat pump technology as well as technological innovation.

3.1 Online and Offline Hybrid Teaching Model

The online-offline blended teaching mode focuses on students' pre-study and post-study through the Super Star Learning Pass platform. Teachers supplement and enhance the understanding of related knowledge through offline teaching [1]. This course reform combines online teaching resources with actual engineering case studies to broaden students' horizons and enhance their ability to analyze problems and practical innovation.

Online Teaching Resources

According to the students' learning situation and the requirements of the course syllabus, we have established online teaching resources for Heat Pump Technology. These include teaching materials such as courseware, lesson plans, course videos, pictures, and engineering cases, as shown in Figure 1. which are imported into the course on the Learning Access platform.

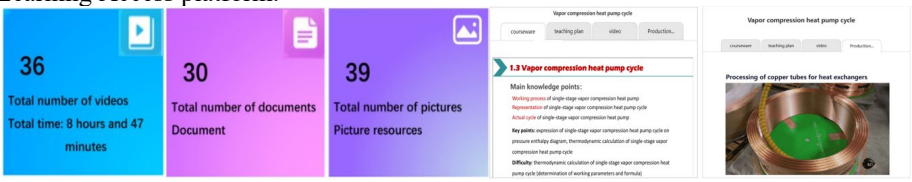
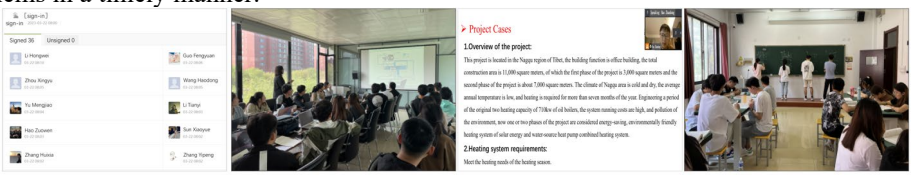


Fig. 1. Teaching resources

Pedagogical Implementation

Sign-in is released 10 minutes before the class, and students are reminded to complete the sign-in through the notification of Super Star Learning Pass. The course "Heat Pump Technology" is very targeted, in order to strengthen the training of students' practical skills, the teaching is carried out jointly by full-time teachers on campus and part-time staff of enterprises, and the online and offline classroom activities are combined [2], as shown in Figure 2. Through the activities in the Learning Pass, we can carry out exercises, quizzes and questions in the classroom to solve students' doubts and problems in a timely manner.



Online Attendance | Teachers on campus and part-time teachers from enterprises teach | Classroom Activities

Fig. 2. Teaching implementation

3.2 Improvement of Teaching Content

Through an in-depth analysis of the course content of "heat pump technology", we have integrated the teaching content into four main modules: heat pump fundamentals (basic theory) module, air-source heat pump system module, water-source heat pump system module and soil-source heat pump system module. These modules are independent and interrelated, covering all the theoretical and practical contents required for heat pump technology. Our goal is to cultivate application-oriented talents, so typical engineering cases are introduced into the classroom to guide the theoretical learning, so that the students can apply what they have learned and really make use of what they have learned. Students improve their ability to analyze and solve problems by taking part in competitions and participating in horizontal projects of enterprises.

3.3 Reinforcement of Practical Sessions

Integration of Theory and Practice

The theoretical knowledge of "heat pump technology" may seem a bit boring if it is only explained. Therefore, we need to closely combine it with real life, adding more engineering cases to enhance students' learning enthusiasm. For example, when introducing the air source heat pump system, we can start from the air source heat pump water heater and other practical applications, so as to let the students have a perceptual understanding first. Next, combined with specific cases, guide students to find out the system's "four big pieces", and draw the system diagram. Finally, gradually guide students to learn the structure of the equipment and the principle of operation.

Diversification of Practice Pathways

This course adopts the mode of combining on-campus practical training platform + Central Air Conditioning Industry College + off-campus internship base (school-enterprise cooperation enterprises) + online production video, and at the same time, hiring enterprise technicians as part-time teachers to co-teach in school, as shown in Figure 3. This not only broadens the students' horizons and brings them closer to enterprises, but also broadens their knowledge.

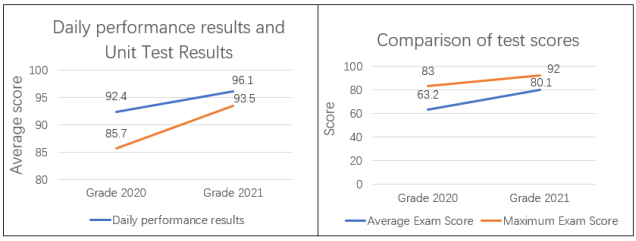
Students in the training room | Students in Central Air conditioning College | Students in school-enterprise cooperative enterprises

Fig. 3. Practical approach

At the same time, as many students as possible are involved in teachers' research projects, lateral projects, and comprehensive practice and innovation projects for university students, and students are guided to study and communicate with enterprises to enhance their knowledge of heat pump systems. Since September 2022, 23 students have participated in 6 teachers' lateral projects and 2 research projects; 15 students have participated in 3 comprehensive practice and innovation projects for university students.

Diversified Assessment and Evaluation

For the course "heat pump technology", the focus of the assessment of students' ability to use the theoretical knowledge to analyze and solve practical engineering problems. Adopt diversified assessment and evaluation methods, i.e., "M+N" assessment method, the specific content is as follows: 50% of the total assessment of the usual grades + 50% of the final exam. In the usual grade of the course, classroom performance accounts for 20%, online learning accounts for 30%, usual homework accounts for 30%, and practical skills account for 20%. Increase the proportion of process assessment to improve students' classroom participation [3]. Comprehensively assess students' learning outcomes from multiple perspectives. Realize the "all-round, multi-stage, comprehensive" process assessment plan based on the evaluation of students' abilities, so as to make the assessment and evaluation more diversified and scientific. At the same time, combining quantitative and qualitative assessment, it reflects the comprehensive quality of students more objectively and comprehensively. The comparison of students' learning effects before and after the curriculum reform is shown in Figure 4.



Comparison of usual grades and unit test scores | Comparison of paper grades

Fig. 4. Diversified assessment

After the case study, it was found that the integration of theory and practice, diversified practice and diversified assessment and evaluation for the cultivation of applied ability, combined with the strategies of case teaching, group discussion and collaboration in the teaching process, were applied to the course of Heat Pump Technology and achieved remarkable results. Students have a deeper understanding of heat pump technology, improved their practical ability, teamwork and communication skills, and practiced their problem-solving ability [4].

3.4 Incorporating Elements of Curriculum Civics

The study of heat pumps is based on the two hot issues of energy problems and environmental pollution. The concept of energy saving and environmental protection is integrated into the teaching, and energy saving and emission reduction technologies such as work mass selection, renewable energy utilization, low-level heat utilization, and waste heat recovery are carried through in order to reflect the characteristics of the course [5]. Students are guided to cultivate good socialist core values and the entrepreneurial spirit of self-improvement, and are willing to realize their own values on the front line of industrial production, so as to internalize and externalize them.

The course "Heat Pump Technology" integrates the concept of "green low-carbon, clean energy, scientific and technological innovation", cultivates students' innovative consciousness of researching green low-carbon products and practical ability of applying clean energy [6]; and cultivates high-quality applied talents in the field of artificial environment and energy application technology from the aspects of knowledge, ability and literacy.

4 Concluding Remarks

With the continuous development of science and technology and the continuous change of social demand for talents, the reform of the course "Heat Pump Technology" will also face new opportunities and challenges. Based on the exploration and practice of online and offline hybrid teaching mode in "heat pump technology", we further update and enrich the content of the course, introduce cutting-edge technology and practical case study; diversify and personalize the teaching mode, focus on the selection and

innovation of teaching methods, introduce interactive, inquiry and project teaching methods, and use modern information technology means to realize the combination of online and offline teaching mode in order to meet the needs of different students [7]. Information technology means, realize the combination of online and offline teaching mode, in order to meet the learning needs and personality development of different students; increase the proportion of practical teaching content close to the actual needs and the forefront of the industry; improve the teaching evaluation system, and cultivate the application ability and comprehensive quality of students.

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