A Case Study on the Teaching of College Physics through to Major

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Abstract: This study focuses on the case teaching reform from college physics to specialty. This paper puts forward the necessity and feasibility of "professional characteristic module". The preparation process of teaching cases is elaborated in detail, including the selection of case materials, design principles and the construction method of specific cases. Taking eight major engineering majors as examples, this paper analyzes the specific requirements of each major for college physics and integrates them into teaching cases. The research results show that teaching cases are helpful to improve the connection between college physics teaching and professional needs, and improve students' learning enthusiasm and application ability.

Keywords: teaching cases; college physics; professional characteristics

In August, 2023, the Steering Committee of College Physics Course Teaching of the Ministry of Education revised the Basic Requirements for College Physics Course Teaching of Science and Engineering (hereinafter referred to as the Basic Requirements). This document pays attention to "professional connection" or "basic courses are connected to majors", and proposes to organize thematic modules for teaching according to different professional directions, reflecting the basic role and application of college physics courses in specific disciplines and professional fields, and realizing the effective connection between college physics course teaching and professional course teaching [1].

Since the concept of "ideological and political education in curriculum" was put forward in 2014, there has been an upsurge of studying ideological and political education in colleges and universities. For basic disciplines such as college physics, ideological and political cases generally provide reference from three aspects [2]: (1) scientists and philosophers' research and exploration of thinking methods; (2) The scientific thinking method contained in the course of "College Physics"; (3) The relationship between thinking methods in physics and Marxist philosophy. The content of ideological and political education is common to all major students, and it is not closely related to the major, which means copying mechanically. College physics is different from basic professional courses or specialized courses. Specialized courses can be carried out through project teaching and the integration of theory and practice. Because it is closely related to future careers, students are willing to accept it. Solving the problem of knowledge imparting and the integration of ideological and political elements has become a difficult problem to be solved urgently in college physics courses, that is, finding a suitable starting point.

The newly revised "Basic Requirements" provides an important enlightenment: to formulate a teaching system consisting of "basic modules+professional characteristic modules". The basic module is the common basic content of science and engineering students, and the professional characteristic module is a case that is attached to the specialty according to the characteristics of the specialty, which can be used as a breakthrough of curriculum ideological and political education.

1 With the Characteristics of Professional Teaching Case Implementation Plan

The content of college physics course includes classical physics and modern physics. Classical physics mainly includes: classical mechanics, heat, electromagnetism, optics, etc. Modern physics mainly includes: special relativity mechanics foundation, quantum mechanics foundation and so on. Based on the "core content" stipulated in the Basic Requirements, this scheme formulates "characteristic modules" for each major.

1.1 Classification of Engineering Majors

The major categories of engineering majors in our school are listed as follows: materials, chemicals and pharmaceuticals, machinery, civil engineering, mining, computers, electronic information and electrical automation. The specific content of this embodiment is to modularize physics knowledge, and each module customizes teaching cases for different majors. The work of preparing cases can be entrusted to project members to complete in blocks.

1.2 Sources of Teaching Cases

Teachers should have a deep understanding of the selected major and study its characteristics, training objectives and professional needs. This is helpful to clarify the core knowledge and skills that students of this major need to master, and lay the foundation for the design of subsequent teaching cases. On the basis of understanding the characteristics of majors, teachers should design targeted teaching cases according to the key points and difficulties of different majors. Cases mainly come from the following three aspects.

(1) Actual working scene or life situation: apply physical knowledge to practice to help students better understand physical principles and improve their ability to solve practical problems. For example, in the power system, transformers are very important equipment. In teaching, we can take the transformer as an example to explain the application of electromagnetic induction principle in it. The actual data of transformer turns, input and output voltage and load power are given, so that students can calculate physical quantities such as magnetic flux and induced electromotive force, and understand the working principle and performance optimization of transformer.

(2) Industry cases: collect and sort out real cases of related industries, so that students can understand the industry trends and practical problems. For example, thermodynamic problems in building engineering: in the design of HVAC system of buildings, thermodynamic knowledge is involved. Taking a specific office building as an example, the parameters such as building area, thermal insulation material performance, indoor and outdoor temperature are given, so that students can analyze the energy consumption and optimization scheme of air conditioning system by using the first law and second law of thermodynamics and heat conduction formula.

(3) Cooperation with professional teachers: Cooperate with teachers from various professions to jointly design and develop teaching cases that meet professional requirements with scientific research as the background. This can ensure the professionalism and practicability of the case and improve the teaching effect.

The customization and implementation of teaching cases is an important link to improve the quality of higher education. Here, taking eight major categories as examples, we elaborate on what aspects of physics knowledge can provide targeted teaching cases for students according to professional characteristics, training objectives and professional needs.

1.3 The Establishment of University Physics Case Base

Teachers can choose different cases to teach in the "characteristic module" according to different majors, ranging from 8 to 16 hours. Therefore, a case base is established for teaching choice. First, collect case materials, and collect cases from various channels, including teaching materials, academic documents, scientific research achievements, practical engineering applications, network resources, etc. Communicate with experts, teachers and practitioners in the field of physics

to obtain practical cases. Secondly, the collected cases are screened, and the screening of cases should be representative, targeted and inspiring, so that it can be closely combined with physical knowledge. At the same time, students' professional background and interests should be taken into account to meet the differences in physical knowledge needs and application scenarios of different majors. Finally, organize relevant professional teachers to review the case to ensure the scientificity, accuracy and cohesion of the case. According to professional characteristics, case teaching should be adjusted and optimized appropriately to ensure that it is closely related to teaching objectives and professional content.

2 According to the Students' Professional Choice of Teaching Cases

The interpretation of "Basic Requirements" points out that [1]: Colleges with professional characteristics are encouraged to build their own teaching connection modules according to their respective professional characteristics. It is suggested to write five interrelated knowledge points for the teaching content of the cohesion module. Teaching methods can be classroom teaching, case teaching and academic lectures. The following is a list of teaching case guides added according to the specific professional direction for reference.

Materials

Mechanical basis: including Newton's law of motion, rigid body mechanics, etc., which provides a basis for understanding the stress and mechanical properties of materials. Thermal basis: such as the laws of thermodynamics, thermal properties of materials such as thermal conduction and thermal expansion are very important for studying the performance changes and phase transition processes of materials at different temperatures. Fundamentals of electromagnetism: Understanding the interaction between electric field, magnetic field and materials is of great significance for the research and application of materials involving electromagnetic properties (such as magnetic materials and conductive materials). Optical basis: mastering the knowledge of light propagation, refraction and reflection is helpful to analyze the optical properties of materials, such as transparency and reflectivity.

Chemical and Pharmaceutical Industries

The specific contents that may be involved include: knowledge of mechanics, such as Newton's laws of motion, rigid body mechanics, etc., is helpful to understand the movement and stress of matter; Principles of thermodynamics, such as laws of thermodynamics, are very important for studying energy changes and phase equilibria in chemical reactions. The knowledge of electromagnetism can help us understand some phenomena and processes related to electricity and magnetism. Optical knowledge may be used to analyze problems related to the propagation and absorption of light.

Mechanical Class

Fundamentals of classical mechanics: it is very important to analyze the movement, force and power transmission of mechanical components. Fundamentals of thermodynamics: Grasp the laws of thermodynamics and understand the concepts of heat transfer and heat engine efficiency, so as to make a reasonable analysis in the design of mechanical systems involving heat exchange and energy conversion. Fundamentals of electromagnetism: It is essential to understand the application of electrical equipment such as motors and electromagnetic brakes in mechanical systems. Wave optics: To understand the propagation characteristics, interference and diffraction of mechanical waves, and the basic principles of optics, which are involved in the application of some precision measurement and optical instruments.

Civil Engineering

The mechanical analysis method can calculate and analyze the internal forces of building structures and bridge structures to ensure the stability and safety of the structures. Thermal aspect: it is recognized that in architectural design, the influence of thermal factors on building structure and environment should be considered

in order to realize energy-saving and comfortable living or using environment. For example, how to use thermal insulation materials to reduce heat transfer and reduce building energy consumption should be considered in the design; Or through reasonable design of ventilation system, thermal convection can be used to improve indoor air quality and thermal comfort. Mechanical vibration: Understanding the wave principle is helpful to understand some phenomena related to wave. For example, in large-scale civil engineering such as bridges and tunnels, it may be necessary to consider the influence of vibration on the structure. Electromagnetism: Although the direct application of electromagnetism in civil engineering is relatively rare, in some projects involving electrical equipment, communication facilities or electromagnetic environment, a certain knowledge of electromagnetism is helpful to better understand and deal with related problems.

Mining Category

In mechanics, analyze the stress of objects and solve problems related to mine structure and rock mechanics, such as analyzing the stability of rock mass during mining. Thermal knowledge is also important in mining specialty. Students need to know about heat conduction, thermal expansion and other phenomena, because they will use relevant knowledge in some problems involving thermal energy utilization and thermal environment control. For example, the design of ventilation system in mines needs to consider thermal factors. In electromagnetism, although not all mining fields are directly and widely used, the principles of electromagnetism may be involved in some specific mining equipment and processes. For example, some automatic mining equipment and electromagnetic beneficiation methods may require students to have a certain understanding of the basic concepts and properties of electric and magnetic fields. The direct application of optical knowledge in mining majors is relatively less, but students may still need to have a basic understanding of the basic properties of light, such as refraction and reflection.

Computer Class

The requirements of electromagnetism for computer majors are relatively important. First of all, it is necessary to understand the basic concepts and laws of electromagnetism, such as Coulomb's law, Ampere's law, Faraday's law of electromagnetic induction, etc., which is helpful to understand the working principles of current, voltage, inductance, capacitance and other components in the circuit. Secondly, in communication engineering related fields, such as wireless communication, electromagnetic knowledge is very important for understanding the propagation of electromagnetic waves, antenna design and signal transmission characteristics. Furthermore, in terms of computer hardware, such as chip manufacturing and integrated circuit design, the consideration of electromagnetic compatibility requires certain electromagnetic knowledge to ensure the normal operation of electronic equipment in electromagnetic environment without interference.

Electronic Information

Knowledge of mechanics is helpful to understand the movement of mechanical parts in electronic equipment and the mechanical characteristics in signal transmission. Thermal fundamentals: It is of great significance to analyze the heating, heat dissipation and energy conversion efficiency of electronic devices. Electromagnetism is the basis of understanding the concepts of capacitors and electrostatic shielding, and it is indispensable to understand the principles of inductors, magnetic storage devices, transformers and generators, and it is the theoretical cornerstone of wireless communication, radar and other technologies. Physical optics: It has applications in laser technology, optical communication and other fields. Modern physics: it is helpful to understand the working principle of semiconductor devices.

Electrical Automation Class

Some knowledge of mechanics is the basis of understanding the principles of motor movement and mechanical transmission. Thermal part: it is very important to analyze the heating and heat dissipation problems and energy loss of electrical equipment.

Electromagnetic part: provide theoretical support for understanding capacitors and electrostatic shielding; It is the key to study the magnetic field distribution of electromagnetic devices such as electromagnets and DC motors. It is the core knowledge of the working principle of transformers, generators and other equipment. Optics: The laws of refraction and reflection in geometrical optics have applications in the design of lighting systems and optical sensors. Modern physics: Some basic concepts of quantum physics are helpful to understand the characteristics of semiconductor materials and related electronic devices (such as transistors).

3 Teaching Case Classroom Implementation Process

In the teaching process, teachers should introduce teaching cases to the "professional characteristic modules" selected by their majors according to the teaching plan and curriculum requirements. In the implementation process, the following steps can be taken to implement [3].

Introduce cases: Introduce cases in different ways according to their characteristics. At the beginning of the course, directly put forward a practical problem and hot topic related to the major, or show a successful professional project achievement through pictures, videos and other forms to stimulate students' interest and thinking.

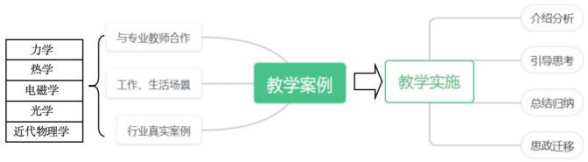
Case analysis: Give a series of leading questions, arouse students to think about the key issues related to the major in the case, encourage students to express their views and ideas, and find the hidden physical problems in the case. Group discussion, class discussion and other forms can be adopted.

Guiding thinking: In the discussion process, teachers organize students to discuss in groups by asking questions and guiding, review and deepen physical problems, and jointly discover ways to solve problems by using physical knowledge in the communication.

Summary: After the discussion, sort out the solution ideas of the case, and connect the physical knowledge involved in the case with the overall knowledge system of the course, so that students can understand how to turn theoretical knowledge into practical problem-solving ability.

Ideological and political transfer: find the points related to social responsibility, scientific spirit and professional ethics in the case, and encourage students to apply the knowledge and methods learned from the case to real life or other similar situations.

Evaluation feedback: Teachers evaluate students' performance in case discussion, provide feedback and help students improve.



Of course, I don't stick to the above teaching order. Cases provide the application of physics knowledge, which is connected with majors. In short, teachers should guide students to think deeply about cases, and help students extract and analyze physical problems from cases by asking questions and discussing. It is helpful for students to know the working scene and needs of their major in advance and to be familiar with the problems that can be solved with physical knowledge in the professional field, which is helpful to cultivate their professional thinking and literacy.

4 Key Issues in the Implementation of the Program

Based on the research and practice of case teaching in college physics, this paper explores a case teaching mode suitable for the actual situation of our school, improves the connecting role of college physics in specialty, and makes students truly knowledgeable and practical. The proposal of this plan is only a preliminary plan and has not yet been implemented. Some key issues need to be prepared.

(1) Case selection and design: Select representative, targeted and inspiring cases, and make them closely combined with physical knowledge. At the same time,

students' professional background and interests should be taken into account to meet the differences in physical knowledge needs and application scenarios of different majors. According to the professional characteristics, the case teaching is adjusted and optimized appropriately.

(2) Classroom implementation process: Teachers should guide students to think deeply about cases, and help students extract and analyze physical problems from cases by asking questions and discussing. Case teaching often requires students to carry out group cooperation and communication, and teachers should organize group activities reasonably, promote interaction and cooperation among students, and cultivate teamwork spirit and communication ability. Establish a scientific evaluation system, comprehensively and objectively evaluate students' performance in case teaching, and give timely feedback to help students improve.

(3) Knowledge transfer and application: to encourage students to apply the knowledge and experience learned in the case to practical problems and cultivate students' application ability. Teachers should pay attention to cultivating students' practical ability and problem-solving skills in case teaching.

5 Conclusion

Customizing teaching cases according to different majors is helpful to improve the teaching quality of physics courses. In the process of implementation, teachers should fully understand the professional characteristics, design targeted teaching cases, and work closely with professional teachers to jointly promote teaching reform. Through continuous exploration and practice, we will contribute to the cultivation of high-quality professionals.

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