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On the Innovation of the Course of Atomic Physics

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Abstract: Through the partial transplantation of the course content, setting the order of teaching objectives, make full use of the network and teaching resources, targeted to solve the problems encountered by students in the teaching process. Open the laboratory reasonably, teachers give guidance, encourage students to participate in competitions, and create conditions for students to apply theory to practice. Through the communication between teachers and students, the students are taught according to their aptitude, and the knowledge can be absorbed and applied in multiple directions and at multiple levels. Students are encouraged to demonstrate their learning achievements by reading notes, giving presentations, participating in competitions and other means to achieve learning goals and improve their professional skills and discipline literacy.

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1. Course Overview

Atomic Physics is a link course that carries on classical physics and opens modern physics. In the late 19th century and early 20th century, the physics stage presented many experiments and phenomena that could not be explained by classical physics, such as blackbody radiation, photoelectric effect, X-rays, radioactivity and electrons. The development of atomic physics not only perfectly explained these experiments and phenomena, and initially established the physical model of the microcosmic world, but also gave birth to the birth of quantum theory and opened up new research directions. Nowadays, the field of atomic, molecular and optical physics (AMO) is more active in the forefront of basic science and technology application research, and constantly opens up new roads.

2. Analysis of learning situation

In the teaching process, we found the following problems:

2.1 Pre-class preview is not in place. Students report that there are too many courses in sophomore year, they spend their spare time on homework that must be handed in, and they pay little attention to optional preview tasks. As a result, the discussion on preview content conducted by teachers in classroom teaching cannot be reasonably promoted, so it is necessary to occupy class time to preview for students.

2.2 Passive acceptance of classroom teaching, unwilling to think, most of the questions answered “don’t know”. Because atomic physics involves the micro field and quantum thinking, it is hard to see and touch in real life. New theories also go against our common sense, which makes students more confused and difficult to construct new knowledge framework, and their interest in learning gradually weakens. In addition, there are few practical opportunities to apply advanced mathematics to solve physical problems, and sometimes students will give up deducing formulas because of high number jam, thus unable to deeply understand their physical meaning.

2.3 Since the after-school research results are included in the regular grades, the completion rate of students is high, but the completion quality is low. For example, PPT report, PPT page production often appear large blocks of dense text, speech is read by PPT, without their own opinions and prospects. Some reading notes directly copy and paste, or use software translated text. The above phenomenon indirectly reflects that students cannot settle down to carry out extended learning.

3. Practice and reform

Based on the problems in the teaching process, combined with the characteristics of the subject and the situation of the students, we have made useful attempts from the following aspects:

3.1 Transfer part of the preview and expansion content of Atomic Physics to the experimental courses and elective courses offered at the same time, make reasonable use of the organic connection between courses, and provide favorable conditions for students' practical operation and deep learning.

Atomic physics involves many modern physics experiments, which always runs through the development law of "experiment -- theory -- experiment". We hope to integrate experimental courses into theoretical courses, so that students can complete relevant modern physics experiments independently through pre-class preview. Therefore, In the past, the course of Modern Physics Experiment, which was offered after the end of the course of Atomic Physics, was advanced to the same semester as Atomic Physics, so that students could complete the task of pre-class preview of Atomic Physics in the special experimental course and answer the teacher's questions in the theory class well. For example, in Atomic Physics, the photoelectric effect experiment has played an important role in inducing the quantum hypothesis. After the actual operation of the photoelectric effect experiment, the students will ask "what are the variable and measurable physical quantities involved in the experiment? What is the function of the blocking voltage? What is the threshold frequency? Does the photoelectric effect occur instantaneously whenever a monochromatic light hits a metal surface?" When classical theories fail to explain experimental phenomena, quantum theories naturally lead to them. After class, the teacher will push the video of photoelectric effect application in real life and popular science articles to students through the Internet to stimulate their interest in further learning.

Mathematics is an indispensable tool for physics learning. We extract the knowledge related to this course from Higher Mathematics and explain it to students in the form of professional elective courses in combination with actual needs. For example, the third chapter of Atomic Physics uses a lot of calculus and linear algebra knowledge, and the research of spectrum and quantum effects uses a lot of experimental data. Therefore, the team members set up the optional course of Computational Physics, which is combined with the study of Matlab to review the relevant high number knowledge, and let students operate on the computer and process the experimental data with programming. In this way, it is not only beneficial to the study of specialized courses, but also can improve students' practical skills and transform the knowledge learned into practical application.

3.2 Set hierarchical goals with chapters as the center, teach students according to their aptitude according to their individual differences, and provide students with multi-directional and multi-level knowledge absorption and application.

During the course of the class, the teacher will understand the learning plan of each student. For example, some students aim to pass the exam, some students plan to enter the postgraduate study, some students are interested in the field of practical application... Combining with the characteristics of students and the teaching content, we set diversified and multi-level teaching objectives and evaluation methods, adopt the form of free combination, and carry out the mixed teaching model of ascending order.

Taking the first section of Chapter 2 of Atomic Physics textbook of Yang Fujia Edition as an example, the low-level teaching content is to understand the background of the generation of quantum hypothesis and master the spectral law of hydrogen atom. The former can be realized by students' introduction to relevant physicists and physical experiments, while the latter can be achieved by teachers' classroom teaching by deducing the general Rydberg equation from students' known Balmer formula. The middle level teaching content is the formula and classification of hydrogen spectrum line system, which can be achieved through deduction and classroom discussion. The advanced teaching content is the principle and application of several classic experiments in "Experimental Basis for the Establishment of Quantum Hypothesis", which will be briefly introduced in classroom teaching and encourage students to learn independently and experiment in class.

The teaching objectives of the above contents are summarized as: 1. Understanding and mastering (primary); 2. Deduction and migration (intermediate); 3. Practice and application (advanced). In the teaching activities, groups were selected to complete the following tasks of different difficulties: 1. PPT presentation of "The Solvway Conference Profile", "Interesting Talk on Photoelectric Effect", "Brief Discussion on Spectrum and Application"; 2. 2, reading notes to complete the book "please the reader calculation", "formula derivation can refer to......" "We recommend to our readers..." Etc.; 3. Completed extracurricular innovation experiments with experimental instruments, such as Building Visual Spectrometer, Multiple Measurement Methods of Planck Constant, etc. The above tasks change from simple to complex. Students can choose to complete one of them according to their own interests and abilities. Through independent learning, they can consolidate the knowledge framework learned in class, expand the scope of knowledge and improve the practical ability.

3.3 The effective use of intelligent terminals and networks, reasonable use of teachers' time and laboratory resources, so that students can efficiently complete learning tasks.

The "Documentary" and "Science and Technology" sections of b website are used to push some videos to students, such as "A Brief History of Genius" and "MIT Open Courses", and encourage students to collect relevant materials on their favorite platforms for fragmented learning.

By learning the self-built course of Atomic Physics on TongApp and using superstar resources, extended reading materials are attached at the end of each chapter to guide students to have a wide range and in-depth exploration of the issues they are interested in.

In the form of appointment, students can discuss with teachers in their spare time, or go to the laboratory to complete relevant innovative experiments. Through the contact with students after class, teachers can have a deeper understanding of students' learning status, answer questions and solve doubts for students in average situations, and guide students who are capable of learning to conduct in-depth research and practical innovation. In this process, students can learn how to view professional papers, make PPT skills, improve the ability of presentation, experience the fun of teamwork and innovative practice.

3.4 Introduce philosophical thoughts into textbooks, guide students to pursue scientific stars, and strengthen patriotic education.

The textbook will quote several famous quotes at the beginning of each chapter, which not only reflects the content of this chapter, but also carries philosophical meaning. For example, in the third chapter, Lu Xun is quoted as "It has always been so, is it right?". "And Einstein" the development of the thinking world, in a sense, is the constant rid of the 'surprise' "two famous words. In the teaching process, teachers can follow the main line of "breaking the foundation" and "thinking", guide students' three views correctly according to the teaching content, and cultivate the scientific literacy of seeking truth from facts, daring to seek proof, not afraid of authority and advancing with The Times.

There have been many outstanding scientists in the history of atomic physics. Their patriotic feelings, struggle experience and scientific spirit are worth students to feel and pursue. Through research and presentations, students can actively spread this positive energy in the interactive class.

The concept of atom is both ancient and young. The idea of "indivisible" appears in the Classic of Mochi and the Doctrine of the Mean, while "Mozi" and "Jiuzhang" highlight the rapid development of quantum technology in China. Combined with the development of the history of science and technology, these ideological and political elements can be interspersed in classroom teaching to stimulate students' pride in Chinese civilization and sense of mission for scientific and technological innovation.

4. Summary

Through the above teaching innovation, our teaching effect is reflected in 1. Theoretical learning: solid professional knowledge, enhanced information collection ability, learning interest and learning efficiency have been greatly improved. 2. Application innovation: Improved practical ability, actively participated in discipline competitions, exercised comprehensive ability and professional skills.

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