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Reform and Exploration of Modern Physics Experiment Teaching Methods for Innovative Talents in Local Universities

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Abstract: "Modern Physics Experiment" is an important professional experimental basic course for physics majors in colleges and universities, and an important link to cultivate the practical and innovative ability of physics majors. Through the synchronization of classroom teaching and experimental teaching in modern physics experimental teaching, the introduction of experimental design ideas in experimental teaching, and the rational use of smart classrooms, this paper breaks through the limitations of modern physics experimental teaching in local colleges and universities in terms of software and hardware, and effectively It has greatly improved the quality of modern physics experimental teaching, and provided new ideas and references for the reform of experimental teaching.

Keywords: Physics major; Modern physics experiment; Zeeman effect; Innovation ability

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Innovation ability is the ability to continuously provide the society with new ideas, new theories, new methods and new inventions with economic value, social value and ecological value, and it is the core of a nation's sustainable development and progress. The cultivation of college students' innovative ability is the basis for building a world science and technology power and realizing the great rejuvenation of the Chinese nation [1,2]. Among them, experimental teaching is an important part of university education, an important link between theoretical knowledge and practical operation of textbooks, and one of the important ways to cultivate students' innovative ability [3]. For a physics subject mainly based on experimental verification, its experimental teaching is particularly important in cultivating innovative talents.

The experimental teaching of college physics majors mainly includes two parts: "general physics experiment" and "modern physics experiment". Modern physics experiment is an important professional experimental basic course after ordinary physics experiment. It involves the knowledge of various basic courses and professional courses in physics, and the content mainly includes the famous experiments in the 20th century that opened up new development directions and methods of physics, as well as new experiments related to the experimental methods commonly used in modern science and technology. Modern physical experiments focus on cultivating the necessary physical experimental skills for future scientific research and various practical scientific activities, and are an important link in cultivating students' innovative thinking and practical ability.

However, in the teaching of modern physics experiments in colleges, we still follow the traditional teaching mode that teachers teach, students operate experiments according to the steps of the lesson plan, and complete the experimental report after class. This traditional experimental teaching mode is particularly prominent in the vast majority of local colleges and universities, and the modern physics experimental teaching of physics majors in local colleges and universities is directly related to the cultivation of innovation ability of most physics majors in my country, and it is also a must for physics experiment teachers. and problems to

be solved.

1. The common problems and analysis of modern physics experimental teaching in local colleges and universities:

1.1 The time gap between theoretical knowledge teaching and experimental teaching

Every enomena and laws by great physicists, reflecting their extraordinary wisdom. It is difficult for some students majoring in physics in local colleges and universities to understand and master these knowledge points in a timely manner, and there is a phenomenon that they have little understanding of physics knowledge. In addition, the arrangement time of the experimental teaching and the involved knowledge points have a time span of one semester or even two semesters, which can easily lead to some students forgetting the relevant physics knowledge points before the experiment, although there is also a preview before the experimental class. In this case, it is necessary to extend the teaching time of knowledge points and compress the time for students to operate. As a result, some new experimental teaching modes are difficult to promote, such as the "flip-type" physics experimental teaching mode. As a result, the teaching mode in which teachers mainly teach and students complete experiments as required has become more and more prominent.

Therefore, how to make full use of the limited resources of local colleges and universities, through the reform of modern physics experimental teaching mode, to explore the modern physics experimental teaching mode with the characteristics of local ordinary colleges and universities. Let students change from coping to complete experiments to actively requesting experiments, so that students can deeply understand the ideas of modern physics experiments, and improve the innovation ability of physics majors. In recent years, many experts and scholars at home and abroad have made useful explorations on how to use university physics experiments to cultivate students' innovative ability. The author has taught physics basic courses and modern physics experiments for nearly 20 years in the physics major of Xiangtan University, and has accumulated certain experience. Now, he summarizes the following points about his teaching reform attempts in the teaching process.

1.2 Lack of awareness of the physical ideas and design principles behind the experiments

More than 20 experiments in the modern physics experiment class are some very representative classic experiments in the development process of physics, many of which are Nobel Prize-winning classic physics experiments, such as Zeeman effect experiments, electron diffraction experiments, Frank-Hertz experiment et al. At local colleges and universities, lab lectures are often very detailed due to fears of damage to lab equipment. In the teacher's "meticulous" explanation, the students can successfully complete the experiment step by step. It seems to be a "harmonious scene", but the students did not have a deep understanding of the process of discovering, analyzing and solving problems experienced by scientists behind the experiment, and did not understand the scientific thinking of physicists when facing scientific problems. The experimental teaching in this mode limits the divergent thinking of students to a certain extent, and is not conducive to the potential cultivation and nurturing of students' innovative ability.

1.3 Coping learning for middle school students in experimental teaching

The software and hardware resources of the experimental teaching of physics majors in local colleges and universities have limitations. In physics experiments, students' experimental results are basically given in the form of pre-class experimental reports, in-class experimental results and after-class experimental reports. This kind of assessment mode can easily lead to the phenomenon of "fishing" in students' learning. The preview report is copied from the experimental handout, the experimental results are mixed with everyone, and the experimental report and the thinking questions are copied together. Students' interest in experimental classes is not high, and their participation is not strong. Most students develop a coping learning attitude towards experimental classes, not to mention cultivating students' innovative ability in experimental classes.

2. Plans for the reform of modern physics experiment teaching in local colleges and universities:

2.1 Synchronization of theoretical knowledge points and experimental teaching

Innovation is not a temporary fabrication, but a sense of innovation and a solid knowledge reserve. Cultivating college students with a solid theoretical knowledge base is still the basis for cultivating college students' innovative ability. During the experimental teaching of the Zeeman effect, the author found that most of the students' pre-experiment reports were mere formalities. They simply copied and copied the lecture notes. They had little understanding of the theoretical knowledge involved in the experiments, or some students could only memorize some physical terms occasionally. , the experimental results are not ideal. In order to solve this problem, the author, together with the teachers of the "Shaofeng Class" of the physics major of our school, tried to arrange the students in

time after completing the fourth chapter of "Atomic Physics" "Fine Structure of Atom: Electron Spin" in class. The "Zemann Effect" experiment was carried out. This reform attempt to combine theoretical teaching and experimental teaching synchronously, through the teaching of experimental courses, found that:

First of all, this form of experimental teaching has improved students' initiative and interest in learning, which can be seen from the performance of students in experimental classes. In the question-and-answer session before the experimental class, most students can answer the relevant physics knowledge points, which is significantly improved compared with the previous experimental class. This greatly reduces the author's explanation of the theoretical knowledge points related to the Zeeman effect experiment, and focuses on the teaching of knowledge background and operation precautions, and also increases the time for students to operate.

Secondly, the students' problems in the experiment process increased. For example: if the light source is placed outside the magnetic field, will there be spectral splitting? Why use mercury light source, can't anything else? Why is the singleness of the light source emphasized in the lecture notes, and the wavelength is accurate to one decimal place? With the increase of hands-on time, students also found out under what conditions a clearer diffraction halo can be obtained, and how to increase the spacing between the rings. These seemingly simple questions show that students have been thinking about problems in the process of operating experiments, and the raising of such questions and the discovery of rules are also the beginning of cultivating students' innovative ability.

Therefore, the author is trying to synchronize the basic classroom teaching time involved in modern physics experiments with the experimental teaching, using the limited teaching resources of local colleges and universities to consolidate students' mastery of physics knowledge to the greatest extent, and lay the foundation for cultivating their innovative ability.

2.2 The introduction of experiential teaching in modern physics experiments

Modern physics experiments can not only strengthen students' understanding of theoretical knowledge and train students' hands-on ability, but also help students to deeply experience the extraordinary wisdom of scientists behind the experiments in solving scientific problems.

Often this is ignored in our experimental teaching process. There is a lack of training to help students establish the ability to discover, analyze and solve problems, which is the key to cultivating students' innovative ability through experimental teaching.

Through the adjustment of the above modern physics teaching experiment time, most of the students can successfully complete the entire experimental process and obtain correct data results according to the teacher's detailed lectures and the operation steps on the handout. However, in the process of experimental teaching, the author found that few students would ask why the experiment was designed in this way? Or exclaim "This experiment is so perfect!". Explain that students do not have a deep experience of the innovations of physicists in solving problems.

In the teaching of "Electromagnetics", Ampere designed "four zero-representation experiments" to establish the famous Ampere's theorem. This idea of solving scientific problems by cleverly designing experiments is the best innovation. In order to help students build up the innovative ability to solve problems in the modern physics experiment teaching, the author takes the Zeeman effect as an example, and adds a content of "the logical idea of the Zeeman effect experiment" to the traditional teaching plan of physical principles and experimental steps. The Zeeman experiment that won the Nobel Prize in Physics must have something for students to think deeply about and learn from. String together the design ideas of the Zeeman effect experiment, and let students immerse themselves in the experiment to solve problems with Zeeman. In this experience, students feel the ingeniousness of experimental design and the law of scientific development: the process of discovering, analyzing and solving problems. I feel why the experiment content is to measure the charge-to-mass ratio instead of the direct energy level splitting; I realize that in the era of no previous accurate spectrometer, a simple multi-beam interferometer is used to measure the wave number difference; I realize the Zeeman effect The experiment is how to transfer the proof of the Zeeman effect step by step to the measurement of the diameter of the simple interference ring. The edification of the extraordinary wisdom of great scientists is the enlightenment to cultivate students' innovative ability.

2.3 Online platform experiment preview and assessment mode

With the emergence of Internet classrooms, platforms such as Chaoxing Learning Link and Course Center have provided a new model for experimental teaching. Before class, teachers can upload the experimental courseware that incorporates sound, animation and micro-video content to the online classroom platform, avoiding the pure text form in traditional experimental courseware, and showing abstract physical models and complex mathematical derivation in a more vivid form. process. Before class, students can open online classes anytime and anywhere to study, make full use of fragmented time, and change the traditional experimental classroom from teacher-centered to student-centered. After class, students can complete homework and thinking questions related to experiments in the course center to consolidate their understanding of knowledge. Using the online smart classroom, teachers can develop some

small programs that improve the current experiments, allowing students to optimize and design physics experiments on the platform. If students can form a certain feasible plan, they can also apply for relevant college students' innovative experiments to schools, provinces, and even the country, so that the innovative training process of college students can be better formed.

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