

A Brief Discussion on the Problems and Reform Suggestions of Physics Experiment Teaching in Colleges and Universities

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Abstract: With the cooperation of physics experiment teaching and theoretical teaching, colleges and universities put forward three dimensions of experiment teaching objectives, that is, optimize the experiment content and experiment equipment, attach importance to the quality control of the whole process of experiment teaching and establish a diversified experiment teaching evaluation model, and determine the teaching objectives of physics experiment courses. Under the trend of education reform, the physics experiment teaching in colleges and universities is constantly innovating, developing comprehensive experiments and designed experiments, improving experimental equipment, and optimizing the test work of experimental courses. This paper discusses the work of physics experiment teaching in colleges and universities, analyzes the focus of the reform of physics experiment teaching, and probes into the specific strategies of the reform, hoping to provide strong support for promoting the reform of physics experiment teaching in colleges and universities.

Keywords: Universities; Physics experiment; Teaching strategy

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1. Introduction

College physics courses involve mechanics, heat, optics, electricity and other aspects. Theoretical teaching and practical teaching are integrated, and practical teaching is of great significance for students to consolidate theoretical knowledge of circuits, cultivate physical analytical thinking, and exploration ability, and solve practical problems^[1]. After the study of physics experiment courses, students can effectively consolidate and deepen the study of professional theories, broaden the scope of professional knowledge, strengthen comprehensive thinking, and cultivate basic scientific research ability and innovation ability.

2. Take scientific literacy as the orientation

Experimental teaching should first clarify the teaching objectives. Appropriate experimental objectives

dominate the whole process of experimental teaching and plan the correct direction of teaching and learning. Training scientific thinking and scientific research ability is one of the important objectives of experimental teaching. These two contents can be summarized by scientific literacy, or further divided into scientific knowledge, scientific method, scientific attitude and scientific values. To summarize scientific literacy in professional language, it can be explained as follows: that is, the ability to apply scientific knowledge to explain or solve practical problems, to explain natural phenomena, human activities and their changes and to give strong evidence ^[2].

Specifically, the teaching goal of physics experiment can be set as the mastery of the following five contents: (1) the ability to understand and apply knowledge; (2) the ability of hands-on operation; (3) the ability to carry out experimental inquiry, that is, the ability to observe experimental phenomena, measure data, analyze experimental results and get scientific conclusions; (4) To understand the general methods of scientific inquiry and (5) develop an interest in scientific exploration. The first four points point to the experimental teaching objectives focused on in the traditional teaching mode, that is, the cultivation of operation ability, exploration ability and innovation ability, and the fifth points to emotional attitude and values ^[3]. Based on the above goals, the teaching mode, experiment content, hardware facilities, experiment steps and evaluation mode of physics experiment teaching are reformed.

3. Change “verification experiment” to “design experiment”

The physics experiment course has been unable to break through the limitations of the traditional teaching mode. In the experiment teaching, the teacher has more demonstration and the student has less operation. There are more confirmatory experiments and less innovative experiments. As a result, the teaching of physics lacks innovation and the training of students' logical thinking is insufficient. Although students have mastered certain physical laws through experiments, they have not developed innovative physical logical thinking, and their experimental skills and practical ability are also weak ^[4]. Experimental design ability is one of the important goals of physics experiment teaching in colleges and universities. The cultivation of experimental design ability requires teachers to adjust the experimental teaching mode, increase the design and comprehensive experiment, reduce the verification experiment, reflect the openness and exploration, and allow students to independently design experiments and analyze experimental results. In addition, some teachers have the consciousness of innovation in experimental teaching, and take the initiative to guide students to participate in the design and operation of physics experiments, highlighting the innovation and openness of experimental courses. However, many students are unable to put their hands and feet in the experiment process, afraid of operation mistakes, cautious and imitative in operation, and lack of innovation in experimental design ideas ^[5]. To solve this problem, teachers need to further create an experimental atmosphere that encourages innovation. By changing the experimental conditions, teachers can encourage students to think boldly, operate freely, and explore and discover in the experimental course.

4. Strengthen the control of the experiment process

In order to ensure the quality of experimental teaching, teachers need to take all links in the process of experimental teaching seriously, pay attention to details, and control each link of the experiment well.

4.1. Pay attention to details, reflecting a rigorous and realistic scientific attitude

It is necessary to establish a set of strict experimental systems, strictly regulate experimental operation, seriously treat experimental data, ensure the authenticity of experimental data, and resolutely refuse to tamper with and plagiarize experimental data. After the end of the experiment, fill in the experiment report and submit it to the instructor for review. The instructor will analyze whether the experimental ideas in the students' experiment report are reasonable, check the original data, and finally sign for confirmation ^[6].

For example, in the circuit experiment operation specification, students should not touch the bare live conductor with their hands. Power off before replacing and disassembling circuits to avoid accidents or equipment failures. If it is found that the instrument pointer is too hard, there is a burnt smell, smoke, arc, someone is electrocuted, and other abnormal phenomena, cut off the power immediately, report the cause to the teacher, and troubleshoot. After the end of the experiment, put the instrument back to its original position, turn off the power supply, clean the experimental table, and wait for the instructor to check and leave the laboratory. Standardizing experiment management and paying attention to experiment details can cultivate students' rigorous and serious experimental attitude, guide them to treat the experiment with the most sincere heart, and build a good scientific research literacy.

4.2. Strengthen the preparatory work

Doing a good job of previewing work and understanding the experimental principle is more helpful in ensuring the quality of the experiment. Therefore, teachers can design preview tasks and, through the preview, guide students to deeply understand the purpose, content and steps of the experiment, and effectively master the use of experimental instruments. After the completion of the preview, the preview results in the form of preview report submitted to the teacher, the latest one day before the experimental class to submit the preview report. According to the preview report, the teacher will find out the difficulties in the experiment, so that the experiment class will be more efficient and more targeted.

The students' experiment preview is mainly divided into two parts: the preview of the experiment content and the preview of the experiment instrument. According to the preview situation, students write the preview report. The preview report does not simply copy the experimental data, nor does it follow the same script, but adds its thinking results, reflects their understanding of the experimental purpose and content, improves the weak links of the experiment, and carefully masters the requirements of the use of instruments and equipment, etc. ^[7]

4.3. Adhere to the student-centered

The reform of physics experiment teaching should always adhere to the student-oriented, let students be the protagonists in the classroom, and teachers play the role of cooperators and guides in the learning process of students. In some confirmatory experiments, the traditional practice of "prescription medicine" should be changed, and students should be allowed to think independently, discuss cooperatively and write experimental plans in groups ^[8]. In the process of experiments, teachers supplement and improve the problems in students' experiments according to the specific experimental conditions. Finally, the teacher makes a spot check on the experimental plan of the learning group and makes an evaluation and appropriate correction.

In the traditional teaching process, students' learning initiative is often ignored, which leads to students being in a passive state. In the long run, students' learning interests will be reduced, and it is not conducive to the improvement of learning efficiency. In the context of core literacy, teachers need to pay attention to

students' learning interests and learning enthusiasm^[9]. At the same time, they should also pay attention to the cultivation of students' learning habits, organize experimental courses through diversified teaching methods, mobilize students' active initiative to participate in experimental course learning and encourage them to develop good scientific thinking and learning habits, so as to promote students' continuous improvement of physics core literacy.

The organization and implementation of experimental courses should focus on students' ability to accept, use, express and learn. Teachers should do a good study before class, have a detailed understanding of students' learning situation, and design reasonable teaching objectives and efficient teaching modes, which will help students internalize and absorb teaching content and effectively improve the effectiveness of classroom teaching^[10]. At the same time, teachers should carry out relevant teaching design according to the specific situation of students, affirm the students' innovative thinking and strengthen the communication and communication between teachers and students and students, which can effectively improve the teaching efficiency and students' learning efficiency.

4.4. Strengthen teacher-student communication and interaction

Establish the teaching concept of process as the center and continuous improvement of operation. After the completion of the experimental project, the teacher and students will discuss the experimental phenomena and experimental results together, summarize the empirical methods obtained in the experiment, analyze the shortcomings of the experiment, find problems in the experiment, solve problems, or put forward new ideas, and write these problems in the form of records in the experiment report. The experimental effects are analyzed and fed back to the design and improvement of experimental teaching objectives to form a cyclic teaching of the whole life cycle^[11].

In class, teachers should break through the restrictions of traditional teaching mode, return the class to students, encourage students to think, discuss and summarize as a leader, and let students cooperate in groups to complete an experimental task. After completion, teachers can comment on students' questions and the experiment of each group to help students understand their shortcomings and improve them, and consolidate the classroom content^[12]. After class, teachers can release homework and expand extracurricular knowledge through the education cloud platform, so that students can further consolidate knowledge and broaden their horizons. Teachers can comment on the homework results submitted by students, and can also interact with students in real-time to guide students' learning.

5. Integrate ideological and political education elements to cultivate scientific spirit

The goal of physics experiments is to enable students to consolidate and verify physical theories, and to form basic experimental innovative thinking and operation abilities. In physics experiments, students need to design and operate experiments to form logical thinking ability to analyze and derive correct conclusions based on experimental phenomena. In experimental teaching, the principal position of students should be fully demonstrated. With the help of active and effective thinking activities, students' creativity can be developed while acquiring professional knowledge and improving experimental operation ability, to cultivate students' innovative thinking to the maximum extent^[13]. In order to highlight the goal of cultivating scientific research ability, colleges and universities have explored innovative experimental teaching methods, giving students more autonomy in experimental teaching, allowing students to independently consult relevant literature and

books, explore scientific and reasonable experimental techniques, and design experimental schemes to verify their feasibility. By writing the experiment report, the experimental results are demonstrated.

6. Build a diversified teaching evaluation system

Based on the physics experiment teaching goal, teachers also need to construct multiple teaching evaluation models, evaluate and motivate students from multiple dimensions, and carry out experimental teaching evaluation throughout the whole experiment process to strengthen students' sense of gain in experimental learning. Dilute the proportion of the experiment report, optimize the content of the experiment report, and increase the preview report, pre-class summary and innovative thinking^[14]. The confirmatory experiment focuses on whether the students standardize the experimental operation process and whether the experimental results are correct. Comprehensive experiment focuses on students' understanding and application of extensive knowledge, allowing students to sort out the knowledge system, design a comprehensive experiment scheme, and carry out high-level experimental exploration. In the design experiment, students design their experimental scheme according to the actual situation, formulate experimental operation steps, and complete the experiment.

In line with the diversification of evaluation subjects and evaluation indicators, to build a scientific and systematic teaching evaluation system, reflect the real learning effect of students, and encourage teachers to carry out teaching reflection and teaching improvement. In the evaluation method, the teacher evaluation, student self-evaluation and student mutual evaluation are integrated, and the results are weighted based on a certain proportion, to obtain a more fair course score. From the level of evaluation indicators, in addition to reflecting physical theory, practical ability and other indicators, students' learning attitude, cooperation spirit, innovation ability, etc., are also reflected in the comprehensive assessment of students' comprehensive quality^[15].

7. Conclusion

In traditional physics teaching, teachers often take theoretical knowledge as the focus of classroom explanation. This teaching method ignores the cultivation of students' hands-on ability. Students' enthusiasm for learning is not high, and the classroom atmosphere is not active enough, which seriously affects students' learning efficiency. In addition, some students' learning attitude is not correct, lack of interest in physics learning, showing a perfunctory attitude, which greatly affects the improvement of students' physics learning ability. Under the background of education reform, physics experiment teaching in colleges and universities should update the teaching concept, apply new teaching models and new teaching tools to promote teaching innovation, propose to increase the proportion of designed experiments, reflect the student-centered education concept, and strengthen the quality control in the early, middle and late stages of experimental teaching, to create an experimental model of full quality cycle teaching. At the same time, it is proposed to increase the proportion of assessment of experiment reports.

Disclosure statement

The author declares no conflict of interest.

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