The Application and Thinking of Research-Oriented Teaching in College Physics Experiment Teaching

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Abstract. Research-oriented teaching is a new teaching mode, which is more conducive to cultivate students' innovative thinking and innovation ability. Based on the actual situation of college physics experiment course, we discuss the specific method of applying research-oriented teaching to physics experiment course.

Introduction

Research-oriented teaching is a new teaching model which is student-based and teacher-assisted. It is a kind of teaching model that with the guidance of teacher, students could complete the teaching objectives of the teaching through independent thinking and in-depth study of the knowledge they have learned, collaborative learning and mutual inspiration in the group discussion.[1] Compared with the traditional teaching mode, it not only can help students to understand and master the knowledge and skills, but also help to cultivate students' innovative thinking and innovation ability, which is conducive to the cultivation of innovative talents, and it is consistent with the new situation of personnel training objectives. University physics experiment is a compulsory basic course of science and engineering in colleges and universities, and plays an irreplaceable role in cultivating students' scientific quality and experimental ability. So it is a unique condition to carry out research-oriented teaching in the university physics experiment course. Below we’ll talk about the following aspects of based on our experience.

To Penetrate the Research-Oriented Teaching into the Daily Teaching

The lack of learning time, the large number of students and the difference from basic learning levels are the reality that we have to face in the teaching process of university physics experiment. It is impossible to reduce the time of the existing basic experiments to conduct the research-oriented teaching. So does this means that the research-oriented teaching can not be used in the basic experimental teaching? Actually it is not, we can absolutely introduce it into the existed teaching.

(1) Based on the existed physical experiment content system, we may take some measures, such as, change the existed teaching mode, select some novel experimental projects which are easy to moderate or which the students are interested in as well as which they have opportunities to practice, to design carefully the teaching plan. Our measures will improve the students initiative in learning and guide the students to study and discuss in the experiment by themselves.[2]

For example, the holographic experiment uses the principle of light interference and diffraction to record and reproduce objects’ information. This experiment involves a series of steps, such as the experimental optical path layout, exposure, washing, reproduction and so on. For the traditional practice, teachers explain first the specific requirements, methods, and matters needing attention of each step. Then the students follow the teacher's request to complete the experiment step by step. This method has several disadvantages, for example, since the students need to receive a lot of knowledge at the beginning, they may forget the details of the teacher explained. So the teacher has to repeat it again and again. Therefore, although the students are interested in the experiment, they
may feel too hard to perform, and their enthusiasm is not high enough. After introducing the research-oriented experimental teaching mode, in the teaching process, the teacher needn’t to explain first, 2 or 3 students group together to self-study and set optical path layout. When the experiment finished, the students check first, if they can not find the problems they should ask another group for help to find out the problems. After that, the teacher organizes the students to discuss the advantages and disadvantages of each optical path and the other problems. Then the students adjust the optical path to exposure and rinse, when reproducing, students can analyze and discuss the reasons for this result according to the reproduction. If who is not satisfies with the results, he can re-arrange the optical path to shoot again. In this way, not only the learning enthusiasm of students is high, the success rate of the experiment has greatly improved. More and more students are willing to stay laboratory to discuss the experiment after class.

(2) In some traditional representative experimental projects, the teachers can introduce new contents, new methods and new means[3]. Then they try their best to change the traditional experiment into research-oriented experiment, or use the method to solve the problems in our life [4], or achieve diversification of experimental teaching methods. For example, the students can complete relatively simple experiments independently, and for more complex experiments they can finish it through the way of group discussion and mutual cooperation. While in some experiments the data calculation is very complex and students are easy to make mistakes during calculating, we can calculate the experiment data by computer software. In this case, the students can use the computer knowledge they have learned in physical experiment teaching.

For example, the polarization experiment of light is an experiment where the students produce various polarized lights in the laboratory by using the instruments and determine the type of polarized light occurred according to the experimental phenomenon. This experiment is very simple, but the physical knowledge is very abstract. A considerable number of students are hard to understand only though the teacher’s explanation, even someone thinks that circularly polarized light is a round spot seen on the screen. In order to help students understand the relevant knowledge, we should find or produce the corresponding animation, so that we can vividly and intuitively display the vibration of the polarized light, and even change the shape of light through the mirror. After then, we guide students to see the essence of it through the phenomenon, so as to think on the basis of understanding.

(3) Pay attention to cultivate students’ ability to independently analyze and solve problems in the teaching.

Because of students' ability, equipment, environment and other factors, something we are not expect may happen in the processing of experiment teaching. It is very common that the students’ first reaction is to ask the teacher when facing these problems. As a teacher, we shouldn’t tell the students the answer immediately, but should guide the students to identify the cause of the problem and solve it. In addition, compared to chemistry and biology, most of ordinary physical laboratory equipment is relatively safe, after students understand the operation of the instrument requirements, we should encourage students to independently operate instruments and equipments as much as possible, then they can better grasp and perform the experiment.

(4) We should carry out different levels of experimental teaching. Because of majors differs, students’ individuality, we should design different levels of teaching objectives, set different levels of learning requirements and provide different levels of counseling, so that each student learning can get independent development, and all students are able to progress and develop on their own basis in the physical experiment.

For example, for students of telecommunications and automation majors whose experimental basis and practical ability are good enough, the teaching objectives should be different from the students who major in food and mathematics, so as to classify different levels and teach the students according to their aptitude.

(5) Increase the proportion of designing experiments. When designing experiments, the teachers need to go through the selection, designing, experiment, collection of experimental data, analysis of experimental data collated and writing experimental reports or papers several stages. After
mastering some experimental skills and methods, students can use the knowledge they have learned and search for information to design a experimental program about the subject the teacher given (or their own topics), then they will finish the experiment in the laboratory and analyze the data and result. Through the aspects above they can finally write a complete experimental report or a small paper.[5] The purpose of the designing experiment is to develop students' ability to find problems, analyze problems and solve problems, then improve their experimental quality. It is of great significance to cultivate high-quality innovative talents. For most universities, the proportion of designing experiments is still relatively small. There is an example, the lessons of the designing experiments accounted for only one-sixteenth of the total physical experiments in our university.

Set up Innovative Experimental Projects.

The purpose of innovative experiment is to train students to think independently and research creatively. The student carry out experiments by topics choosing, designing their designs, and instructing their teachers.[6] In the process of innovation experiment, the student is the leader of the experiment, the teacher is in the auxiliary position. Compared to the traditional experimental teaching, innovative experiment is more emphasis on the experimental process rather than the results. Not subject to the time and length of class, in their spare time students can do in-depth exploration and research for some areas they are interested in. At the same time, it is worthy promoted that several students work together to complete the experimental project. These advantages have stimulated and mobilized the students’ initiative and enthusiasm for scientific inquiry, cultivated the students’ spirits to take the initiative to explore, rigorous truth-seeking, unity and cooperation, laid a good foundation of scientific research in the follow-up teaching and work. [7]

To carry out innovative teaching and experiment is the new direction and issue of teaching reform. Colleges and universities are conducting this experiment and exploration. Taking our university for example, we carried out some projects such as the student research program (SRP) and the laboratory open fund. More and more students enjoy participating in the innovative experiment. Furthermore, combined with the provincial physics experiment design contest, the Chinese physics academic competition, we also held the corresponding school contest, a large number of students involved, and received excellent results.

Summary

Research-oriented teaching is an important subject in the reform of college physics experiment teaching. In order to give full play to the role and advantages of physical experiment teaching in cultivating innovative talents, every experimental teacher have to participate in and carry on the unremitting exploration and research. We should contribute our efforts to cultivate high-quality innovative talents in the new period.

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