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How to Develop Students' Thinking Ability in College Physics Teaching

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ABSTRACT
In the process of College Physics teaching, it is found that students generally think that College Physics are difficult, and not helpful for their future work. In the classroom, they have no interest and no sense of gain, and so pursuing lower goal. Combined with the subject characteristics and the reform requirements of "new engineering", we adjust the teaching ideas as follows: taking students' development as the center, stimulating students' thirst for knowledge with interest and challenge as the starting point, cultivating students' thinking ability as the fundamental point, and stimulating students' sense of social responsibility as the leading point. The core of our teaching goal is to cultivate students' ability of autonomous learning, the ability of raising and solving problems, and the ability of innovation and entrepreneurship. In order to achieve the teaching goal, we have made some innovations in the teaching content, teaching design, teaching methods and teaching means, which have been widely praised by students and their abilities in all aspects have been improved.

Keywords: *Thinking ability, Physics, Interest, Sense of gain.*

1. INTRODUCTION

The university stage is an important transitional period for students to enter the society and an important preparation period to decide whether students can settle down in the society in the future. Therefore, we should first know what the needs of students' future development are. In the society of Internet and artificial intelligence, under the environment of online resources, what students need is not only the knowledge itself, but also the ability of autonomous learning in the face of massive knowledge, the ability of using knowledge to analyse and solve problems, and the ability of innovation and entrepreneurship.

College Physics is a science based on observation and experiment. It is also a science that advocates rationality and thinks highly of logical reasoning. Therefore, college physics not only provides essential basic knowledge of physics for students to learn follow-up courses and solve practical problems, scientific and technological problems, but also provides scientific thinking methods and the ability to put forward and solve problems [1], which is of great significance to cultivate students' spirit of exploration, innovation consciousness, and scientific world outlook. Hence, other courses cannot replace the role of College Physics [2], College Physics is a public compulsory course. However, many students have heard that College Physics is difficult; the failure rate of the examination is high; college physics has no direct help for the future work. And they have no great interest in physics, so their requirement for themselves is just to pass the exam.

Facing the above problems, we gave a lot of thought: (1) what will college students need after ten years? (2) how to support these needs in College Physics teaching? (3) how can I reform my classroom so that students can have high sense of gain? Combined with the characteristics of College Physics, and the reform requirements of "new engineering", we updated our teaching philosophy as follows: Taking students' development as the center, stimulating students' thirst for knowledge with interest as the starting point, and cultivating students' thinking ability as the fundamental point. Our teaching objectives have changed as follows: to cultivate students' ability to acquire knowledge independently; to cultivate students' ability of scientific observation and logical thinking; to cultivate students' ability of critical thinking and innovation. Under the guidance of this teaching philosophy, in order to achieve our teaching objectives and give students a multi-

dimensional sense of gain, we have made the following innovations about College Physics teaching.

2. COURSE CONTENT

2.1. Reconstruction and Optimization

First, we reconstructed and optimized the content of college physics to make it modular, ensuring that each knowledge module is more logical and scientific. This can help students to comb the logic and cultivate their logical thinking ability.

2.2. Updating With The Times

Physics is a subject based on observation and experiment, so we should expand the physics related content including life phenomenon, demonstration experiment, practical experience, scientific research progress, and technology application, which should update with the times. The practicality and interest can stimulate students' learning motivation, and then cultivate their autonomous learning ability

2.3. Challenging

In order to guide students to think from multiple angles, we should expand the challenging content. This can inspire students' deep thinking and cultivate their critical thinking ability.

3. INSTRUCTIONAL DESIGN

The instructional design integrates three main lines: logic line, story line and thought line, which closely integrates ability training with knowledge imparting and value shaping. We will explain these three main lines separately with the example: the theorem of angular momentum and the conservation law of angular momentum of rigid body.

3.1. The Logic Line

The logic line emphasizes the logic and scientific of knowledge, and helps students to achieve the knowledge goal.

Previously, we learned the law of rotation, the theorem of angular momentum of a particle. First, we derived the theorem of angular momentum of a rigid body from the angular momentum of a particle through calculus. The theorem of angular momentum is more universal than the law of rotation. The law of conservation of angular momentum can be derived when the external torque of the rigid body is zero. This is the logic line of this lesson, and helps students to comb the thoughts and get the knowledge.

3.2. The Story Line

The thinking of story line is: attracting the attention -opening up the thought - autonomous learning - deep thinking - extending the vision. The theorem of angular momentum and the conservation law of angular momentum correspond to a story line respectively.

The story line of the theorem of angular momentum is: why cannot a rotating wheel overturn - it depends on whether there is an initial angular momentum – the precession phenomenon in our life (gyroscopic inertia) - what's the use of the gyroscopic inertia (navigation).

The story line of the conservation law of angular momentum: why does a helicopter have two propellers - the propellers and fuselage will rotate in opposite directions if there is only one propeller - analysis of wheel experiment - how to adjust the attitude of space station (gyroscope).

The core of the two story lines is to inspire students' deep thinking, which can not only cultivate students' ability to solve problems, but also cultivate their ability of critical thinking and innovation.

3.3. The Thought Line

The thinking of thought line is: stimulate interest - arouse thirst for knowledge - solve puzzles - further challenges. Through problem scenes, students' interest and desire to acquire knowledge are greatly stimulated. On this basis, the teacher guide students to explore new knowledge, and solve the first puzzle. After that, we'll introduce challenging scientific and technological problems, stimulating students' desire for challenge, and finally solve the problems through discussion. This thought line can not only make students interested engaged in the whole teaching process, but also make students have a sense of multi-dimensional acquisition.

4. TEACHING METHOD

In the teaching process, different teaching methods are used for different knowledge modules, and each knowledge module adopts a combination of multiple teaching methods, which are scientific and diversified.

Each knowledge module at least integrates three methods: case study method, problem heuristic method and logical reasoning method.

4.1. Case Study Method

Case study method focuses on interest and practicality, which are the driving force of human beings to explore science. We can create problem scenes through life phenomenon, demonstration experiment, practical experience, technology application, and other cases, which can promote students to enter the scene,

construct knowledge system, and trigger the positive thinking. Therefore, case study emphasizes the introduction of teaching characterized by inducing cognitive conflict and the teaching process characterized by self-construction.

4.2. Problem Heuristic Method

Creative thinking comes from the process of constantly searching for answers [3]. The problems in the classroom must be suitable for students' thinking level. The problems can cause students' strong resonance, produce cognitive conflict, which can effectively stimulate students' interest in thinking and activate students' thinking process. Therefore, problem inspiration emphasizes the "double subject" teacher-student relationship with teachers as the leading and students as the main body in teaching activities.

4.3. Logical Reasoning Method

Logical reasoning ability is the foundation of all thinking ability [4]. In teaching activities, the process of solving the puzzles and completing the challenges can constantly train the students' logical reasoning ability. After the problems are solved, the teacher should guide students to summarize, reflect and evaluate the process of establishing their own laws or models, and cultivate students' practical ability of scientific construction. In the process of summary, reflection and evaluation, we can internalize the method of scientific thinking, monitor the results of students' thinking process, and facilitate students to better construct their own knowledge. Therefore, logical reasoning method emphasizes the collection, arrangement and processing of knowledge and the thinking training of the brain.

5. TEACHING MEANS

5.1. Preview Micro Videos

Make micro videos [5] for preview, encourage students to think actively and discuss interactively, and cultivate their ability of independent thinking and acquiring knowledge independently.

5.2. Experiments and Multimedia

Through demonstration experiments and multimedia, combined with video, animation, pictures and other ways, we can make the ability training and knowledge teaching concrete, intuitive and visualized.

6. CONCLUSIONS

Therefore, combined with appropriate teaching methods and teaching design, students' thinking can be "taught". Through the introduction of cognitive conflict, students' learning motivation can be stimulated; in the problem exploration activities, teachers can organize and listen first, let students construct independently, and complete the thinking process; in the places where students are confused and unable to reach, teachers can timely inspire and point out, monitor students' thinking process, insure that students' deep thinking can really occur. This process can train students' thinking ability, let them have enough thinking space for knowledge transfer, and prepare for their future learning and work.

AUTHORS' CONTRIBUTIONS

Hongxia Wang proposed the ideas of innovation and applied it to practice; wrote the paper. Zhaocun Zong practiced and revised the teaching theory; revised the paper. Guanghai Guo Revise teaching theory; revised the paper.

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