Research and practice of cooperative learning method in photoelectric technology training of college students

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Abstract: Based on the constructivist learning theory, this paper adopts cooperative learning teaching method and constructs the COME science and technology education model with classroom, ideas, methods and elements as the unit according to the model of Chinese college students' physics academic competition. After more than ten years of exploration and practice by the micro-nano optical science and technology innovation team, the results show that the teaching method of combining teacher guidance and cooperative learning in the teaching of university photoelectric science and technology training not only strengthens the communication and cooperation between students, exercises students' ability to analyze and solve problems, cultivates students' cooperative consciousness, innovative spirit and scientific research quality, but also improves students' academic performance in a large area, which can definitely enhance students' knowledge, ability and quality comprehensively and harmoniously.

Keywords: Constructivist learning theory; Chinese university student physics academic competition; cooperative learning method; come model; micro-nano optics; scientific and technological innovation team; scientific research quality

1. Introduction

In May 2016, as China's reform and development entered a critical and transition period, the CPC Central Committee and the State Council issued the outline of the national innovation-driven development strategy, proposing the three-step goals of becoming an innovation-driven country by 2020, becoming an innovation-driven country by 2030 and becoming a world power in science, technology and innovation by 2050. Eight strategic tasks were also laid out, including "building a high-level talent team and laying a solid foundation for innovation". At the national science and technology innovation conference, general secretary Xi Jinping proposed five requirements, including "carrying forward the spirit of innovation and cultivating talents that meet the requirements of innovation and development"[1]. Premier Li Keqiang also pointed out at the Higher Education Reform and Innovation Forum: "for schools, the first priority is to cultivate talents, which is the fundamental task of schools. At present, the key is to have the consciousness of innovation and the ability to practice, which is closely linked with innovation. So I think it's very important that how these basic studies can cultivate a sense of innovation."[2] In the aspect of cultivating scientific literacy in Chinese universities, there still exist many weaknesses, such as: how to exercise the students' ability to analyze problems, solve pro-
blems, to cultivate the students' innovation consciousness, team work spirit and communication skills as well as dilemma as how to enhance students' knowledge, ability and quality comprehensive coordinated development while pay more attention to strengthen the friendship and communication between students.

For this reason, this article establishes micro-nano optical science and technology innovation team in view of undergraduates and graduate students of optical information science and engineering, applied physics, physics. Based on the constructivism learning theory, it adopts the model of Chinese college students' physical academic competition and uses the method of cooperative learning to build the educational model with characteristics of classroom, viewpoint, method and elements, hoping that it can establish collaborative innovation idea, guide students to voice their opinions and have friendly discussions, show the elegant demeanour, learn from each other and improve together. Thus, it can finally help improve students' comprehensive ability to analyze and solve actual problems of photoelectric with their knowledge and cultivate students' open thinking ability to promote students' active exploration and construction of knowledge.

2. Theory and model

2.1 Core viewpoint of constructivism learning theory

Constructivism originates from the theory of children's cognitive development put forward by Swiss psychologist Piaget[3]. Since the individual's cognitive development is closely related to the learning process, the use of constructivism theory can better explain the cognitive rules of human learning process, that is, how learning occurs, how meaning is constructed, how concepts are formed and what major factors should be included in the ideal learning environment. Under the guidance of constructivism, a new set of effective cognitive learning theories can be formed and an ideal constructivism learning environment can be realized. The basic contents of constructivist learning theory mainly involve "the meaning of learning" (about "what is learning") and "the method of learning" (about "how to learn"). In this process, teachers are helpers and promoters of meaning construction rather than providers and cultivators of knowledge. Therefore, constructivist learning theory advocates taking student view, teaching view, knowledge view and learning view as the four basic viewpoints.

2.2 Basic elements of teaching mode

The teaching mode suitable for constructivist learning theory and constructivist learning environment is as follows: "Taking students as the center of the whole learning process, teachers play the roles of organizer, mentor, helper and facilitator in the whole teaching process to trigger students' initiative, enthusiasm and initiative spirit by learning environment elements such as situation, collaboration and conversation. What teachers' priority is to make students effectively realize the meaning construction of the current knowledge[4]. In this mode, students are the active constructors of knowledge meaning while teachers are the organizers, guides, helpers and promoters of the construction of teaching process. The knowledge provided by textbooks is no longer the content taught by teachers but the object of students' active construction of meaning. Media is no longer a means and method to help teachers impart knowledge but serves as a cognitive tool to create context, collaborative learning and conversational communication for the active learning and cooperative exploration of students. On such occasions, the role and relationship between teachers, students, teaching materials and media thus become a stable structural form of the teaching process, which are the teaching elements in the constructivist learning environment.

2.3 Cooperative learning

Under constructivism learning theory, it mainly includes inquiry learning[5], situational teaching[6], scaffolding instruction[7] and cooperative learning[8]. Among them, the cooperative learning method refers to the construction process that students and teachers share the results of thinking and enjoy the fruit of meaning construction in the form of study groups (referred as the interaction between teachers and students) by mutual communication, discussion, argument and amendment to achieve the goals of teaching and learning[9], as shown in Figure 1. Only when students' needs for belonging and influence are satisfied can they feel that learning is meaningful, then they will be willing to learn and learn
well. Based on this understanding, cooperative learning will be realized by satisfying students' psychological needs. In cooperative learning group cooperation activities, group members can communicate with each other, learn from each other, help each other and improve together. Students satisfy their need to influence others by offering help while they can also enjoy the sense of belonging by caring for each other. In this atmosphere, students are more willing to take the initiative to learn. Every student is to learn as an indispensable members of the team and everyone has his own unique tasks. Each member can make his unique contribution to the team and earn more respect from peers after that. In this way, students can be more willing to study for the need of winning self-esteem while the subjectivity of students can be further enlarged.

2.4 COME educational mode

According to the constructivist learning theory, student-centered cooperative learning method is adopted to form the education model COME referring to Classroom, Opinion, Method and Element, as shown in Figure 2. Through this model, we can actively create a good environment for classroom learning, innovation and entrepreneurship. The method follows the internal rules between students' view, teaching view, knowledge view and learning view and gives full play to the roles and advantages among students, teachers, textbooks and media. It embodies that cooperative learning is an effective learning way of interaction between teachers and students under the constructivist learning theory. Meanwhile it also creates an opportunity for students to communicate actively. In a certain period of time, students can get more abundant time to communicate with each other, inspire mutually, explore innovation, help each other and develop together. Teachers play the roles of manager, facilitator, consultant and participant in activities to constantly promote students' active exploration and construction of knowledge.
3. Teaching practice

3.1 Objectives of training

In the highly cooperative information age, good cooperation between people is the most fundamental requirement for human quality. Therefore, it is extremely important to create a democratic and cooperative teaching atmosphere mutual aid and a cheerful and relaxed teaching environment in classroom teaching in order to guide students to learn cooperatively and make progress together, which is not only an effective way to improve teaching efficiency but has a great effect on promoting the formation of good interpersonal relations among students. Therefore, we draw lessons from Chinese college students' physical academic competition pattern. Under the guidance of the constructivist learning theory in the modern education, integrating the theory with the situation of the optoelectronic information science and engineering and other majors as well as the characteristics of optical engineering, we carry out the teaching practice for three years on the basis of the study of the basic concept and theory of cooperative learning and on the premise of cooperation between teachers and students. From the perspective of teaching objectives, what we want to achieve will be shown as follows: (1) transformation of teachers' role; (2) transformation of students' learning style; (3) combined with the characteristics of optical engineering and physics, finding suitable cooperative learning teaching tasks and teaching content; (4) the grouping strategy under the condition of each grade.

3.2 Instructional design

Cooperative learning encourages students to work together for the benefit of the collective and the individual and to realize their own ideals in the process of completing common tasks. The following cooperative learning methods are generally adopted at home and abroad, namely, problem cooperative learning, performance cooperative learning, discussion cooperative learning, thesis cooperative learning and discipline cooperative learning. For example, for achieving technical papers, patents, projects, competitions, conferences etc., related to optical waveguide, optical switch, grating, optical module in the field of optoelectronics, each study group can focus on a variety of data related to the subject, observe a variety of data related to optoelectronics and finally write the discussion content together. Each group is made up of four or five students from the same grade (mainly referring to students of sophomore year, junior, senior and postgraduate students) and with the same theme, letting the predecessors help their successors and work together. Thus, students can integrate into the real practice environment through the utilization of the concept in reality. In this way, students' ability to solve problems can be greatly enhanced.

Targeting at senior and junior, graduate and undergraduate group strategy, this paper learns lesson from Chinese college students' physical academic competition mode and puts forward the strategy of making up groups of 4 to 5 members (pro group, opposition group and comment group) in each activity to establish equal, democratic and harmonious relationship between teachers and students and fully arouse the enthusiasm of students learning initiative. This is not only conducive to communication and cooperation but also does good to the arrangement and stability of interests, specialties and topics. An academic and technical seminar is held every two weeks with one topic for each discussion conducted by groups of pros, cons and critics, each of which is randomly composed of 4-5 students according to the subject situation. The process and control time of each discussion are shown in Table 1.
| Order | Major Content                                                                 | Time Limit (Minutes) |
|-------|-------------------------------------------------------------------------------|----------------------|
| Step 1 | The pro carries out a report on the subject                                   | 12                   |
| Step 2 | The opposite side asks the positive side and the positive side answers       | 2                    |
| Step 3 | cons to prepare                                                               | 2                    |
| Step 4 | The opposition reports (maximum 3 minutes), positive and negative discussion | 13                   |
| Step 5 | The critics ask questions and the pros and cons answer                        | 3                    |
| Step 6 | Comment party preparation                                                     | 2                    |
| Step 7 | Reviewer's report                                                             | 4                    |
| Step 8 | The pro summary                                                               | 1                    |
| Step 9 | Teacher makes comments and has discussion                                    | 6                    |
| Total | Total                                                                         | 45                   |

Table 1. Cooperative learning teaching process design process

In the whole process of teaching design, when the teacher guides the party to make a statement on a certain issue, the key points should be highlighted, including experimental design, experimental results, theoretical analysis, discussion and conclusion, etc. The cons party questions the weaknesses or fallacies of the pros' statement and summarizes the positive and negative aspects of the report. However, the content of the question raised by the opposite party shall not include its own answer to the question. They can only discuss the answer of the positive side and the commentator shall give a brief comment on the statement of the positive side and the negative side. Each side shall have one person in charge of the speech while other team members shall do a good job of supporting the speech and communicate with the team member in charge.

3.3 Cooperative learning

Before the seminar, students prepare for two weeks and release the topics and related materials in advance while they also have to organize the members of the positive side team to prepare the report and communication. The negative side and the critic read the discussion topics and contents released by the positive side and prepare relevant contents.

The seminar should be conducted according to Table 1.

At the end of the seminar, summary, publicity and in-depth communication will be conducted to make active preparations for the next topic selection.

4. Data and analysis

Evaluation methods shall refer to the evaluation standards of Chinese college students' physics academic competition, as shown in Table 2.
Table 2. Tripartite standard evaluation

According to the statistics from 2006-2018, we can see from Table 3.

| Time Year | Number of Students in School | Number of Papers Published | Number of Academic Conferences Attended | Number of Science and Technology Projects Hosted | Number of Patent Applications | Number of Graduate Students | Number of Entrepreneurs |
|-----------|----------------------------|----------------------------|----------------------------------------|-----------------------------------------------|-------------------------------|---------------------------|------------------------|
| 2006      | 12                         | 2                         | 3                                      | 5                                             | 2                            | 2                         | 1                      |
| 2007      | 15                         | 4                         | 5                                      | 7                                             | 2                            | 3                         | 1                      |
| 2008      | 16                         | 3                         | 6                                      | 8                                             | 3                            | 4                         | 2                      |
| 2009      | 17                         | 4                         | 7                                      | 10                                            | 3                            | 4                         | 1                      |
| 2010      | 18                         | 6                         | 7                                      | 11                                            | 3                            | 5                         | 1                      |
| 2012      | 16                         | 4                         | 8                                      | 12                                            | 3                            | 4                         | 2                      |
| 2013      | 19                         | 7                         | 8                                      | 10                                            | 3                            | 6                         | 2                      |
| 2014      | 20                         | 8                         | 9                                      | 14                                            | 2                            | 6                         | 3                      |
| 2015      | 17                         | 6                         | 8                                      | 11                                            | 2                            | 4                         | 2                      |
| 2016      | 18                         | 6                         | 9                                      | 12                                            | 2                            | 5                         | 2                      |
| 2017      | 17                         | 5                         | 9                                      | 14                                            | 2                            | 4                         | 2                      |
| 2018      | 15                         | 7                         | 8                                      | 16                                            | 3                            | 3                         | 1                      |

Table 3. Students' basic statistics from 2006-2018

The results from Table 3 show that the students' desire for scientific exploration is increasing, the publication of academic papers has been significantly improved, the awareness of participating in academic exchanges has been significantly enhanced, the team's ability to conduct scientific research has been improved, the awareness of intellectual property protection has also been improved and the comprehensive quality and social recognition are strengthened.

5. Conclusion

Through the training of photoelectric science and technology innovation and learning lessons from Chinese college students' physical academic competition pattern, the model COME has been found, which transfers the one-way traditional teaching into the two-way communication between teachers and students. It not only improves the students' learning initiative and self-control of learning but also enhances the teaching efficiency and promotes the good inter-
personal relationship between students and the development of the students' psychological quality and social skills. It is a new model of quality education that meets the development requirements of the new era.

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