Research on PBL teaching mode reform for the course of introduction to microelectronics

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Abstract. Problem-Based Learning (PBL) teaching mode is an effective teaching method for cultivating innovative talents. Based on the analysis of the teaching background of Introduction to Microelectronics and the PBL teaching mode, the course construction was planned and implemented in four aspects: the project topic selection of Problem-Based Learning, the course ideological education elements design, the material employment of science-technology cutting-edge and the construction of course assessment system. In addition, PBL teaching mode was designed the process of raising questions, exploring and solving questions, discussing and reporting and summarizing. The teaching design had been applied to practice and good teaching results had been obtained.

1 Introduction

With the improvement of human cognitive ability, professional science and synthesis had become the inevitable trend of contemporary science development [1, 2]. In the traditional form of teaching, teacher paid attention to the content of textbook, which was easy to make students incompetent for the theory using. Students had to memorize a large number of laws and theorems, through doing exercises to consolidate knowledge and methods. In many cases, it was difficult for students to combine the knowledge they had learned with the application in real work [3]. The teaching mode of Problem-Based Learning (PBL) emphasized that students should solve real problems in their own professional context through group learning, actively explore the subject knowledge hidden behind the problems, and fully mobilize their wisdom and creativity. Learning in the actual situation was conducive to students assimilating and indexing the new knowledge they need to learn from the original cognitive structure, so as to make learning new knowledge become to the source power, and strengthen the development and application of major in the process of new knowledge construction [4].

The development of social made college students' interests and aspirations become more diversified, and the mode of talent training tended to be diversified [5, 6]. In this paper, on the basis of the analysis of the PBL teaching mode and the course background of "Introduction to Microelectronics", the teaching design was carried on and applied and the teaching effect was analysed.

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2 PBL teaching mode

In 1969, Barrows, a professor of neurology in Canada, initiated the Problem-Oriented Teaching (that is Problem-Based Learning, PBL) in order to solve the problem that medical students would face complex situations in their future work and school classroom teaching was disconnected [7]. Later, the PBL teaching mode migrated from the medical field to architecture, management, economics, education and other fields. PBL teaching mode was an effective teaching method for cultivating innovative talents. It took students as the center and designed courses and practiced according to students' majors and future career characteristics. Teachers played the role of helpers, collaborators and promoters to improve students' cognition [8]. While recognizing the differences in learning styles and disciplines, PBL teaching advocated learning from practice and experience, mastering knowledge and developing skills simultaneously, meanwhile respecting students' self-development and encouraging teamwork [9].

PBL teaching mode was consistent with constructivism theory and Kolb's cognition theory. In the teaching, students were the main body with problems as the core and carried out learning centering on research projects and teachers were the director and guider in the whole process. According to Kolb's cognition theory, through reflection and abstraction, knowledge can be mastered from project research practice and applied to further work. PBL mode advocated setting learning in meaningful practical problems, allowing students to become the subject of learning. Students analyzed the problems, learned and mastered the knowledge needed to solve the problem, and solved the problem by cooperation. In the process of learning, teachers gave appropriate guidance to stimulate students' thinking and exploration, and cultivate students' ability of independent learning and innovation.

3 Teaching design

In today's society with the rapid development of information science and big data, microelectronics science and technology and industry plays an important role in the national economy, so it is very important to train high-quality microelectronics talents [10]. The course of Introduction to microelectronics teaches the basic knowledge of microelectronics for the students, which is more helpful to the cultivation of comprehensive talents. The main content of the course includes the semiconductor device physics, the system behaviour level design, the integrated circuit manufacturing process, testing and packaging, etc. Introduction to Microelectronics covers some of the latest ideas and achievements in the field of microelectronics. Students can have a general and comprehensive understanding of microelectronics by learning this course. It is found in teaching that students improve their knowledge level of microelectronics through systematic learning, but their ability to connect with practical application and solve practical problems is still quite lacking [11]. For example, students have learned Electronic Design Automation (EDA) technology, but it is still difficult for them to master the "Top to Down" Design method.

At present, there were mainly three kinds of problems in the teaching of Introduction to Microelectronics:

- Teaching method and assessment was single.
- The teaching content was numerous and complex.
- Teaching hours was limited.

In view of the course "Introduction to Microelectronics" offered in universities, we mainly conducted a side investigation through the network information. Based on comparative analysis, combined with the characteristics of students and curriculum settings

of the applied physics major in our school, the construction of the course of Introduction to Microelectronics is planned from four aspects:

- Material library construction of topic selection

The first way was by the class teacher to designate the topic. The second method was by the professional teachers to provide some research topics for students to choose. Third way was students choosing the topic by themselves and checking by the teacher.

- Construction of cutting-edge education materials for science and technology
- Consummating course assessment system construction

The typical teaching process of PBL teaching method was generally "Asking Questions -- Team Learning -- Teacher Evaluation -- Summary and Improvement". In the PBL teaching of Introduction to Microelectronics, we constructed the teaching process as shown in Figure 1. First of all, before the implementation of the PBL teaching method, students were allowed to combine freely and divided into 1 group of 3-4 people. A leader of each group was selected to coordinate the group's work and a recorder was selected to record the thinking process of the group's learning. Each group prepared a computer for searching information online.

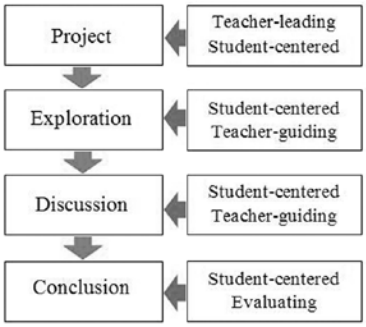

Fig. 1. Planning of PBL teaching implementation process.

Step 1: Asking questions
Step 2: Exploring and solving questions
Step 3: Discussing and debriefing
Step 4: Summarizing and reflecting

Through the Problem-Based Learning, students has a deeper understanding of microelectronics. Reflection on the learning process can further summarize the experience and deepen understanding. Teachers organized students to defend the project, helped students summarize the learning results, improve their knowledge level and increase their learning and research ability. The corresponding evaluation made by the teacher was numbered the course examination result.

The course construction and PBL teaching design had been completed in 2017 and applied in the teaching for the undergraduate students of applied physics major. By comparison, it is found that students' learning conditions had changed significantly before and after the PBL teaching of Introduction to Microelectronics, which was mainly manifested in the following aspects:

- Students' learning autonomy had been significantly improved.
- Students had strong interest in research.
- Course ideology and politics teaching can cultivate student a good attitude and habits.
- Cooperative learning and mutual learning became a habit.

In the PBL teaching mode, the relationship between team members also provided reference for students' future work and study. Harmonious and happy team relationship was

conducive to the development of benign interaction, to create a positive atmosphere for learning. The relationship between students is also more harmonious.

4 Conclusion

This study showed that the course of Introduction to Microelectronics is suitable for PBL teaching. In PBL teaching, individual differences of students were respected and independent learning, cooperative learning and research-based learning were carried out with project as the core. In the practice, students broadened their horizons, acquired knowledge, mastered the research methods of related problems and improved their own learning ability. Before and after the use of PBL teaching mode, students' learning status had changed obviously. PBL teaching made the students improve their learning autonomy significantly and have a strong interest in project research. They were good at cooperative learning and had formed a good attitude and learning habits. In addition, the problems in PBL teaching of Introduction to Microelectronics tended to focus on one or several knowledge points in the class. The knowledge points in the textbook that were not involved in the project research should also be paid attention to and learned. Moreover, according to the current curriculum setting, PBL teaching mode of Introduction to Microelectronics still needed to be integrated with the traditional teaching mode. Only by giving full play to the advantages of PBL teaching mode and learning from the successful experience of traditional teaching mode, the connotation construction level of university education will be really improved and truly returned to the road of original education.

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