PBL Teaching Application to the International Student Class

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Keywords: PBL teaching method, Circuit theory, International student education.

Abstract. With the increasing of enrollment scale of international students, their education is becoming an important part of the internationalization of Chinese colleges and universities, focusing on the college international students education is a key subject in our college education at present. These international students are from different countries, their knowledge background is quite different, especially on mathematics and physics. In order to help foreign students adapting to the professional training plan, the Problem Based Learning (PBL) method was adopted by full-English class teaching in Huazhong University of Science and Technology. This paper introduces the exploration of PBL Teaching Method in Circuit Theory Course, including design of teaching scheme, realization process in class and experience summarization, as a conclusion, PBL teaching combines classroom teaching and practice teaching organically, stimulated the students study interest, has received the good teaching effect.

Situation of International Student Education

With the increasing of enrollment scale of international students, their education is becoming an important part of the internationalization of Chinese colleges and universities, focusing on the college international students’ education is a key subject in our college education at present. The Ministry of Education persists in the policy of “expanding scale, improving level, ensuring quality, and standardizing management” opening to the international students, aims to train science, education, diplomacy and management talents for the world, especially the developing countries[1]. In 1950, China accepted the first group of international students from Eastern European countries. As the reform and opening up, the number of international students, the proportion of academic students (as shown in Fig.1) and the number of colleges and universities receiving international students continues have been increasing (as shown in Fig.2). However, international students are mainly from developing countries, a large fraction of the international students are from Asia and Africa, while a little of the students are from Europe, America and Oceania. As shown in Fig.3, in 2018, international students from Asian and African countries reached 77% of the total number of students, while European students are mostly from countries along the “Belt and Road” of China, such as Poland and Hungary[2].

![Figure 1. Statistics data of international students.](image-url)
Minister Yuan Guiren of the Ministry of Education proposed to implement the “Program of Studying in China” at the 2015 National Education Work Conference[3]. In recent years, all colleges and universities have taken strengthened measures on the education of international students and have paid more attention to the classroom teaching of international students. This is an efficient method for improving the quality of international students education and will lay strong foundation for the sustainable development of international student education[4]. Taking Huazhong University of Science and Technology as an example, this university has excellent traditions and rich experience in the cultivating international students, A project “full-English class teaching for international students“ has been launched to improve the teaching quality since 2005, the author took part in this project in order to teach circuit theory for international students. This English-speaking classes are open for international students coming from several different countries, their knowledge background is quite different, especially on mathematics and physics. In order to help foreign students adapting to the professional training plan, The Problem Based Learning (PBL) method was adopted in teaching and it has received good results. This paper introduces the PBL Teaching Method and Its Application, In response to the small number of students in the classroom and the high enthusiasm of students participating in the class discussion, Practice of PBL Teaching Method in Circuit Theory Course including design of Teaching Scheme, realization process in class and experience summarization, as a conclusion, classroom teaching and practice teaching organically, stimulated the students study interest, has received the good teaching effect.

PBL Teaching Method and Its Application

Traditional teaching methods have always been the main channel for imparting knowledge to students. However, if teachers adopt full-filled and crammed teaching methods, students will lose their initiative and autonomy, resulting in a dull classroom atmosphere and a weak relationship between teachers and students. Problem Based Learning is a problem-oriented, student-centered teaching method, it was first put up by American professor of neurology Barrows in 1969, it has become an internationally popular teaching method [5,6] and has a successful experience in medical, business, law and social education [7-9].
The PBL teaching method emphasizes students' active learning, the teacher is the designer of problem, the students solve problems through discussion, finding information, and asking questions. Students need to solve problems by independent inquiry and cooperative discussion, so as to learn the scientific knowledge hidden behind the problems, and form problem-solving skills and self-learning skills at last. On the other hand, Teachers are no longer "knowledge stockman", but promoters of knowledge construction and information consultants. Electric circuit theory is fundamental theory upon which other branches of electrical engineering are built, such as power, electric machines, control, electronics, communications, and instrumentation[10]. Many useful electrical systems are less complicated if one understands the electrical phenomena that take place at the terminals of the electrical components and devices that make up the system, such systems are adequately analyzed, and even synthesized, by the proper application of circuit theory. The goal in circuit theory is to define ideal elements so that when they are connected, the resulting interconnection will quantitatively predict the behavior of the actual system, and our major concern is the analysis of the circuits (interconnection of electrical elements). Therefore, the electric circuit theory course is the most important course for an electrical engineering student, and always an excellent starting point for a beginning student in electrical engineering education[11].

Practice of PBL Teaching Method in Circuit Theory Course

Electric circuit theory provides simple solutions (of sufficient accuracy) to practical problems that would otherwise become hopelessly complicated if approached from the broad point of view of electromagnetic field theory. The international students should have completed work in basic physics and mathematics, including differential equations, matrices and determinants. The course is difficult, in order to use the limited time to achieve good teaching results, it is necessary to stimulate the students' enthusiasm for learning. In the exploration of the application of PBL teaching method in the teaching practice of such important professional basic courses, the author selected several important knowledge points to design the PBL teaching plan and implement it in groups among students. This article takes the teaching plan of the "Magnetically Coupled Circuits" analysis as an example, and describes its implementation steps briefly.

Design of Teaching Scheme

"Magnetically Coupled Circuits" is a very important part of the sinusoidal steady-state circuit analysis, when two loops with or without contacts between them affect each other through the magnetic field generated by one of them, they are said to be magnetically coupled. Design of the teaching scheme includes: chapter objectives and contents. Chapter objectives are listed below:

1. Understand mutual inductance, dotted terminals, coupling coefficients.
2. Proficiently write the voltage-current relationship of the coupled inductors, analyze the sinusoidal steady-state circuit with the coupled inductors.
3. Understand and analyze the circuits with linear transformer and ideal transformer.

Chapter Contents includes “Mutual Inductance”, “Circuit Analysis with Coupled Inductors”, “Linear transformer”, “Ideal Transformers”, and “Applications”. Teaching Scheme of “Magnetically Coupled Circuits” begin with the concept of mutual inductance and introduce the dot convention used for determining the voltage polarities of inductively coupled components. Based on the notion of mutual inductance, the circuit element known as the transformer is introduced, transformer is a device that is based on magnetic coupling. The students are required to read through the transformers, which are used in both communication and power circuits. In communication circuits, the transformer is used to match impedances and eliminate dc signals from portions of the system. In power circuits,
transformers are used to establish ac voltage levels that facilitate the transmission, distribution, and consumption of electrical power. Then the knowledge of the sinusoidal steady-state behavior of the transformer is required in the analysis of both communication and power systems. We will discuss the sinusoidal steady-state behavior of the linear transformer in class, which is found primarily in communication circuits. We will deal with the ideal transformer, which is used to model the ferromagnetic transformer found in power systems.

**Realization Process in Class**

After the design of PBL teaching scheme, the realization process in class includes the following stages:

1. **Before class.** Arrange the goals and specific tasks of learning in advance, and students form a study group.

2. **In after class learning.** Teachers help students with poor mathematical and physical foundations make up for their deficiencies and let them get the basic knowledge of relevant content. Students with good foundations learn independently to master the preliminary analysis methods.

3. **In class group discussion.** First, let each student report their respective information, then let them discuss in the whole group. Finally, after the teacher's summary and guidance, students at different levels will understand the new knowledge points and correct the previous misunderstandings.

The application of PBL teaching in circuit theory course is a good compensation of the traditional classroom teaching. The basic concepts and basic laws of each content should be first taught by the teacher in the classroom, which provides a shortcut for students to understand the basic concepts. Combine circuit analysis method learning with PBL teaching to form a process of “teacher design problems—students solve themselves—groups share knowledge”. Throughout the teaching process, the teacher refers to the pathfinder, the students clearly understand the relevant issues and participate in the discussion with other classmates.

**Experience Summarization**

PBL teaching is open mode, it requires teachers' knowledge support and teaching skills. Teachers should be familiar with the syllabus and the ability of students, plan the knowledge points of learning, formulate targeted discussion outlines, and design appropriate questions. Teachers must have the ability to ask questions and solve problems, to use knowledge flexibly, and have rigorous logical thinking skills and good organizational management skills. This requires teachers to have a very high level of business to ensure that the teaching objectives can be achieved.

In addition, PBL teaching is suitable for small-scale international students' classrooms, which can solve the problem of large differences in the international students' knowledge background. However, the successful implementation of PBL teaching method needs the active participation and cooperation of students. Under the premise of teachers’ careful organization and serious participation in the discussion, PBL teaching can guarantee the effect of class and improve the quality of international students.

**Conclusion**

In summary, PBL teaching puts higher requirements to teachers on their teaching ability and knowledge level, more time and attention will be paid than traditional teaching, it is difficult to carry out in the big classroom of Chinese students and is unrealistic to promote in the undergraduate teaching process of higher education. On the other hand, PBL teaching is conducive to stimulating international students’ learning enthusiasm and developing their ability to learn independently, it also helps international students to communicate with each other, strengthens their teamwork awareness, and promotes the friendship between them.
As a result, PBL teaching needs excellent faculty, independent study, and active participation in discussion. The author has carried out PBL teaching exploration in international students class in Huazhong University of Science and Technology for many years, and has achieved good effect in classroom teaching.

Acknowledgement

This research was financially supported by the fund project of the School of Electrical and Electronic Engineering of Huazhong University of Science and Technology, “Building the English Course System for International Students in Electrical Engineering”.

References

[1] Information on http://www.moe.gov.cn/s78/A20/gjs_left/moe_850/tnull_48305.html

[2] Zhang Yan, Yi Hongjun, The Opening-up of Education in the Background of the Initiative of “The Belt and Road”: An Analysis of the Education for International Students in China, J. Tribune of education culture, 2019, 11(03): 67-72.

[3] Information on http://edu.people.com.cn/n/2015/0212/c1053-26554713.html

[4] Wang Yan, Xu Yani, Analysis on the Internationalization of Higher Education Courses, J. Education and Vocation, 2013, 23: 125-127.

[5] Gao Hong, The Characteristics and Enlightenment of German Vocational and Technical Education, J. Education and Vocation, 2004(07): 57-58.

[6] Chang Lixue, Higher Vocational Education in Canada and the United States, J. Journal of Shandong Institute of Commerce and Technology, 2004(01): 78-80.

[7] Jia Rui, Qu Qiumin, PBL Application and Experience of PBL in Neurology Teaching, J. China Higher Medical Education, 2011(02): 86-87.

[8] Lin Sha, Han Zhenguo, et al, A Brief Talk on PBL Teaching Method and Its Application in Teaching Reform in Our University, J. Health Vocational Education, 2003(02): 43-45.

[9] Li Lifan, Preliminary exploration of the application of PBL combined with traditional teaching methods in biochemistry teaching, J. Journal of Guangxi University of Chinese Medicine, 2006(03): 137-138.

[10] Zhu Yanfeng, Li Yangyang, Geng Dayong, Talking about the Ways to Improve the Teaching Quality of International Students’ Circuit and Circuit Experiment Course, J. China Electric Power Education, 2014(12): 122-123.

[11] Su Shiwei, Xiong Wei, Chen Mo. Exploration and Practice of Brand Course Construction for International Students in China, J. New Curriculum Research, 2016(12): 26-28.