

Exploration and Practice on Teaching Mode of Circuit Course in Engineering Education

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Abstract. Engineering education plays an important role in training the practical and innovative abilities of college students. However, there are obvious deficiencies in the traditional teaching mode of Circuit Course, such as outdated teaching contents and methods, single course evaluation system and so on. Aim at the shortages above, a new teaching mode of Circuit Course is proposed, including teaching contents of combining theory with practice, multi-dimensional course evaluation system and the training of various abilities of students. By employing proposed teaching mode of Circuit Course, various abilities of students such as practical ability and innovative consciousness could be trained and developed, and the overall development of knowledge, ability and quality is promoted.

Keywords: Engineering Education, Circuit Course, Teaching Mode Reform

1 Introduction

Circuit Course is one of the important basic specialty courses for electronic information undergraduates. This course mainly focuses on the principles of circuit elements and circuits, then introduces and demonstrates the fundamental circuit laws and analysis methods. The cultivation of engineering and technical talents in the new engineering education era needs to closely adapt to the rapid changes in national society, the progress on engineering technology, and the developing requirement of the industry [1-3]. In 2015, the general office of the state council issued the implementation suggestions on deepening the reform of innovation and entrepreneurship education in higher education institutions. The proposal indicates that based on the positioning of talent cultivation and the requirements of innovation and entrepreneurship education goals, all the colleges or universities should promote the integration of professional education, innovation and entrepreneurship education [4-6].

Traditional teaching mode takes the teachers as the center, which inhibits the initiative of students and bounds the cultivation of innovative talents [7,8]. Meanwhile, the phenomenon of disconnection of theory and practice is common and the evaluation system is examination-oriented, which is unfavorable for evaluating the comprehensive abilities of students [9,10]. Thus, the traditional teaching mode can no longer meet the requirements of current engineering education. Aim at the current problems of Circuit Course, the teaching exploration in this paper takes the cultivation of circuit thinking, engineering thinking, innovative thinking as the

breakthrough points and is carried out in aspects of teaching contents, teaching methods, course evaluation and so on, which are designed to develop professional ability, practice ability and innovation ability. Through the exploration and practice on teaching mode of Circuit Course, the teaching effectiveness and the teaching quality could be improved.

2 Problems in Circuit Course Teaching

As a standard technical basic course in the field of engineering education, Circuit Course has its own characteristics, such as: 1) a large amount of knowledge and relatively stable basic knowledge points; 2) involving the knowledge related to mathematics and physics; 3) calling for the high comprehensive abilities of students; 4) the continuous emergence of new application technology. Owing to these characteristics, some restrictions on teaching mode or methods might be involved, and even limit their further development. Combined with the characteristics of Circuit Course, the current problems in teaching are given as follows.

2.1 Outdated Teaching Contents and Methods

Circuit Course is the important basis of the successive professional courses. It focuses on the principles of circuit elements and circuits, the fundamental circuit laws and the analysis methods of circuits, where many kinds of circuits and their analysis methods are the emphases and difficulties. In addition, as for circuit components, circuits and their relative analysis methods, a large amount of physical and mathematical knowledge is involved. For this reason, teacher-centered lecturing method is mainly adopted in Circuit Course. Moreover, Circuit Course is so abstract and full of a large amount of knowledge. All these cause that the enthusiasm and interests of students cannot be inspired, and the classroom teaching seems monotonous. In-class teaching is an important factor that affects the result of in-class teaching. Thus, the teaching methods should be copious and represent student-centered teaching theory.

2.2 Single Evaluation System

The teaching of Circuit Course contains theory, practice and knowledge integrated application, which requires students to be equipped with various abilities. At present, the course evaluation system includes exam results and peacetime results as the main form. The exam results depend on a written final exam, and the peacetime results focus on coursework, class participation and so on. This traditional course educational evaluation exists serious abuse in functions, contents and styles of evaluations, which is unable to effectively evaluate various abilities of students. Therefore, the multi-dimensional course evaluation system is important to pay attention to the overall development of students.

2.3 Neglecting Development of Various Abilities

In the traditional teaching process, great emphasis is placed on theory teaching, and practice ability training is always ignored [11]. It causes that theoretical knowledge is divorced from practice. On the other hand, with the development of new circuit techniques, parts of teaching contents need to be properly adjusted and updated for adapting new technology development. Hence, the traditional teaching mode is adverse to develop innovation ability and cultivate

innovative consciousness. To satisfy the requirement of highly skilled personnel, theory combining with practice plays an important role in the teaching process of Circuit Course.

Based on the above problems in Circuit Course teaching, it is important to select the teaching mode that chooses for Circuit Course in keeping with teaching contents, teaching means and evaluation system.

3 Exploration on Teaching Mode of Circuit Course

3.1 Teaching Contents of Combining Theory with Practice

The traditional Circuit Course teaching contents mainly focus on theoretical knowledge, and students are mostly constrained to the textbooks, which results in lacking of combining together with the practical applications and the theories. Even owing to the abstract theories and concepts, students lose interest in learning and lack learning motivation. Based on these, the new teaching contents combine textbook knowledge with course experiments, frontier researches and college students' innovations and pioneering project, shown in Figure 1.

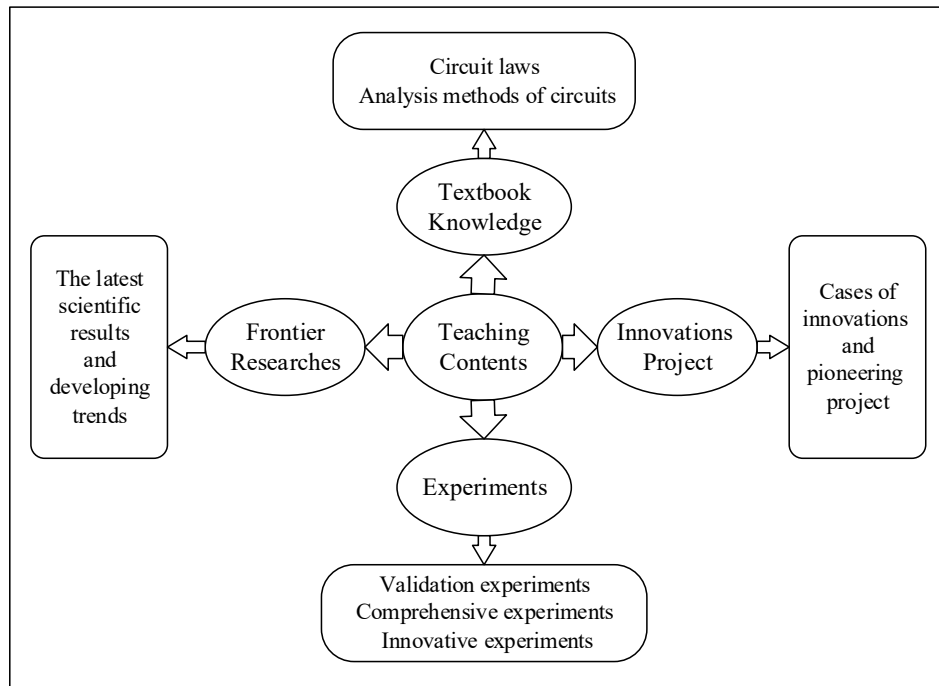


Figure. 1. Proposed Teaching Contents of Circuit Course

1) **Course experiments:** the practical training of Circuit Course.

Although circuit experiments combined with theoretical teaching were performed in some universities or colleges, there are some problems in experiments, such as single and fixed content, lack of innovative experiments, etc. To solving the above problems, a system of circuit

comprehensive experiments is established. It is the verification and application of circuit concepts, circuit principles and circuit theorem. More importantly, there are validation experiments, comprehensive experiments and innovative experiments in proposed system. The innovative experiments require that the experimental circuits need to be designed by the students according to the experimentation tasks. Fundamental practical ability, engineering practical ability and creative practice ability of students can be improved. Course experiments take sixteen class hours and consist of six parts, shown in Table 1.

Table 1. Experiment assignments of Circuit Course

Class hours	Contents
4	Volt-ampere characteristics of circuit elements and Kirchhoff law
2	Thevenin theorem and Norton theorem
2	Operational amplifiers and controlled sources
2	Linear dynamic circuits
2	Resonant characteristics of RLC series circuit
4	Frequency characteristics of RC circuit

2) **Frontier Researches:** the hotspots in the field of circuits.

The latest scientific results and developing trends should be put in the process of Circuit Course teaching. The introduction of subject front issues could help students receive the latest technologies, arouse the curiosity and stimulate thirst for knowledge.

3) **Innovations and pioneering project:** enhancing innovation ability of undergraduates.

Here, the innovation and entrepreneurship project for college students are taken as an example during the teaching. The Innovations and pioneering project could strengthen the innovative consciousness and entrepreneurial ability, and cultivate high-level innovative talents.

In this way, the interest of learning and enthusiasm of students could be motivated, and various abilities could also be developed.

3.2 Multi-dimensional Course Evaluation System

The traditional Circuit Course evaluation system mainly focuses on exam results and peacetime results. There seems to be a lack of monitoring the whole process of teaching, which causes the shortcomings of evaluating student capacity. Here, to compensate the above shortcomings, the proposed multi-dimensional course evaluation system is made up of two parts: process evaluation and summative evaluation. The two symbols of process evaluation are feedback and process, which are different from traditional peacetime evaluation. The process evaluation is formed by coursework, experiments, class participation and phased exams. The results of summative evaluation are also decided by a written final exam. The proposed Circuit Course evaluation system is given in Figure 2.

The components of process evaluation are introduced in some detail as follows.

1) **Coursework:** Tamping the basic concepts and principles of Circuit Course.

Coursework accounts for ten percent of the final Circuit Course results. On completion of this course, the coursework results are the mean value of all five coursework marks.

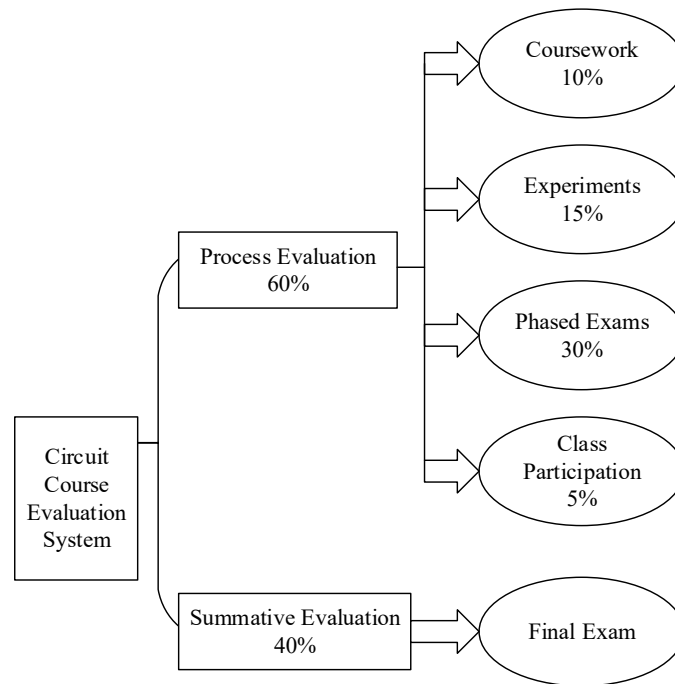


Figure. 2 Proposed Evaluation System of Circuit Course

2) **Experiments:** Training the innovation and practicing ability of students.

Experiments make up fifteen percent of the final course results. At the end of the course, the experiment results are decided by the average value of all six experiment marks.

3) **Phased Exams:** Capturing and feedbacking the dynamic learning state of students timely.

During the whole class session, there are three phased exams to check the learning of students, seen in Table 2. The phased exams account for thirty percent of the final course results, and the phased exam results are the sum of three phased exam marks.

Table 2. Phased exams of Circuit Course

Order Number	Contents
1	Kirchhoff law and equivalent conversion of circuits
2	Analysis of DC resistance circuits
3	Analysis of first order circuits

4) **Class Participation:** Inspiring the interest of students, promoting interaction cooperation of students and cultivating autonomous learning of students.

Class participation is five percent of the final course results, and it is evaluated on the basis of classroom questions, group discussion and so on.

By adopting different kinds of examination models, various abilities of students are estimated from multiple dimensions.

3.3 Developing Various Abilities of Students

The traditional Circuit Course teaching process makes theory teaching as the center and neglects the development of practice ability, which induces that theoretical knowledge is divorced from practice. In proposed teaching mode of Circuit Course, new teaching contents and multi-dimensional course evaluation system are employed.

The multi-dimensional course evaluation system consists of two parts: process evaluation and summative evaluation. In the process evaluation, coursework, experiments, phased exams and class participation are adopted for evaluating various abilities of students. Through the process evaluation, the instructors could assess the learning state of students, find some problems in time and help students grasp course knowledge better. According to the features of Circuit Course, experiments are systematically arranged with a unified planning and designed from simple to comprehensive. It could guide students to observe creatively, think diligently and practice more. The practice ability of students is gradually developed.

Moreover, in the whole process of Circuit Course teaching, frontier researches and innovation projects of college students are involved, which could help students increase the capacity of innovation and arouse innovative consciousness.

In a word, the proposed teaching contents and evaluation system of Circuit Course could raise the students all kinds of abilities, shown in Figure 3.

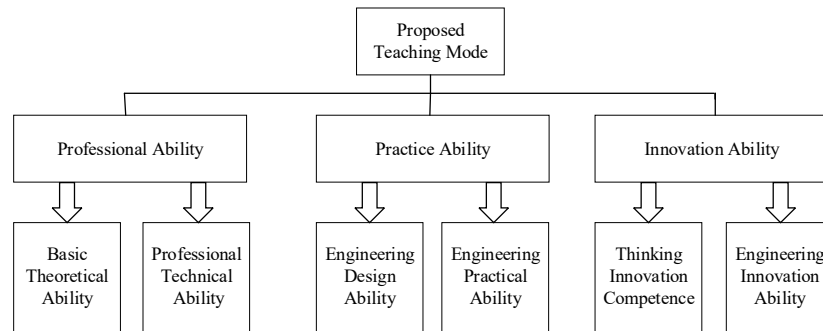


Figure. 3 Development of Students' Abilities by Employing Proposed Teaching Mode

4 Conclusions

In the light of the existing problems in the traditional Circuit Course teaching, this paper gives new teaching mode in engineering education, including teaching contents and multi-dimensional course evaluation system. The proposed teaching mode is student-centered and guided by developing various abilities of students, and the main contributions of this paper are listed as follows.

1) According to the needs for the development of engineering education, new teaching contents of Circuit Course are integrated. Experiments, frontier researches and innovation projects of college students are covered. Combining with textbook knowledge and the above three parts, the practical ability and innovative consciousness of students could be gradually aroused. The

improvement of various abilities could help students know how to apply what they have learned in engineering problems.

2) Based on the proposed teaching contents, the multi-dimensional course evaluation system is given, which plays an important role in enhancing teaching effectiveness and evaluating various abilities of students. In proposed evaluation system, process evaluation is employed besides the final exam. Through process evaluation, the instructors could timely make full understanding of the students and grasp the situation to adjust teaching.

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