Exploration on experimental teaching reform of non-electrical major electrical and electronic technology course

Rong Chen * , Lijing Yang

Guangdong University of Science and Technology, Dongguan, Guangdong 523083, China

Abstract. Aiming at the disconnection between theory and practice in the experimental teaching of electrical and electronic technology courses, students do not have a deep understanding of knowledge and cannot exercise their practical ability. This paper puts forward the application of simulation software to the experimental teaching process of electrical and electronic technology to form an experimental teaching model combining theory, simulation and practice. The results show that the proposed teaching method can deepen the students' understanding of theoretical knowledge, improve their interest in learning, enhance their innovative application ability, and significantly improve the teaching quality.

1. Introduction

The course of electrical and electronic technology is a basic compulsory course for non-electrical majors of science and engineering. Through the study of this course, students will be familiar with the basic theories of electrical and electronic technology, master the basic knowledge, have the corresponding basic skills, and cultivate students' ability to discover, analyze and solve problems. Students are required to master the working principle, basic characteristics and basic operation skills of electrical and electronic components and electronic devices in common use; Understand the basic concepts, basic theories and basic laws in electrical and electronic engineering; Understand the current development status of electrical and electronic technology; And can correctly use common electrical instruments and electrical and electronic devices, can correctly connect the circuit. There are many knowledge points in the course of Electrical and Electronic Technology, and it is difficult for students to learn and understand the theoretical knowledge by using traditional classroom teaching methods. In the case that the class time of the course is limited, in order to complete the theoretical knowledge, the experimental teaching time of the course will be invisibly compressed. Usually, the experimental teaching of this course is arranged for 5-7 experimental lessons, and each experiment can only verify the corresponding theoretical knowledge points. [1]

In addition, there is a separation of theory and practice in course teaching. Under normal circumstances, students focus on theoretical learning first, and then carry out experimental operations after the experimental manager arranges time, which will indirectly cause the mismatch between theoretical knowledge and experimental knowledge. The content of the experiment is the verification of the learned circuit law, which is relatively fixed, without innovation, and lacks the cultivation of students' ability to explore and innovate. Students connect, verify data and conclusions according to the circuit assigned by the teacher. For students with a general foundation, it can meet their learning needs, but for students with a good foundation and strong interest in learning, it is tasteless, and can not fully mobilize the enthusiasm of these students. [2]

In view of the above situation, this paper adds simulation software on the basis of the original experiment teaching to form a teaching model combining theory, simulation and practice.

2. Online experimental teaching of chaoxing platform

Online experimental teaching was established on the chaoxing platform. chaoxing platform is a course-centered, teacher-led and student-centered smart online teaching platform targeting online teaching and learning, covering a variety of classroom teaching modes. On this platform, teachers can easily set up teaching resources, and teaching activities have rich functions, such as homework, discussion, sign-in, examination and so on. Before the experimental class, an online class of "Electrical and electronic Technology experiment" was established on the chaoxing platform, materials required for preview were uploaded, and learning tasks, such as short videos, experimental content and other related materials were published, to provide rich preview materials for students. The knowledge points are set as task points to urge students to complete the preparatory work on time and efficiently. Students enter the chaoxing platform for learning and complete the corresponding task points. Teachers can know the preview situation of each student in real time on the chaoxing platform and urge the learning to complete the task in time. Through online classroom learning, students fully understand the

*Corresponding author: Rong Chen,Email: 1140835901@qq.com

experimental purpose, experimental principle, experimental content and matters needing attention in the experimental process, and further consolidate the learned knowledge through the knowledge point test, so as to improve the efficiency of the experimental class.[3]

3. Simulation experiment with simulation software

Students can use Multisim or Proteus simulation software to simulate experiments, as shown in Figure 1, and use the simulation software to draw the basic circuit diagram as shown in Figure 1. According to the simulation results, students draw the output waveform diagram of the diode and its application experiment, and draw it on the experiment report, so that students can master the experiment principle and get familiar with the experiment operation. Try to avoid students due to improper operation of experimental equipment damage or overuse, so as to improve the service life of experimental equipment and improve experimental efficiency. [4]

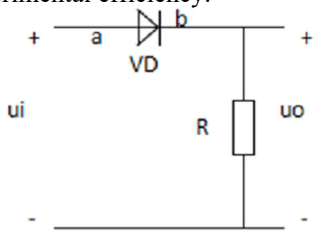

Fig. 1. Diode rectifier circuit

Multisim is a Windows-based simulation tool for board level analog/digital circuit board design. It includes the graphic input of the circuit schematic, the input of the circuit hardware description language, and has rich simulation and analysis ability.

Proteus software not only has the simulation function of other EDA tool software, but also can simulate single-chip microcomputer and peripheral devices. It is a good tool to simulate microcontroller and peripheral devices. Proteus provides a wealth of test signals for circuit testing, including analog signals and digital signals. [5-6]

The basic operation learning video of the two simulation software and the verification experiment simulation operation video will be posted on the learning portal for students to learn before class.

4. Laboratory for practice

Through the study of theoretical knowledge and simulation, students have a relatively intuitive impression of diodes and diodes, resistors and conductors used in application experiments, and then the study of experimental courses will get twice the result with half the effort. At the same time, students will be reminded of precautions when doing experiments, protecting experimental instruments, and using electricity safely. The main instruments and materials used in the experiment are: low-frequency signal generator, oscilloscope, diode and resistor. [7]

The experimental process of diode and its application is as follows:

(1) The discriminant polarity of the diode: respectively measure the positive and negative resistance of the diode, and the resistance value measured is smaller once, that is, the positive resistance of the diode.

(2) Diode application circuit:

Connect the circuit in Figure 1 to the test box.

A.when the input voltage Ui is 5V, 0 and -5V, use a digital multimeter to measure the circuit voltage Uab and output voltage Uo at both ends of the diode, and write down the data.

B.when the input voltage ui= (5Sinwt) V, use the oscilloscope to watch and draw the ui and uo waveforms. (Assume that the input voltage frequency f=1000Hz is generated by the signal generator.)

There will be some errors between the results of the experiment and the data of the simulation and principle, so students should be correctly guided to deal with the error value.

5. Experimental course management

The class was divided into three to five students in each group, and a leader was selected for each group. They learned theoretical knowledge before class, and analyzed the experimental results with theoretical knowledge by understanding the experimental content, while other students analyzed the correctness of the results. The leader of each group reasonably divided the work to be completed by the group, and ensured that every student was involved. In the class, two students will practice in a group and strive for each student to achieve the experimental purpose and requirements. After class, each student completes their own experiment report.

6. Assessment and evaluation of experimental courses

The evaluation result consists of three parts: the preview of the experiment class, the practice of the experiment class and the experiment report after class. Preview results can be derived from the completion degree of preview tasks and video learning rate in learning. The practical exercise in class mainly evaluates students' subjective initiative and practical ability, and grades students according to the design and connection of experimental circuits, the use of instruments, and the integration of laboratories. After class, teachers give grades according to the correctness and completeness of students' experiment reports. [8-9]

7. Innovative Practice

Taking diode and its application experiment as an example, the whole teaching process of experimental reform in the course of electrical and electronic technology is described. Other in-class experiments such as the measurement of voltage potential and external characteristics of power supplies, the verification of Kirchhoff's law and superposition theorem, the response test of first-order RC circuits, the test of common emitter

single tube amplifying circuits, the basic combination and logic circuit experiments, the analysis and design of combinatorial logic circuits, etc., can follow this teaching process. In the course of the experiment, some students have strong hands-on ability, so after completing the content of the experiment report, we will arrange the students who have the ability to carry out the design experiment, so as to prepare for the follow-up study of other professional courses and participate in the skill competition. [10]

In order to better master the basic knowledge of electrical and electronic engineering, students of non-electrical majors are arranged to have 1-2 weeks of electrical practical training after offering theoretical courses (including in-class experiments), so that students can further improve the knowledge they have learned.

In electrical engineering practice, the students need to master the following skills and knowledge: (1) the guaranteed stop control of three phase asynchronous motor: students need to know about motor start, maintain, and stop the process, and how to implement these functions through the circuit. This includes the use of contactors, push-button switches and other electrical components to control the start, stop and hold of the motor. (2) Positive and negative circuit control of three-phase asynchronous motors: Students need to understand the positive and negative principle of the motor, and how to achieve the positive and negative rotation of the motor by changing the connection mode of the circuit. This includes the use of contactors, push-button switches and other electrical components to achieve positive and negative motor control. (3) Y-Δ step-down start control of three-phase asynchronous motors: Students need to understand that the motor needs a larger current when starting, and a smaller current when normal operation, and how to achieve this function through the Y-Δ step-down start circuit. This includes the use of contactors, push-button switches and other electrical components to achieve Y-Δ step-down start control. (4) Control practical exercise of two-speed motor: Students need to understand that the motor has two speeds, high speed and low speed, and how to achieve high speed or low speed operation of the motor by changing the connection of the circuit. This includes the use of contactors, push-button switches and other electrical components to achieve the control of the two-speed motor.

The main objective of electrician training is to broaden students' knowledge and improve their practical skills. When conducting practical training projects, students are required to pay attention to safe operating procedures, such as the correct use of electrical tools and compliance with electrical safety codes. In addition, students also need to learn to use electrical measuring instruments to measure and judge electrical parameters. Through the study of these practical training projects, students will better understand and master the basic knowledge and skills of electrical technology, and lay a solid foundation for future work.

8. Conclusion

The teaching of theory and simulation promotes students' understanding of abstract theoretical knowledge. Through static or dynamic demonstrations of circuits, students are better able to analyze and solve design circuit problems. Simulation teaching provides students with unlimited opportunities to try, has a rich library of components, and brings unlimited possibilities to learning. At the same time, simulation and experiment teaching also improves the utilization efficiency of laboratory equipment and reduces the loss rate of equipment. Through the experimental teaching reform integrating theory, simulation and practice, students not only master the theoretical knowledge of the course more skillfully, but also improve their practical ability greatly. This teaching mode is conducive to mobilizing the enthusiasm of students, so that they can grasp the curriculum knowledge, and improve the ability to analyze and solve problems.

Teaching and research Projects:

Guangdong University of Science and Technology 2022 Higher Education Reform project: Construction and implementation of innovative talent training model for mechanical majors. (Project No. : GKZLGC2022094)

Guangdong University of Science and Technology 2023 curriculum Ideological and political demonstration course: Electrical and electronic technology. (Project No. : GKZLGC2023203)

References

1. Dong Yingying. Application of Multisim10 Simulation Software in Practical Teaching of Electrical and Electronic Technology [J]. Information and Computer,2019(21):248-249.
2. LI Wenchao, Wan Xiaohang, LI Minghui. Application Research of "EveryCircui+ Breadboard" in Teaching Practice of Electrical and Electronic Technology Course [J]. Modern Vocational Education.2023(5):34-36.
3. Wang Yanhong, Feng Junjie. Practice of Teaching Reform of Electrical and Electronic Technology Course based on "Theory + Simulation + Practice" [J]. Computer Knowledge and Technology. 2022 (7) : 144-145.
4. Zou Wang, Ji Chang, He Chao. Research on Teaching Reform of Electrical and Electronic Technology Experiment Course Based on "Learning Pass" and Multisim Simulation [J]. Computer Knowledge and Technology. 2022 (7) : 164-165.
5. Li Hui, Zhao Ming, Zhang Yuru. Electrical Technology Teaching Reform based on Proteus Simulation [J]. Science and Technology Wind,2019,371(03):24+31.
6. Wu Xia. Design and Practice of teaching mode combining online and Offline experimental courses [J]. Laboratory Research and Exploration,2019,38(5):173-176,199.

7. Wang Guiqin, Wang Youlin. Electrical and Electronic Technology (2nd Edition) [M]. Beijing: China Machine Press, 2023:170-173.
8. HernándezChávez Macaria, CortésCaballero José M., PérezMartínez Ángel A. et al. Development of Virtual Reality Automotive Lab for Training in Engineering Students[J] Sustainability, 2021, 13(17)
9. Manuel Förster, Maur Andreas, Weiser Constantin et al. Pre-class video watching fosters achievement and knowledge retention in a flipped classroom[J] Computers & Education, 2021(prepublish)
10. Bi Yuchun, Chen Lianyu. Design of Experimental Teaching Model for Electrical and Electronic Technology Course [J]. Application of Integrated Circuits, 2023,40 (11) : 228-229.