Research on the Teaching Reform of the Integration of Professional Education and Innovation and Entrepreneurship Education in the Course of Digital Electronic Technology Under the OBE Concept

Chengquan Liang(✉), Ying Zhang, Deshen Lv, and Xinqiang Yang

School of Intelligent Manufacturing, Nanning University, Nanning 530200, China
759137827@qq.com

Abstract. The teaching reform of the integration of professional education and innovation and entrepreneurship education based on the OBE concept is proposed in response to the issues in the course of digital electronic technology, including dull theoretical teaching, serious disconnection between practical teaching and theory, insufficient depth of content, and lack of integration of innovation and entrepreneurship education. The project achievements suitable for the course are derived from innovation and entrepreneurship competitions and enterprise projects. By integrating innovation and entrepreneurship projects with professional knowledge, project-based teaching involves students learning by engaging in real projects under the guidance of teachers. It has been proven that the reform has yielded impressive results, with students demonstrating heightened enthusiasm for learning and a firm grounding in professional knowledge, alongside a marked improvement in their practical abilities. Consequently, the reform serves as an assurance of the emergence of innovative individuals who are capable of making significant contributions to society .

Keywords: OBE Concept · Digital Electronic Technology · Integration of Professional Education and Innovation and Entrepreneurship Education · Project-Based Teaching

1 Introduction

Compared to analog circuits, digital circuits have the advantages of easy integration, high reliability, fast processing, easy storage, and programmability, making them a widely used class of circuits [1]. Digital circuits can be seen everywhere, and it can be said that we are now in a world of digital circuits [2]. The computers, mobile phones, televisions, printers, scanners and projectors we use in our daily lives all belong to the category of digital circuits. The manipulator control, product count, and circuit automation welding are also applications of digital circuits in the industry. Along with the constant improvement of industrial production technology, and digitization of equipment is the direction of transformation and upgrading [3].

D. Kumar et al. (Eds.): IEIT 2023, AHSSEH 10, pp. 1124–1132, 2023.
https://doi.org/10.2991/978-94-6463-230-9_134

Digital Electronic Technology is a highly practical course that introduces the basic principles, theories, and design of digital circuits [4]. The main teaching content includes the basics of digital circuits, logic algebra, basic gate circuits, analysis and design of combinational logic circuits, and analysis and design of triggers and sequential logic circuits [5]. This course focuses on cultivating students with knowledge of digital circuits, logical analysis ability, circuit design ability, and operation ability, laying a foundation for subsequent courses on microcontroller principles and applications, computer control technology, PLC technology, etc. Digital integrated chips are commonly used in the course to cultivate students' self-learning ability and ability to access information [6]. It can help students develop a serious, hardworking, and practical work style as well as a standardized, upright, and rigorous academic attitude. Therefore, it is essential to learn the course of digital electronic technology well [7].

Against the backdrop of building an innovative nation, universities stand as the primary ground for nurturing the country's innovative talents. Therefore, the cultivation of a significant number of innovative and entrepreneurial individuals is imperative for the country's advancement [8]. Integrating innovation and entrepreneurship education into professional education helps to cultivate students with professional knowledge, innovation awareness and entrepreneurial ability. Outcome-based education (OBE for short) is a student-centered and results-oriented paradigm, one of the core concepts of professional certification in engineering education [9]. It aims to cultivate students' ability to solve practical problems in engineering. Accordingly, it is imperative to reform, based on the OBE concept, the course of digital electronic technology by integrating professional education and innovation and entrepreneurship education. The key to this reform is how to integrate innovation and entrepreneurship knowledge with professional knowledge of digital circuits in practical projects in a systematic manner.

2 Status Quo and Main Issues of the Digital Electronic Technology Course

Most colleges and universities have set up courses in digital electronic technology in such majors as electrical engineering and automation, electronic information engineering, communication engineering, and electronic science and technology with traditional teaching methods. The traditional teaching method of digital electronic technology gives first place to theoretical teaching, separated from experimental one.

In terms of the theory course of digital electronic technology, first of all, the basic knowledge of logical algebra is taught, which mainly includes base conversion, basic laws, basic rules, common formulas, logical function representation, logical function simplification (formula simplification, Karnaugh map simplification) [10]. Secondly, after the introduction of integrated logic gate circuits, combinational logic circuits are taught, including adders, encoders and decoders, data allocation and selectors, and digital comparators, with a focus on the application and design of combinational logic circuits. The triggers are introduced to lay the foundation for the learning of sequential logic circuits in the next chapter, followed by the design and analysis of sequential logic circuits. The final part goes to the application of other digital chips, such as the 555 integrated chip and analog-to-digital and analog-to-digital converters. The teaching process is shown in Fig. 1.

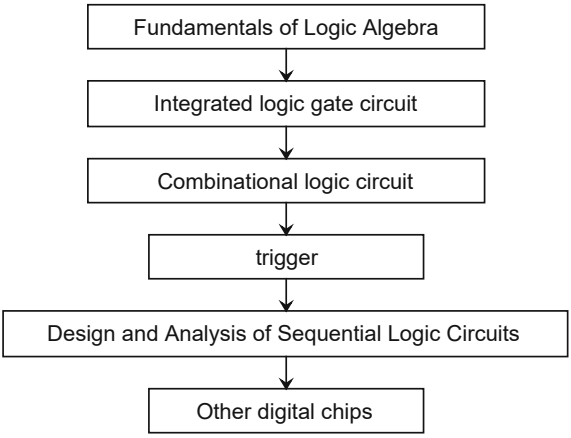

Fig. 1. Theoretical teaching process of digital electronic technology course

As for the experiment course, the experiments to be conducted are as follows, (1) Functional verification of basic logic gate circuits; (2) Analysis of combinational logic circuits; (3) Design circuits using basic gate circuits; (4) Design circuits using combinational logic chips (74LS138, 74LS151, 74LS153, etc.); (5) Functional verification of common triggers; (6) Design of counters; (7) Design of an N-scale circuit composed of counters; (8) Comprehensive application of counters.

Most teachers in colleges and universities conduct theoretical teaching and experimental teaching separately and carry out experimental teaching after completing theoretical teaching. Such theoretical courses appear dull and uninteresting without mobilizing students' enthusiasm, with the serious disconnection between practical training courses and theory, insufficient depth of content, and lack of integration into innovation and entrepreneurship education. In the new era of "mass entrepreneurship and innovation", it is difficult for students to meet the demands of enterprises if trained without sufficient theoretical knowledge, strong hands-on ability, and rich practical experience. Therefore, traditional teaching methods of the digital electronic technology course should be replaced by those that are tailored to students' needs by integrating professional education and innovation and entrepreneurship education.

3 Teaching Reform of the Integration of Professional Education and Innovation and Entrepreneurship Education in the Course of Digital Electronic Technology Under the OBE Concept

With a focus on students' innovation and entrepreneurship, the reform of the integration of professional education and innovation and entrepreneurship education in the course of digital electronic technology aims to reconstruct new projects that meet the requirements of teaching content in combination with digital circuit knowledge by selecting enterprise projects and innovation and entrepreneurship competition projects (e.g. college students' "Internet Plus" innovation and entrepreneurship competitions, college students' innovation and entrepreneurship training plan projects, college students' electronics design

contests, college students' smart car competitions, and college students' innovation production competitions) and. Besides, new projects have propped up, including (1) Design of smart cars; (2) Design of a gate circuit-based multiplayer voting device; (3) Design of logic functions implemented by decoders and data selectors; (4) Design of traffic lights based on sequential logic circuits.

The result-oriented teaching is carried out in a project-oriented and task-driven manner, decomposing digital circuit knowledge into each task to transform teaching-based into learning-based, and turn passive learning into active learning. Students preview the relevant content in the textbook, and the teacher prepares tools and electronic components before class. In class, various tasks are assigned by the teacher with clear instructions. Students then work on them in small groups with defined roles to accomplish tasks together.

Below are the first, third, and fourth projects to illustrate the process of specialized innovation integration.

3.1 Design of Smart Cars

Smart cars are common in all kinds of competitions. College students' smart car competitions act as a platform for small cars to compete, usually requiring the completion of various tasks within the specified time. Tracking, obstacle avoidance, and recognition are the most basic functions of intelligent vehicles. Considering that students just get to know circuits, the teaching content should not go deep. This project aims to design the tracking function of the smart car. The reference circuit of the car is shown in Fig. 2.

Tasks: (1) Design of a photosensitive sensor to detect black and white wire circuits; (2) Design of analog signal conversion to the digital signal circuit, with high and low levels reflecting black and white lines; (3) Design of a DC motor drive circuit and use black and white wire output to drive the motor at high and low levels.

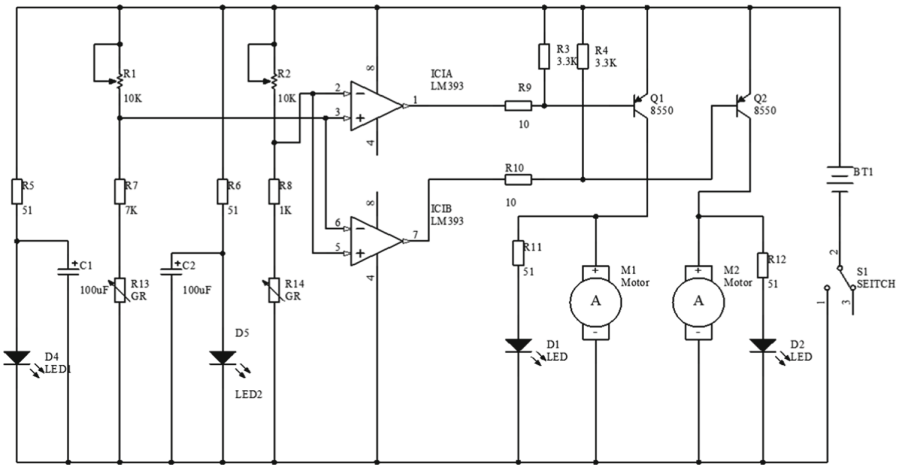

Fig. 2. Reference circuit diagram of the smart car

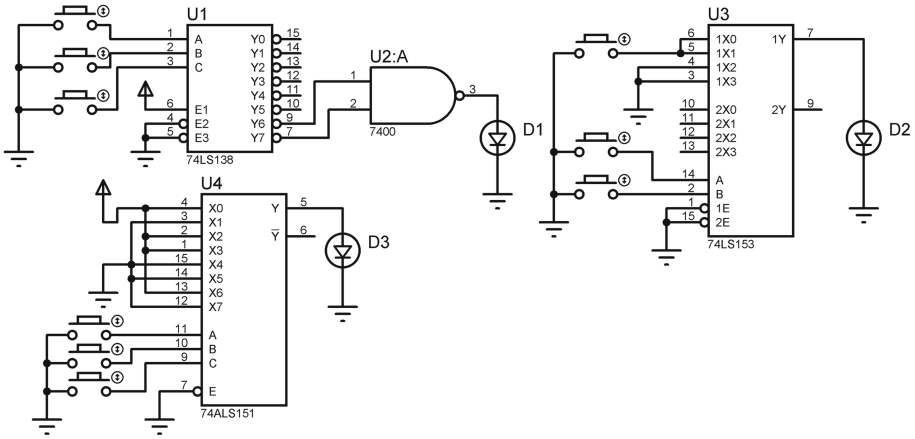

Fig. 3. Implementation of logic circuits of 74LS138, 74LS153, and 74LS151

The main knowledge points cover the difference between digital circuits and analog circuits, base conversion, basic laws and rules of logic functions, basic gate circuits, composite logic gate circuits and integrated logic gate circuits.

3.2 Design of Logic Functions Implemented by Decoders and Data Selectors

The teaching content of combinational logic circuits includes common gate circuits, encoders, decoders, data distributors, and data selectors. The design of combinational logic circuits is one of the important parts of the digital electronic technology course. After the learning of the design of gate circuits, the next goes to the design of project-based decoders and data selector circuits. Figure 3 shows the design of the circuit of decoder 74LS138 and data selectors 74LS153 and 74LS151 in teaching.

Tasks: (1) Implementation of logic functions of decoder 74LS138; (2) Implementation of logic functions of the one out of four data selector 74LS153; (3) Implementation of logic functions of the one out of eight data selector 74LS151; (4) Design of combinational logic circuits.

The main knowledge points consist of encoder and decoder, implementation of logic functions of decoder 74LS138, data selector and data distributor, and implementation of logic functions of data selectors 74LS153 and 74LS151.

3.3 Design of Traffic Lights Based on Sequential Logic Circuits

This project takes the traffic lights that students see in their daily lives as the starting point, and integrates knowledge such as 7474 triggers, CD4017, and 555 integrated circuits into the digital electronic technology course, stimulating students' learning enthusiasm and achieving good teaching results. The traffic light reference circuit diagram based on the sequential logic circuit is shown in Fig. 4.

Tasks: (1) Design of multi-input and gate circuits; (2) Design of the circuit of a two-person voting device; (3) Design of the circuit of a three-person voting device; (4) Design of the circuit of a four-person voting device; (5) Design of a multiplexer.

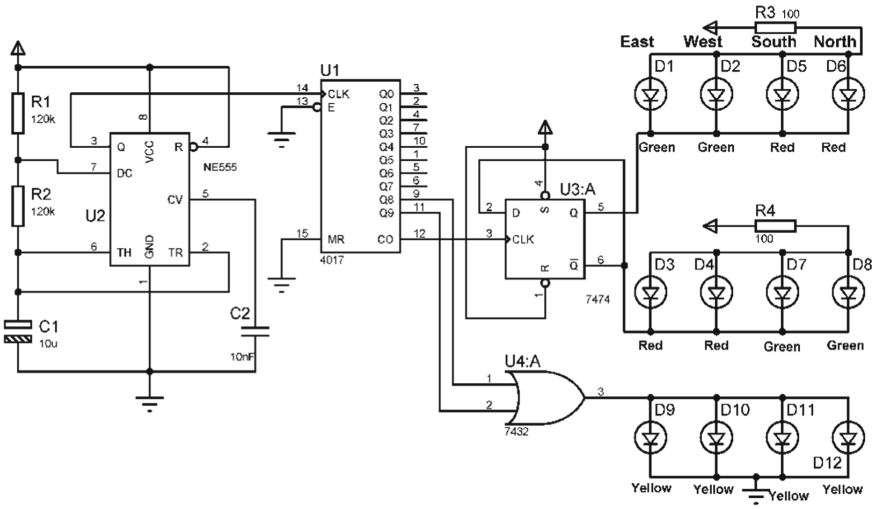

Fig. 4. Traffic light circuit based on sequential logic circuit

The main knowledge points are composed of several common triggers, RS trigger, JK trigger, D trigger, T trigger, design of trigger circuit, common counters, synchronous binary and decimal counters, design of counters, 555 circuit and monostable trigger, Schmitt trigger, and multivibrator.

3.4 Matrix Table of Projects and Teaching Content for the Reform of the Integration of Professional Education and Innovation and Entrepreneurship Education

The teaching content of the digital electronic technology course is decomposed into various projects, and each knowledge point is assigned to the task learning. The matrix of the project and teaching content is shown in Table 1.

The digital electronic technology course is based on innovation and entrepreneurship competition projects and enterprise projects, deriving projects suitable for teaching. Innovative design is applied throughout the entire process by integrating traditional knowledge and innovation and entrepreneurship, combining theory with practice, with emphasis on knowledge and innovative design ability.

4 Effectiveness of the Reform of the Digital Electronic Technology Course

Under the OBE concept, the result-oriented reform of the integration of professional education and innovation and entrepreneurship education in the course of digital electronic technology adopts a project-based and task-driven teaching approach. The reform has laid emphasis on cultivating innovation and entrepreneurship abilities with great

Table 1. Matrix of the project and teaching content

	Fundamentals of logic algebra	Integrated logic gate circuit	Combinational logic circuit	Trigger	Sequential logic circuit	555 chip
Design of smart cars	√	√				
Design of a gate circuit-based multiplayer voting device	√	√	√			
Design of logic functions implemented by decoders and data selectors	√	√	√	√		
Design of traffic lights based on sequential logic circuit	√	√	√	√	√	√

teaching results achieved. Significant improvement can be seen in the scores of the digital electronic technology course in the Electrical Engineering and Automation major of Nanning University have significantly improved, as shown in Fig. 5.

The reform was carried out in 2021 and 2022. According to the figure, students' performance after the reform has been significantly enhanced compared to 2019 and

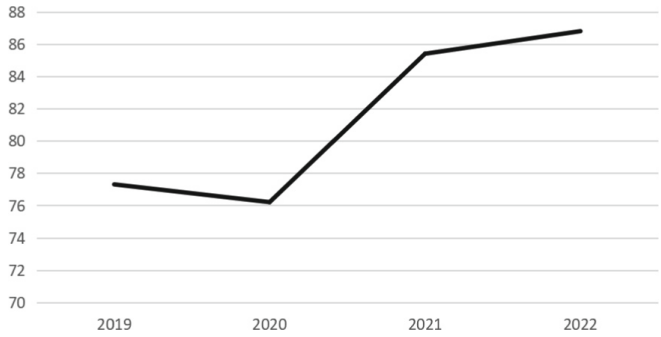

Fig. 5. Scores of electrical engineering and automation in the digital electronic technology course in the past four years

2020 indicating that the integration of professional education and innovation and entrepreneurship education has a good effect on students' learning.

5 Conclusion

Theory and practice were separated, and innovation and entrepreneurship content was not included in teaching before the reform of the integration of professional education and innovation and entrepreneurship education in the digital electronic technology course. As a result, students' learning interest was not strong, leading to a worse teaching effect. After the result-oriented reform, with a focus on cultivating students' practical abilities and innovative awareness, we carried out research and optimization of teaching, which effectively combined innovative abilities with the curriculum system, mobilized students' initiative and enthusiasm for learning, not only improving their innovative abilities but also enhancing their theoretical knowledge and practical abilities. It is expected to provide a good reference for the teaching of digital electronic technology course in universities.

Acknowledgment. The educational reform project of Nanning University is numbered 2023XJJG41.

References

1. Zhang Zhong, Wu Deyin. Reform and practice of flipped classroom teaching of public basic courses -- taking college linear algebra as an example [J]. Higher Architecture Education, 2022, 31 (04): 152-16
2. Qi Yajun, Jiang Juan, Zhang Lei. Innovation and Reconstruction of the Experimental Curriculum System for Optoelectronic Materials and Devices in the Context of New Engineering [J]. Education and Teaching Forum, 2022 (15): 21-24
3. Chen Xi, Yu Jinpeng. Experimental Teaching Design of "Digital Electronic Technology" Based on OBE-CDIO Concept [J]. Journal of Electrical and Electronics Teaching, 2023, 45 (01): 200-203
4. Zhang Haili, Shi Huangxia. Applied undergraduate "Digital Electronic Technology" integrated theory and practice "OBE" concept teaching [J]. Office Automation, 2022, 27 (18): 39-41
5. Yang Cuiyun, Huang Ping, Wang Yanling. Research and Practice on Digital Electronic Technology Teaching Reform Based on CDIO Mode [J]. Guangxi Physics, 2020, 41 (04): 80-82
6. Li Xiaoping. Exploration of Teaching Reform in Digital Electronic Technology Curriculum Based on OBE Concept [J]. Henan Agriculture, 2020 (27): 28-29. DOI: https://doi.org/10.15904/j.cnki.hnny.2020.27.010
7. Han Xinfeng, Gao Haitao. Research on the Curriculum Reform of "Digital Electronic Technology" Based on OBE-CDIO Mode [J]. Modern Computer Science, 2020 (20): 74-79
8. Wang Huaiping, Deng Wenjuan, Feng Lin, Guan Xiaoming. Reform and Exploration of Digital Electronic Technology Experimental Teaching Based on CDIO Education Concept [J]. China Education Technology Equipment, 2020 (02): 122–124+127

9. Sun Min, Jin Yinbin, Ning Gaidi, Liu Ningyan, Zhang Jiao. Reform and Practice of Digital Electronic Technology Experimental Teaching under the OBE Concept [J]. China Education Informatization, 2020 (02): 41-43
10. Chen Jing, Zhang Geli. Project-driven teaching analysis of digital electronic technology experiments [J]. Electronic Technology, 2022, 51 (05): 128-129