The Digital Electronic Technology course is optimized to adapt to a variety of new majors

Zongfu Xie *, Yawei Ji, Chunxiao Dong, and Jinjin Liu

University of Information Engineering, Zhengzhou, Henan, China

Abstract. In view of the practical teaching problems encountered in the training process of a variety of new professionals in the course of the Digital Electronic Technology, this paper optimizes the content, teaching mode and assessment mechanism of the course, and proposes a tailorable and scalable curriculum system suitable for a variety of new majors. The optimization of the curriculum organically combines the discipline characteristics of different new majors, talent training programs, knowledge content systems, modern teaching resources, and new teaching models, completes the adaptation and optimization of course teaching, and designs the knowledge-ability-quality assessment mechanism. Practice has proved that curriculum optimization can better adapt to a variety of emerging majors. The course content setting and implementation are more reasonable, which fully mobilizes the enthusiasm of students to learn, improves the comprehensive quality of students from multiple dimensions, and achieves good teaching results.

1. INTRODUCTION

With the rapid development of emerging technologies such as artificial intelligence, unmanned intelligent systems, biological interdisciplinarity, and brain-like disciplines, a variety of new majors, new disciplines, and interdisciplinary majors are constantly emerging, which puts forward new requirements for the construction of basic courses and disciplines such as Digital Electronic Technology. In addition, the demand for talent training in a variety of new majors has also undergone profound changes.

To meet the demand for talent training in a variety of new majors, in recent years, our university has opened new majors such as artificial intelligence, unmanned systems, and big data in many colleges to accelerate the cultivation of new professional talents. The course of Digital Electronic Technology is an introductory professional basic compulsory course for traditional disciplines such as information engineering and communication engineering, as well as emerging interdisciplinary disciplines such as artificial intelligence, unmanned systems, and big data, mainly explaining the basics of logic algebra, gate circuits, combined sequential logic circuits, memory, FPGA and CPLD, waveform generation and shaping, digital-analogy-to-digital converters, etc. The course has the characteristics of theory, practice, operation, and a wide range of majors, which plays a role in the entire talent training system [1]. However, in the face of the training needs of a variety of new majors and new talents, the traditional curriculum design can no longer meet the needs. After several years of exploration and practice, it is found that there are the following main contradictions between traditional curriculum design and new discipline talent training.

1. The course of Digital Electronic Technology is often taught with the principal application of electronic devices and the operation-processing technology of signals as the core. However, different new majors pay more attention to the application of electronic devices and the cross-application with this discipline, which leads to the lack of adaptability between the traditional teaching content and the emerging majors, and the lack of theory and practice. Therefore, in the process of content explanation, it is necessary to tailor and expand different degrees for different emerging majors and carry out knowledge selection [2].

2. In recent years, many interdisciplinary courses have been arranged in various new majors of our university, which has led to the reduction of the class hours of the Digital Electronic Technology course from 60 to 50 hours. However, the course of Digital Electronic Technology has many knowledge points, and the knowledge is systematic and logical [3][4]. The compression of class time poses new challenges to the teaching of course knowledge and the cultivation of students' quality and ability. Therefore, it is necessary to design a dynamic menu-based, scalable, extensible theoretical and practical teaching content [5] based on the actual teaching situation of different new fields, new quality, and new majors to meet the new requirements of different new disciplines.

3. Oriented to traditional disciplines, the course assessment methods of Digital Electronic Technology course focus on the understanding and mastery of course knowledge. The course assessment includes 10% of the usual grades, 30% of the experimental results and 60%

* Corresponding author: Xie Zongfu 18224517085@163.com

© The Authors, published by EDP Sciences. This is an open access article distributed under the terms of the Creative Commons Attribution License 4.0 (https://creativecommons.org/licenses/by/4.0/).

of the final exam. And the final exam plays the role of a veto, and there is less examination of students' ability and quality. The lack of diversity and hierarchy of such assessment methods leads to the limitation and one-sidedness of the assessment results. The proportion of final exams is too large, which will lead students to despise the exercise and cultivation of personal qualities to a certain extent [6][7]. Therefore, it is urgent to explore a comprehensive curriculum assessment scheme that adapts to multiple aspects and levels.

2. Optimal designs of the course

To solve the contradictions encountered in real teaching, the optimization design of the course of the Digital Electronic Technology for the cultivation of a variety of emerging professionals is mainly reformed from three aspects: overall optimization, teaching content optimization and course assessment mechanism optimization. And the innovative teaching method is cleverly integrated into the optimization design of theoretical and practical teaching content.

2.1. Overall optimized design

To meet the talent training needs of a variety of emerging majors, the course team of Digital Electronic Technology has formed a set of curriculum optimization scheme of tailoring and reconstructing according to needs, diverse teaching modes, and comprehensive quality assessment after several years of teaching practice and research, as shown in **Fig. 1**.

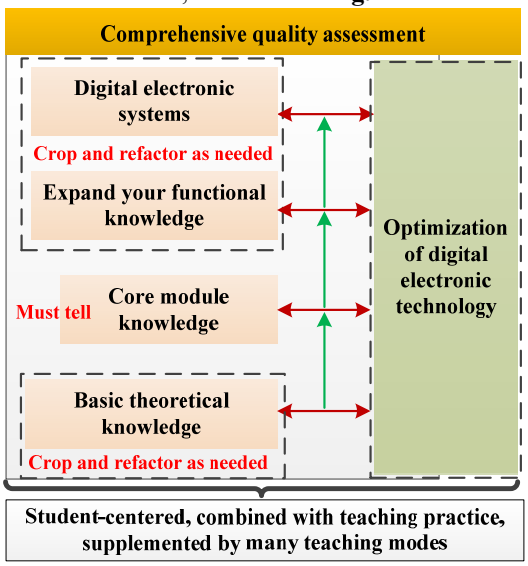

Fig. 1. Layout diagram of the course optimization plan

Crop and refactor as needed. It mainly focuses on the characteristics of emerging majors and the needs of talent training and completes the reconstruction and tailoring of the existing knowledge. In the specific implementation process, it is necessary to study the prerequisites of new professional disciplines according to the teaching situation, learning situation, and the characteristics of different emerging majors. Appropriate trimming and optimization of basic chapters and contents such as logic algebra and gate circuits. On the basis of the follow-up courses in the familiar talent training program, it focuses on the explanation of the core knowledge of the Digital Electronic Technology Course. Combined with the follow-up professional courses, the digital system circuit is reconstructed to achieve the purpose of teaching and learning, so as to solve the problems of compression of class time and obsolescence of teaching content from professional needs.

There are a variety of teaching modes. The diversification of teaching modes is mainly reflected in the fact that there are many but not chaotic, unified and orderly. There are nearly 10 teaching methods used in the Digital Electronic Technology course in our school, such as case-based teaching method, heuristic teaching method, task-driven teaching method, and PBL teaching method. Teaching methods include flipped classroom, online teaching, offline teaching, MOOC teaching, smart teaching, etc. The teaching philosophy includes student-centered, diversified, individualized CDIOC, etc. Through the unremitting efforts of the early course team, the teaching concept of the student-centered, combined with teaching practice, supplemented by a variety of concept optimization has been explored. In this way, there is unity of thought and main line of method. It has achieved the purpose of a variety of teaching methods, models, and concepts that are not chaotic, unified, and orderly.

The comprehensive quality assessment mainly assesses the overall quality of students from three aspects: knowledge, ability, and quality. Knowledge is mainly reflected in the assessment of various knowledge such as mid-term, final, quiz, homework, etc. The ability is mainly reflected in experimental operation, independent learning, group cooperation and so on. The quality is mainly reflected in the responsibility and mission of strengthening the country, the scientific style of rigorous and truth-seeking, and the innovative spirit of courage to explore. Focusing on the goal of talent training, the course team has established a formative all-round three-dimensional training and assessment mechanism of knowledge-ability-quality.

2.2. Optimized design of teaching content

The course team first studied the knowledge system architecture of the Digital Electronic Technology course. Then, by studying the pre-requisites and follow-up courses of different emerging majors, and skilfully integrating various teaching methods [8] according to the course content, a menu-based, extensible, and tailorable flexible theoretical knowledge framework was designed, as shown in **Table 1**.

Table 1. A list of knowledge schemas.

Course content	Category	Optimized design	Teaching methods
(1) Overview, numerical value, and symbol	The basics	Tailor for different majors and adapt to different majors	Online and offline blended teaching
(2) Logical algebra			
(3) Gate circuit			
(4) Combined circuits	Core knowledge	Must-talk content	It is mainly based on the case-based teaching method
(5) Latch, trigger			Principle + Function
(6) Sequential circuits			Compare combined circuits for teaching
(7) Semiconductors, memorizer	Expanded knowledge	Combined with multi-professional follow-up courses and teaching plans, tailoring, and expanding explanations are carried out.	Online and offline blended teaching. Menu-based explanations are available upon request.
(8) FPGA, CPLD			
(9) The principle and application of the 555 timer			
(10) AD、DA			

Table 1 divides the entire course content into three parts: basic knowledge, core knowledge and extended knowledge.

According to the pre-requisites of different emerging majors, the basic knowledge is tailored and adapted. Adopt a blended teaching model to maximize the efficiency and quality of teaching.

The core knowledge of the Digital Electronic Technology is a must-talk content, but the content, depth, and breadth of the explanation for different majors should be different.

The extended knowledge is mainly aimed at the follow-up courses of different majors, strengthens the connection with the follow-up courses, and provides menu-based tailoring and extended teaching.

Knowledge closely related to the profession focuses on offline teaching, supplemented by online learning. Knowledge that is not closely related can be mainly self-taught online, supplemented by tutoring, to concentrate and improve the quality of teaching. In the process of theoretical teaching, we pay attention to cultivating students' scientific style of seeking truth from facts, the attitude of facing problems directly, the engineering literacy of collaborative inquiry, and the sense of mission of serving the motherland.

2.3 Optimization of the course assessment mechanism

The course assessment mechanism is supplemented and optimized based on the assessment mechanism of the usual-practice-final period. And a formative all-round three-dimensional training assessment mechanism is established from the three aspects of knowledge, ability, and quality, as shown in Table 2.

Table 2. Three-dimensional assessment mechanism table

Assessment elements	Evaluation session		Assessment basis
Knowledge	Closed-book exams	Homework Take a quiz in the classroom	Exam scores, rain classroom statistics, homework completion, etc.
Ability	Hands-on experiments	Explore independently Group collaboration	Group discussions, experiment completion, classroom performance, questionnaires
Diathesis	Innovative research experiments Role in curriculum		The spirit of innovation and breakthrough in the experiment, and the sense of responsibility and mission in the team

The knowledge level in **Table 2** mainly examines the student' mastery of curriculum knowledge, accounting for 50%. At the ability level, the student' ability to find and solve problems is mainly examined, accounting for 30%. At the quality level, it mainly examines the student' rigorous and truth-seeking scientific literacy, the innovative spirit of courage to explore, and the sense of responsibility and mission of strengthening the country in me, accounting for 20%.

3. Teaching Models

Taking the new mode of training and teaching of artificial intelligence professionals in our school as an example, this paper expounds the optimization design and reform of the course of Digital Electronic Technology adapted to the new major.

In terms of teaching content optimization, the learning of basic knowledge such as numeric, code values, and the basics of logical algebra are taught through online video self-study, and key tutoring is carried out after class. Pay attention to the application of gate circuit, weaken the internal structure and principle of gate circuit. Strengthen the knowledge of combinations, sequential logic circuits, semiconductor memory, FPGA, GPU, and other high-performance processors. 555 Timer and ADDA also adopt the teaching method of self-study and tutoring. Through the above optimization design, the problem of completing the teaching task in less teaching class time is well solved.

In terms of the optimization of the assessment mechanism, we pay attention to the three-dimensional assessment mode of knowledge, ability, and quality. At the knowledge level, students will complete in-class tests, after-class homework, chapter quizzes, mid-term exams, etc., through the Yangtze River Rain Classroom, to check students' understanding and mastery of theoretical

knowledge. At the level of quality, the all-round ability of the student is mainly checked through theoretical classroom performance, experimental practical operation, etc. At the level of ability, the comprehensive quality of the student in all directions is mainly examined through the role played by students in the theoretical and practical team learning, and through questionnaires and other methods.

4. Teaching Outcomes

In recent years, the digital electronic technology course group of our school has optimized, reformed, and practiced in terms of teaching content, teaching mode, assessment mechanism and other aspects according to the different needs of a variety of new majors. It has built a rich teaching case library, practice case library, online resources, new professional question paper library and other teaching resources. Fruitful results have been achieved. The course team undertook the teaching tasks of more than 10 majors in digital electronics in 5 colleges of our university and trained nearly 2,000 outstanding students. Nearly 10 education and teaching projects have been applied. He has won nearly 30 national, district-level, provincial and ministerial level in the National College Young Teachers Electronic Technology Foundation and Electronic Circuit Lecture Competition, and the National University Electrical and Electronic Experimental Case Competition. The research group has won nearly 30 national, district-level, provincial and ministerial level in the National College Young Teachers Electronic Technology Foundation and Electronic Circuit Lecture Competition, and the National University Electrical and Electronic Experimental Case Competition. After nearly two years of hard work by the digital electronics technology teaching team, we have built a scalable, reconfigurable, and flexible teaching platform suitable for a variety of emerging majors in our school, which greatly contributes to the high-quality training of new talents in the new era.

5. Conclusion

To meet the new requirements of the training of various new professionals for the course of digital electronic technology in recent years, this paper optimizes the design of the course, which mainly includes four aspects: theoretical teaching content, practical teaching content, new teaching mode and comprehensive assessment mechanism, and solves the more prominent practical teaching problems. The curriculum optimization is mainly combined with the talent training plan of different emerging majors, the characteristics of students, and the new mode of modern teaching and assessment. The teaching content, teaching methods, and assessment mechanism are reconstructed, forming a set of new flexible curriculum designs that can be tailored, reconfigurable, and scalable for a variety of different majors. Finally, combined with the artificial intelligence major of our school, the content and focus of the course optimization design are further explained. The teaching results of the past two years show that the optimization of the digital electronic technology course in this paper is more suitable for the cultivation of a variety of new professionals and has high flexibility and advantages.

References

1. Yu Chunyu, Yuan Huijuan, Wang Yan, et al. Comprehensive optimization design of electronic technology course[C]//Heilongjiang Higher Education Society. Heilongjiang Education Press,2015:63-68.
2. Lu Xiaoli, Lu Liping. Optimization analysis of teaching content and method of "Electrical and Electronic Technology"[J]. Education and Teaching Forum,2012(19):49-50.
3. Wang Guanyu, Zhu Hengjun, Shi Cuiping." Science & Technology Vision,2022,(07):72-74.
4. Yang Ying. Problems and countermeasures of online course construction under the background of new engineering[J].Journal of Electrical and Electronic Teaching,2019,41(05):54-57+77.
5. Keengwe J, Georgina D. The digital course training workshop for online learning and teaching[J]. Education and Information Technologies, 2012, 17: 365-379.
6. Song Lu,Wang Hongxia. Research and exploration of teaching of Digital Electronic Technology[J].Science and Technology Vision,2016(24):115+188.DOI:10.19694/j.cnki.issn 2095-2457.2016.24.088.
7. Lu Xiaoli,Lu Liping. Optimization analysis of teaching content and method of "Electrical and Electronic Technology"[J].Education and Teaching Forum,2012(19):49-50.
8. Yelamarthi K, Drake E. A flipped first-year digital circuits course for engineering and technology students[J]. IEEE Transactions on Education, 2014, 58(3): 179-186.