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Research on Teaching Reform of "EDA" Course for New Engineering

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Abstract

Based on the current situation of "EDA" (Electronic Design Automation) course teaching, combined with the feedback of students, this paper summarizes and analyzes the main problems existing in the current "EDA" course teaching, such as the general theory of teaching, practice teaching hours are slightly insufficient, the course teaching effect is not good. This paper gives some suggestions on teaching reform from the aspects of teaching content, course assessment method and teacher team construction, and provides some references for the construction of the "EDA" course under the background of "new engineering" construction.

Subject Areas

Mechanical Engineering

Keywords

EDA, Teaching Reform, FPGA, Verilog HDL, The New Engineering

1. Introduction

With the release of major national strategies such as "Internet plus", "Intelligent Manufacturing 2025" and "Artificial Intelligence 2.0", traditional engineering majors are facing new opportunities and challenges [1]. In order to cope with the new round of scientific and technological revolution and promote industrial development, the Ministry of Education has actively promoted the construction of "new engineering" since 2017. As an important driving force in the development of electronic information technology, in a broad sense, "EDA Technology" includes all the automated tools and software to assist in the completion of electronic design, for example, Protel/Altium Designer software for electronic circuit design, Proteus software for single-chip computer simulation, Pspice or Multi-

sim software for electronic circuit simulation. The "EDA" course mainly refers to the electronic system design course based on PLD (Programmable Logic Device), which can be used as a required course for the major of electronic information engineering and communication engineering, and can also be used as a professional elective course for other related majors. It is generally opened in the third year of the undergraduate course. The courses are "Analog Electronic Technology", "Digital Electronic Technology", "Electronic Circuit Design", "C Language Programming" and so on.

"EDA" course in electronic design automation is an important practical course of automation specialty. Traditional teaching mainly focuses on theory teaching, which seriously restricts the development of students' practical ability and innovative ability. Therefore, it is inevitable to accelerate the teaching reform of the "EDA" course. "EDA" teaching based on FPGA, by designing the experiment of the organic combination of theory and practice, constructing a platform for teaching, guiding students to master the FPGA chip as the core of programmable digital system study way, and improving the students' autonomous learning, practice, design innovation ability, can not only lay a solid foundation for the subsequent learning, at the same time, it is also conducive to the effective training of composite applied talents.

Problems in "EDA" course teaching: 1) The combination of theory and practice teaching is not close. In "EDA" course teaching, it is usually the first programmable logic device and "EDA" theory course teaching, and then set up a combination of theory and experiment courses, so that students can master a certain theoretical basis after experimental operation learning. However, in practical teaching, this teaching method can not fully meet the needs of improving students' practical ability, especially in the "EDA" course for students to write hardware language ability is very high, students in the theoretical learning process, can not effectively combine with the practical operation, resulting in their practical ability is insufficient. 2) The experimental teaching process is rigid. In "EDA" experimental course teaching, teachers usually provide students with confirmatory experiments, and there are few comprehensive design experiments that require students to learn and operate independently. Therefore, in the experimental course operation, students mainly carry out programming, simulation, and download program verification results in FPGA experimental development board according to the teacher's experimental handout. As a result, most students do not have the ability to complete comprehensive design experiments independently, lack practice exercise, can not really master the course content, and do not have the ability to combine software and hardware design.

2. Current Situation of Curriculum Research

2.1. Content of Courses

"EDA" courses generally consist of two parts: theoretical explanation and practical sessions. According to the current syllabus of the school, the total duration

of the course is 48 hours, with 32 hours for the theoretical part and 16 hours for the experimental part. As the experiment part only accounts for one-third of the total class hours and the frequency of operation practice is not enough, the students' proficiency in EDA comprehensive debugging tools such as Quartus software is low. For example, when the program has a "Warning" or even "Error", it is easy to produce the psychology of "retreating from difficulties".

2.2. Mode of Realization

The current teaching practice loop is based on the imitation of Quartus software, and there is no operation practice based on experimental box or development board. After students input the program according to the experimental content and pass it comprehensively, they can only view the running results from the built-in simulation interface of the software. For example, the seven-section display of the decoder experiment project, after the input of waveform excitation file in the software interface, the software automatically outputs the digital pipe code and the sequence diagram of the bit code signal, indicating the completion of the experiment, which lacks the intuitive physical display and dynamic change effect.

2.3. Evaluation Mode

Reasonable design of curriculum assessment can promote the improvement of teaching quality [2], but the traditional assessment content mainly focuses on the theoretical knowledge of teaching materials [3]. The current teaching assessment scores account for 50% at ordinary times, which are scored according to attendance and homework. The exam scores also account for 50%, which is used to assess and score students' operational proficiency. As the exam questions are derived from the knowledge points in the textbook, in order to cope with the exam, students take short-term review, rote memorization and other ways to remember the commonly used programs, unable to understand the logic of the program in depth [4]. For example, if the decimal addition counter is slightly modified, the octal subtraction counter can be realized, so students' creativity level cannot be trained.

3. Approaches to Curriculum Reform

3.1. Proper Adjustment of Teaching Content

Similar to courses such as "Principle of Single Chip Microcomputer", "Electronic Circuit Design" and "Matlab and Its Application in Engineering", "EDA" course is a practical and highly applicable course. It is the most effective learning way to solve a specific problem by hands-on design and debugging a BUG. However, there are many courses in electronic information major, so it is not practical to increase the number of class hours. Therefore, students can be encouraged and guided to increase the practice time by the following ways: 1) By referring to the flipped classroom model, students can conduct theoretical learning

through Chinese university MOOC and other websites before class, and master the basic knowledge of hardware description language of "EDA" course, such as the definition of variables/signals and program structure. After class, teachers guide students to learn online, and answer questions in class, focusing on difficult parts, so as to save limited classroom time. Teachers can appropriately reduce the explanation of simple theoretical knowledge, increase the FPGA concrete example demonstration and analysis, improve students' interest. 2) Promote learning by competition and stimulate students' interest in learning [5]. There are many electronic competitions every year, such as FPGA application Innovation Competition, SCM and Embedded system application skills competition, electronic design competition, Internet of Things Application Skills Competition and Challenge Cup, etc. FPGA can be used for design. The class C platform of single-chip microcomputer and embedded system competition should be designed and implemented by FPGA, which has strong pertinence. 3) At present, there are many topics related to SCM in the graduation design, and few topics based on FPGA design, which may be the reason for the difficulty of development and debugging. Teachers can gradually increase the proportion of FPGA related topics when setting questions, deepen students' understanding of "EDA" technology, and lay a good foundation for "EDA" design related posts in the future.

In addition, the pre-course "Digital Electronic Technology" [6] is closely related to the course "EDA". EDA tools can be used to assist in the teaching process, so as to cultivate students' interest in FPGA technology in advance and get familiar with the basic operation of Quartus software. As the theoretical basis of the latter, the former mainly includes the knowledge of number system and coding, the principle of basic logic gate circuit, common combination logic and the basic structure of temporal logic circuit. In digital circuit, D flip-flop, as the basic component of timing logic device, is the basic unit of complex timing function device in FPGA, which is used in the design of shift register, state machine and CPU. And or not gate, encoder, decoder, data selector in FPGA is cleverly implemented by LUT (lookup table). "EDA" course can add bricks and tiles to the practical links of "Digital Electronics Technology" course. For example, Quartus software already contains most of the symbols of combination/timing devices taught in digital electronics course. **Figure 1** is the schematic diagram depicted by Quartus software. After searching common gate circuit components from the software and placing and connecting, the required circuit can be synthesized, and the timing diagram can be seen by simulation, which has the effect of being visible, and can be used to assist the explanation of digital electronic circuit courses.

3.2. Develop Language and Practice Platform

The two main languages designed by FPGA are VHDL (Very-High-Speed Integrated Circuit Hardware Description Language) and Verilog HDL. The former has strict grammar, but students need to pay more time to familiarize with the

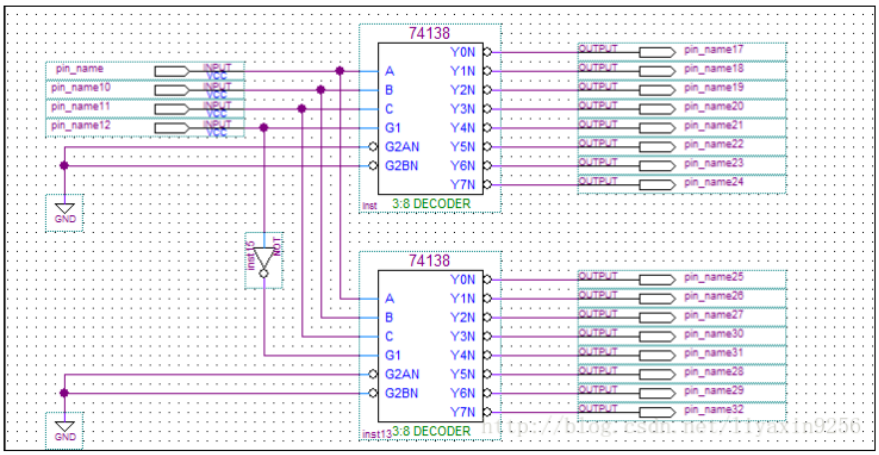

Figure 1. Quartus software schematic input describes the digital logic circuit.

sentence structure and characteristics of VHDL, while the latter is very similar to the style of C language, and the use rate is higher in the industry. Since students generally have the foundation of C language, the use of Verilog HDL can reduce the difficulty of learning hardware description language, so that students can focus their time and energy on the most important design links, and can adapt to the new environment faster in the future. At present, the main language of the course is VHDL, which can be changed to Verilog HDL language in the future. In terms of the selection of practice platform, the traditional experimental box has many functions, but its large volume and poor flexibility have high requirements on the experimental site [7] [8] [9]. In recent years, the pocket FPGA development board has been applied in some schools, its small size, convenient to carry, connected to a laptop computer can be into the "EDA" course of practice process, can not be limited by time, space, and can be carried out in the class experiment.

3.3. Course Assessment Model

In the traditional assessment mode, the test scores are the main, the mastery of knowledge is emphasized, but the cultivation of ability is ignored. Therefore, the proportion of ordinary times and test scores can be adjusted to 70% and 30%. In terms of assessment methods, diversified testing methods can be adopted, such as encouraging students to participate in the competition through the open laboratory of the college, or carrying out project practice based on the hardware development board, etc. which will be counted into the usual score after the review of the teachers of the research group, while different scores will be calculated for the projects with only simulation results and those containing physical demonstrations.

3.4. Course Resource Library Construction

Under the guidance and support of leaders at all levels of the college, the team undertook the course construction project of "EDA Technology" of the Curri-

culum Resource Library of the Autonomous Region of the Innovation and Development Action Plan. More than 500 digital resources such as documents, courseware, videos, animations, micro-lectures, pictures, question banks and test banks have been built in the resource library (see Table 1). The team uploaded the course resources to the cloud teaching platform and the learning platform of MOOC College, respectively, for students and students inside and outside the campus to carry out online learning. In the course resource library construction process, the project team members determined the course resource library construction content through joint discussion on the basis of the college-level quality course construction. The total resources are divided into four parts: framework resources, auxiliary resources, course-level resources and expanded resources, with the emphasis on course-level resources. In the course level resource construction part, the classroom teaching content was re-optimized and reorganized into 6 projects and 27 training tasks. The knowledge points of the course content are fragmented and granulated, the necessary knowledge points are determined, and the knowledge points are integrated into 27 training tasks. The part of expanding resources plans the related contents beyond the course hours as the expansion and extension of the course resources. The construction of course-level resources is designed around the "student-centered, teacher-led", project-oriented and task-driven teaching model. In the course construction process, curriculum resources are constructed, passed and applied simultaneously. Through the combination of online and offline application of curriculum resources, teaching has achieved good results.

4. Implementation of Teaching Effect

In the past "EDA Technology" course teaching, teachers speak more, students listen to more, practice less, students are not interested in the content of the course, do not love to listen to the phenomenon. Through online, under the class, the combination of hybrid teaching implementation, each lesson in the classroom to complete a training mission, each class a homework, homework every time to make a evaluation, using process assessment and comprehensive test combination of evaluation grades, effectively arouse the enthusiasm of the students' learning, Effectively put an end to the unhealthy phenomenon of students sleeping and playing mobile phones in class, and cultivate students' awareness of independent learning with active participation, active thinking and active action, which greatly improves the teaching effect. For example, the statistical table of the passing rate of students majoring in automation in grade 2019 (see Table 2). In the process of teaching, scientific design of class can implement the training mission, with the help of network and vocational education curriculum platform of cloud, using "EDA Technology" the curriculum resource digital teaching resources, the use of information technology teaching means, "a class a task, a class a job evaluation", a class a lesson to use online, under a combination of the implementation of the teaching in class, Guide students to actively participate in teaching activities, guide students to do more, more brain, change passive learning

Table 1. Resource statistics of "EDA Technology" course resource library.

Number	Resource type	Resource quantity
1	audio and video	100
2	document	150
3	picture	20
4	PPT	20
5	test base	200
6	task	20
7	exam	4
8	experimental manual	1
9	etc.	6

Table 2. Statistical table of student passing rate of 2019 automation major.

Class	The number of students	Number of passed	Number of unqualified persons	Pass rate
1901	32	32	0	100%
1902	31	31	0	100%
1903	32	32	0	100%

to active learning, so that students really become the master of learning.

5. Conclusion

Enterprises need to be able to design, and will adjust the test of EDA technology people. With the introduction of a series of policies to promote the development of integrated circuit-related industries, the "EDA" course is becoming more and more important in the training of talents in electronic information, communication engineering and other majors. Through the joint efforts of schools, teachers, enterprises and students, such as open software and hardware practice platform, good teaching methods and rich engineering cases, students can master "EDA" design methods faster. Based on the actual teaching situation, this paper puts forward the existing problems in teaching from the aspects of teaching content, experimental equipment and assessment methods, and gives some improvement measures. In the future, the author will continue to summarize the experience in the teaching process and explore the teaching methods suitable for application-oriented undergraduate universities.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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