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Exploration of Modularized Teaching Method of Computer Practice Course Electrical Engineering and Automation Major

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Abstract: Aiming at the deficiencies in the traditional teaching of on-computer practice courses for electrical engineering and automation major, this paper establishes a set of teaching mode and supporting assessment and evaluation system. Taking the main on-computer practice course "Micro Control Unit (MCU) Principles and Applications" as an example, the professional knowledge system of the course was rebuilt based on the concept of modularized teaching. The teaching system divides the course into nine modules and integrates theoretical knowledge into module case tasks. At the same time, the teaching mode and evaluation system are based on hardware principles, with case tasks as the core and on-computer practice as the means to further stimulate students' learning enthusiasm. This will help students perfect their professional knowledge system and improve their hard- and software analysis and design ability, laying a solid foundation for improving the employment adaptability of future students.

1. Introduction

With the continuous development of China's higher education reform, the construction of new engineering disciplines and double first-class construction has put forward new demands for the cultivation of engineering professionals. The traditional “duck-filling” teaching method is no longer suitable for the training requirements of modern college and university students, and needs to be improved accordingly to adapt to the current reform and development of higher education. Modularized teaching emerged in the 1970s is a kind of field-based teaching, skills training as the core of the teaching method, with flexibility, realism, economy and relevance of the advantages. Based on a specific carrier, breaking the original chapter division and other knowledge structure, all the knowledge points to be learned at a certain stage will be integrated to form a knowledge module. At present, China's education is entering a period of transition, from "test-oriented education" to "quality education" gradually close. As a result, modularized teaching has received more and more attention from educators.[1]

2. Shortcomings of traditional on-computer teaching

2.1. The learning style is passive

When teaching on-computer operation in the laboratory computer room, each student faced a computer, and the teacher demonstrated to the students' computer through broadcasting teaching software. The process was fast and unable to sort out the key points on the blackboard like theoretical teaching. As a result, it is difficult for students to memorize, and students with low self-control are more likely to be distracted by other things due to the blocked vision caused by the machine. In addition, if the teaching design is not reasonable, the time for students to practice on the computer is also very limited due to the fixed classroom time. All these phenomena lead to the lack of active learning, which is not conducive to the improvement of students' software and hardware capabilities as well as the cultivation of innovative capabilities.[2]

2.2. The assessment method is monolithic

At present, most of the on-computer practice courses in colleges and universities use the same single assessment method of determining the final grade through the final examination as the general theory courses. This means that even though students get high scores in the exam, it does not fully demonstrate that they have achieved the comprehensive skills of hardware and software design required by the course objectives. For courses with long contact hours, teachers were unable to keep track of students' learning in the class, and therefore were unable to give feedback to reinforce the weak parts of students' learning. As a result, students do not know their own learning level and their interest in learning decreases. With this accumulation, the learning effect was self-evident. At a result, the students' ability to apply knowledge and innovation was very weak, which in turn prevents them from realizing the ultimate goal of using what they have learned to solve practical problems in life, study and work.[3]

3. Advantages of modularized teaching

The modularized teaching method must be based on social needs to face the future job market, and designing the course content and distribution of modularized teaching according to the corresponding job ability requirements. The content of the course was blended and divided into a certain number of knowledge points, which were combined into corresponding knowledge units based on their inherent logical connections. In the course of teaching, the content should be adjusted and updated in a timely and continuous manner based on the latest developments in the industry.[3]

3.1. Teaching methods emphasizing student subjectivity

The main features of the modularized teaching method are flexibility, relevance and practicality. Compared with the traditional teaching method of "preaching and teaching", modularized teaching pays more attention to students' transformation of knowledge into application practice, so that students' subjective initiative could be maximized. In this way, it reflects the main role of students in class and emphasizes the cultivation of learning ability to ensure the learning effect. Therefore, for the highly practical on-computer courses, the modularized teaching method can realize the updating of the modules according to the feedback of the learning level, which is more conducive to improving the teaching efficiency.

3.2. Evaluation modalities emphasizing long-term and comprehensive approaches

Modularized teaching method wants to be used in the process of on-computer teaching for a long time, it is necessary to establish a personalized evaluation system. The modularized teaching evaluation method does not rely on a separate final exam to determine the results, but after the end of each module learning, the teacher conducts a comprehensive evaluation of the students in the module learning effect. Students check their own learning deficiencies in the module by this evaluation, to find the shortcomings and fill in the gaps, until they have digested and mastered all the content of the module. This kind of long-term evaluation could completely track the learning effect of students, avoiding students' laziness in the course process and the fluke mentality of "doing things at the last minute" before the examination.[4]

4. Modularized teaching and evaluation system design

4.1. Design of teaching modules

Taking the main on-computer practice course of electrical engineering and automation "Micro Control Unit (MCU) Principles and Applications" as an example, its traditional teaching content organization of 64 contact hours was arranged according to the sequence of textbook contents, as shown in Table 1.

Table 1: Traditional teaching content

Sequence of textbook content	
Chapter No.	**Chapter Title**
Chapter 1	Introduction
Chapter 2	Structure and Principle of 80C51 MCU
Chapter 3	C51 Language Programming
Chapter 4	Display, Keyboard and Interface Technology of MCU
Chapter 5	Interrupt System and Timer/Counter of MCU
Chapter 6	Serial communication interface of MCU

As can be seen from Table 1, "Micro Control Unit (MCU) Principles and Applications" involves a wide range of knowledge from three courses: College Computer Technology Basic Course, The C Programming Language Course, and Principle and Interface Technology of Micro Computer Course. It can also be seen that the traditional way of organizing the teaching content maked the connection between some knowledge points not strong enough. For example, C Programming Language Course has been studied in the previous semester, and C51 language is a derivative language, the difference between C language and C51 lamguage is not very big. If C51 language was taught as a seperate chapter between the MCU structure and the specific hardware programming, students would dilute the previous knowledge and need to increase the review energy. Therefore, review and hands-on learning could be directly combined with subsequent specific programming design examples after the explanation of the MCU hardware structure to make the knowledge points more coherent. According to the course syllabus, the ultimate goal of "Micro Control Unit (MCU) Principles and Applications" course is to develop students' hardware design ability and software programming and design ability. Based on these two major training objectives, according to the hierarchical structure and intrinsic connection between the knowledge points of "Micro Control Unit (MCU) Principles and Applications" course, to disrupt the organization of the traditional teaching content order. Based on the long contact hours characteristics of this course, the division of practical modules was refined, and finally the knowledge points of "Micro Control Unit (MCU) Principles and Applications" course were divided into nine modules, as shown in Table 2.

Table 2: Modularized teaching content

Modularized teaching content		
Nature of the module	**Module No.**	**Module Title**
Theoretical Modules	Module 1	Recognizing MCU and their development environments
	Module 2	Structure and Principle of 80C51 MCU
Theoretical+ practical modules	Module 3	LED and Buzzer Program Design and Implementation
	Module 4	Digital tube program design and implementation
	Module 5	Keyboard program design and implementation
	Module 6	LCD program design and implementation
	Module 7	Interrupt System Principle and Program Design of MCU
	Module 8	Timer/Counter Principles and Programming
	Module 9	MCU Serial Communication Interface Principle and Program Design

As can be seen from Table 2, the nine teaching modules contain all the knowledge points of the "Micro Control Unit (MCU) Principles and Applications" course, which integrated the theoretical knowledge into the case tasks, established a set of fixed-thinking teaching mode, and brought into play the initiative of students' learning. Among them, Module 1 and Module 2 were pure theoretical modules that laid the foundation for subsequent program design. Module 1 enabled students to have a more complete understanding of the development of MCU, the basic components, the development process, and the development environment, Keilμ Vision software; Module 2 enabled students to master the internal structure of the 80C51 MCU, strengthens students' understanding of the working principle of the MCU, and paved the way for the subsequent enhancement of hardware design capability. Module 3 to Module 9 are theory plus practice modules, based on hardware principles, with case tasks as the core and on-computer practice as the means, so that students can make clear the purpose of learning and enhance their interest in learning, the details were as follows.[5]

Module 3 LED and Buzzer Program Design and Implementation (8 class hours)

(1) LED principle and lighting LED

(2) LED running lights (different program structure ways)

(3) Patterned LEDs light up and go out (implemented using intrinsicroutines)

(4) Buzzer Principles and Buzzer Experiments

Module 4 Digital tube program design and implementation (12 class hours)

(1) Static digital tube principle

(2) Static digital tube display 0 to F

(3) Dynamic digital tube principle

(4) Dynamic digital tube dynamic display of numbers, English and characters

(5) Dynamic digital tube displaying random integers

Module 5 Digital tube program design and implementation (10 class hours)

(1) Independent Keyboard Principle

(2) Independent keypad control static digital tube display 0 to F

(3) Individual keystrokes to change the integer displayed by the dynamic digital tube

(4) Matrix Keyboard Principle

(5) Progressive scanning method to realize static digital tube display key value

(6) Line inversion method to realize static digital tube displaying key value
(7) Dynamic digital tube displays the square or cube value of the key value
(8) Dynamic digital tube key shift display

Module 6 Keyboard program design and implementation (4 class hours)

(1) Principle of LCD1602
(2) LCD1602 display string

Module 7 Interrupt system principle and program design of MCU (8 class hours)

(1) Principle of MCU system and interrupt handling process
(2) Keystrokes simulate external interrupts to control the moving direction of the running lights
(3) Keystrokes simulate external interrupts to control numerical value addition and subtraction of digital tubes
(4) Priority discrimination by keystroke simulation of external interrupts

Module 8 Timer/Counter Principles and Programming (14 class hours)

(1) Timer/Counter Principle
(2) Outputs a periodic square wave at the pin using a program interrupt.
(3) Using program interrupt to control the LED timed gradual blinking
(4) Generate a square wave with a period of 2 seconds with program counting
(5) Timer and counter cascade to generate a square wave with a period of 2 seconds
(6) Dynamic digital display of timer interrupt count value
(7) Dynamic digital tube displays positive pulse width
(8) Bottle Packaging Line Simulation
(9) Basketball game 24 seconds countdown
(10) Countdown to the Rapid Chess Match
(11) Clock simulation experiment

Module 9 Principles and Programming of Microcontroller Serial Communication Interfaces (6 class hours)

(1) Principle of serial communication interface
(2) Serial port receive and transmit verification experiments
(3) Display the character data received from the serial port on the digital tube
(4) Display the internal code of the Chinese character received from the serial port on the digital tube

4.2. Design of modularized teaching evaluation system

In addition to teaching design, supporting and reasonable course assessment mechanism is also an important part of modularized teaching, but also an important embodiment of testing the final teaching effect of the course, and an important guarantee to mobilize students to adjust their learning strategies and enthusiasm. The modularized teaching evaluation method does not rely on a separate final exam to determine the results, but after the end of each module learning, the teacher conducts a comprehensive evaluation of the students in the module learning effect. The comprehensive evaluation included an integrated design of hardware and software and assessment of in-class case knowledge points alteration. Students check their own learning deficiencies in the module by this evaluation, to find the shortcomings and fill in the gaps, until they have digested and mastered all the content of the module, and also for the end of the semester to lay the foundation for the comprehensive on-computer examination. At the end of the course, the teacher proposes questions based on the requirements of the teaching syllabus and assessment syllabus, and the students are then given a comprehensive on-computer examination. The final exam grade at this point is different from the final exam grade of a traditional course, which was one-sided to

represents whether the students have achieved the comprehensive ability of hardware and software design required by the course objectives. Therefore, the design of the percentage of grades in the two areas should be designed to ensure that students do not pay attention to the final examination due to their focus on the usual modularized examination results, but also to prevent the phenomenon that students do not pay attention to the final examination due to the higher modularized grades. Based on this, the assessment method of this course is set as 40% of the modularized course process evaluation and 60% of the comprehensive practical assessment at the end of the semester. One of the modularized course process evaluation scores was a comprehensive assessment and evaluation of the students' overall learning outcomes for each module by the instructor in the class. Through the reform of the assessment method, students' C programming ability, proficiency in mastering hardware equipment, proficiency in using programming and burning software, program debugging and error correction ability are cultivated and improved to guarantee the teaching effect.

By integrating assessment into the teaching and learning process, students with a strong foundation in their specialty could have more time to develop their thinking. At the same time, students with weak professional foundation can have enough time to digest the knowledge in the classroom, which can mobilize students to participate in classroom practice and initiative. The increase in classroom activity also enhances teachers' enthusiasm for classroom teaching and ensures the ultimate achievement of course objectives.[6]

5. Conclusion

This paper taked the main course of electrical engineering and automation major "Micro Control Unit (MCU) Principles and Applications" as an example, combines the modularized teaching method and teaching design, takes the hardware principle as the basis, the case task as the core, and the on-computer practice as the means to build the class with the students as the main body. Through the modularization teaching concept in the teaching design, the content level and logic between each knowledge point module of "Micro Control Unit (MCU) Principles and Applications" course become clearer. Teachers explained the knowledge points and case tasks to make students understand the knowledge more easily. At the same time, students were instructed to complete the program design and hardware connectivity of the task case, to carry out the in-class case knowledge point alteration assessment, and to get the comprehensive assessment evaluation. As the technology is updated, students prefer new and innovative cases for up-coming classes. Therefore, it is necessary to combine the development of the industry to reflect the practical teaching cases of new technologies, to carry out continuous updating of teaching content, and then to meet the training requirements of professionals.

In summary, for the on-computer practice courses, the use of modularized teaching means to enhance students' learning enthusiasm, but also to a large extent to enhance the students' software and hardware design ability, for the course design, graduation design and employability to lay a solid foundation.

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References

[1] He Siyuan, Lu Yinbin. Analysis of modularized teaching in microcontroller principle and application courses[J]. Integrated Circuit Applications, 2023, 40(6):378-381.

[2] Wang Xia. The application of modularized teaching in software teaching[J]. Science and Technology Innovation Herald, 2018, 15(9):231+233.
[3] Chang Fengxia. Exploration of Modularized Teaching of University Computer Fundamentals[J]. Comparative Research on Cultural Innovation, 2018, 2(30):112-113.
[4] Xu Jiali, Zhou Xiaoqing, Zhu Xiaoling. Research on the application of project-driven modularized teaching based on Principle and Interface Technology of Micro Computer [J]. Computer Knowledge and Technology, 2023, 19(13):152-154.
[5] Ye Mengjun, Jiao Bing, Ye Tianfeng. Exploration and practice of project-driven modularized teaching mode based on Proteus [J]. Journal of Hubei Normal University (Natural Science Edition), 2023, 43(1):96-101.
[6] Mo Zhongkai. The application of modularized teaching in higher vocational microcontroller principle and application courses [J]. Guangxi Education, 2019, 0(3):164-165.