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Reform and Practice of Teaching Model Based on OBE Concept for the Course "Principles and Applications of Single-Chip Microcomputer"

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Abstract: *Considering that there is a disconnect between the theoretical teaching and practical teaching in the training of specialty talents in applied undergraduate colleges and universities, the reform and practice of the teaching model based on OBE concept for the course "Principles and Applications of Single-chip Microcomputer" is carried out in this paper. Taking students as the center and taking the outcomes as the orientation, based on the project driven, the reform of teaching mode is discussed from the aspects of theoretical teaching, practical teaching and course assessment. The practice teaching results show that the teaching reform based on OBE concept not only helps to stimulate students' enthusiasm for learning, but also helps students better understand, master and apply the course knowledge points, which has achieved the effect of engineering education.*

Keywords - *single chip microcomputer (SCM); OBE concept; teaching reform; project driven*

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I. INTRODUCTION

In traditional Chinese higher education, teachers are often used as the main bodies of teaching activities, and students are more passively accepting course knowledge. There is a clear disconnect between the theoretical teaching and practical teaching, which neglects the specialty needs and is a fatal deficiency for the cultivation of applied talents. Outcome based education (OBE) is also known as competency-oriented education, goal-oriented education or demand-oriented education. As an advanced educational concept, it was proposed by Spady, *et al*, in 1981 and has become the mainstream reform concept of the United States, the United Kingdom, and the Canada. Since China was accepted as a full member by the Washington Accord in 2016, the OBE concept has been widely recognized and promoted by domestic universities. Due to the decline in the quality of personnel training in the national specialty - exploration technology and engineering talents, Southwest Petroleum University has revised the training program based on the OBE concept and the international engineering certification system [1]. After years of exploration and practice, the environmental engineering major of Zhejiang University of Technology has proposed a "3-3-3" talent training system based on the OBE concept [2]. In view of the problems existing in the talents cultivation in computer science, on the basis of analyzing the demand of high-quality innovative talents in today's society, Xi'an University of Technology put forward the OBE-based concept of talent cultivation, and constructed a new four-in-one talent training model of "Learning research ability - engineering practice ability - communication and cooperation ability - innovation competitiveness" [3]. In addition, considering that the advanced teaching concept, which is student-centered and is to design and implement teaching based on outcomes, plays an important role in talent training, before the specialty construction, many first-line teaching teachers in Chinese colleges and universities began to try to apply the OBE concept to the curse reform. Zhang Tao, *et al*. in North China University of Water Resources and Electric Power proposed a reform plan for classroom teaching of mechanical control theory based on OBE concept and the characteristics of measurement and control [4]. Wang Hongjun, *et al*. in Beijing Information Science and Technology University carried out the teaching reform of the basic course design of mechanical manufacturing technology based on OBE concept [5]. Based on the OBE teaching concept, Wu Junpeng in Northeast Electric Power University carried out the teaching reform and practice of the course "Principles and Applications of Single-Chip Microcomputer" [6].

The OBE concept is crucial to guiding the teaching reform, promoting specialty construction, and improving the quality of talent training in engineering education. Suzhou Institute of Technology is a local

private undergraduate college. The college closely combines the needs of the local economy and mainly trains applied undergraduate talents. The course "Principles and Applications of Single-Chip Microcomputer" is the core specialty course in the personnel training program, which plays a decisive role in the cultivation of the control ability for electromechanical system. However, in the early teaching, there is a disconnect between the theoretical teaching and practical teaching. In order to change this phenomenon, the department of mechatronics in our college decided to carry out the reform and practice of the teaching model based on the OBE concept.

II. THOUGHTS ON COURSE TEACHING REFORM BASED ON OBE CONCEPT

The OBE teaching philosophy emphasizes "student-centered" and achieves teaching design and implementation through outcomes orientation. The course "Applications and Principles of Single-Chip Microcomputer" has a wide application and is very practical. So, in the OBE concept-based teaching reform, the ability training regarding design and control of the embedded electromechanical system for students is taken as the orientation, the knowledge points at the engineering application level are taken as the teaching goal, and then the theoretical teaching and practical teaching are designed and implemented combing with CDIO. Furthermore, combining knowledge, classroom participation, specialty skills and other factors, a diversified curriculum assessment is carried out. The implementation plan of the course reform of "Principles and Applications of Single-Chip Microcomputer" based on OBE concept is shown in Fig. 1.

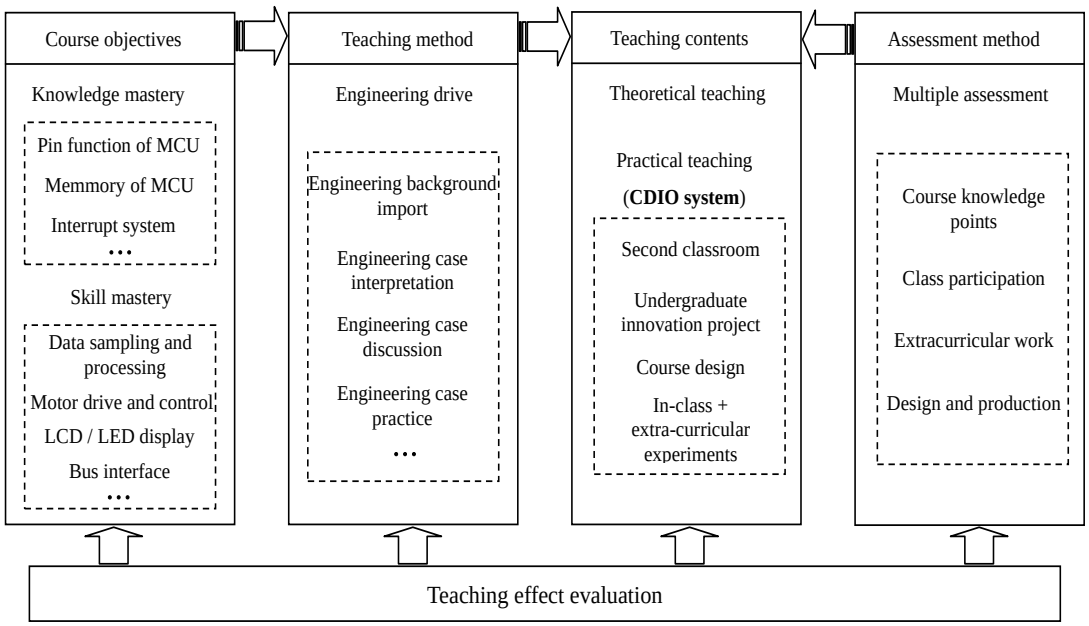

Fig.1. Implementation plan of the course reform based on OBE concept

III. CLASSROOM TEACHING DESIGN BASED ON OBE CONCEPT

Based on the reform implementation plan of the course "Principles and Applications of Single-Chip Microcomputer", after the ability orientation and teaching objectives of the course were determined, the teaching design of classroom teaching contents and teaching methods was carried out.

3.1 Reconstruction of teaching contents based on ability orientation

According to the essence of the OBE concept, in the teaching process, the teaching contents should be carried out around the specialty business ability that students need to cultivate. So, a matrix of teaching ability for the SCM course as shown in Table 1 is constructed.

Table 1 Matrix of teaching ability for the SCM course

Specialty ability		Teaching contents	Quality of ability
Hardware design capability	Construction of the minimum system of the SCM	External input/output pin; memory; interrupt system; Timer/counter; serial/parallel communication; bus; keyboard input; LED/LCD display; AD/DA; motor drive; Protel / Altium Designer software, et al.	1. Complete the construction of the minimum system of the SCM, including the power module, crystal module, reset module, etc.; 2. The hardware construction of the keyboard input and LED/LCD display module can be performed as needed; 3. Master data sampling and processing; 4. Master serial communication technology; 5. Master the control technology of stepping motor and DC motor based on driver module;
	Design of input \ output interface		
	Data sampling and processing		
	Design of bus interface		
	Drive and control		

	of motor Hardware circuit design …		6. Master the drawing capability of hardware circuits.
Software design capability	C51 programming Assembly language programming	Instruction system, addressing mode, C51, program design of the SCM	Master the programming capability for hardware circuits based on C51 or assembly language.
Simulation capabilities for software and hardware	Hardware simulation	Use of Protel / Altium Designer and Proteus software	1. Master the circuit simulation capability of SCM application system based on EDA and other software; 2. Master the simulation and debugging capabilities of the SCM application system based on the software platform.
	Software simulation	Use of Proteus and Keils simulation platform	

The teaching contents of the SCM course always adheres to the principle of applying the principle of learning, and organizes the teaching in the form of "capability-oriented". At the same time, some new technologies in the application field of SCM system are continuously supplemented, such as I2C and SPI bus, which helps to broaden the knowledge of students and improve their ability to adapt and serve the community.

3.2 Engineering-driven teaching method

As mentioned above, the course "Principles and Applications of Single-Chip Microcomputer" is closely related to the actual project, and the course knowledge points are numerous and difficult. In order to improve the teaching effect of the course, an engineering-driven teaching method is adopted in the course teaching.

Before the knowledge points are explained, the engineering background cases related to the knowledge points of each chapter are constructed, and the teaching background is used to inspire teaching, which not only helps students understand the importance of knowledge points, but also stimulates students' interest in learning points. For example, when explaining the AD acquisition knowledge point of the SCM system, the water pollution case was introduced, and then the water quality detection system and the water quality detection sensor were introduced. The problem about how to obtain the analog sensor information problem by the SCM is led to the final knowledge point of AD sampling, which helps students understand the importance of the knowledge points of AD sampling and stimulate students' interest in learning.

In the process of knowledge teaching, some small or partial engineering cases are used to interpret the knowledge points. For example, when introducing the function of the input/output interface of the SCM, the control of flow light is introduced. Furthermore, the music doorbell is introduced when the timer is explained. The introduction of engineering cases helps to make the incomprehensible knowledge points more intuitive, and helps students to understand and master knowledge points more easily.

In order to invigorate the classroom atmosphere, expand the students' thinking and promote students' enthusiasm for learning, the group's engineering case discussion was added to the daily classroom teaching. For example, in order to carry out the discussion of the control mode of the smart vehicle, the teacher first arranges the tasks in the classroom, and then the students consult the literature on the keyboard infrared remote control, the keyboard wireless remote control, the voice remote control, the self-guided line control, etc. after class, and finally discuss the working principle, advantages and disadvantages of all the control methods again in the classroom. The discussion of the engineering case not only helps the students master the knowledge, but also expands the knowledge of the students and stimulates the students' interest in learning.

In order to help students master and apply knowledge points effectively and timely, our teaching team used the extracurricular classroom to carry out engineering case practice. Taking the smart car control as an example, our research team developed a series of smart vehicles as shown in Fig. 2. These vehicles integrate various control methods, and the students can use the extracurricular classroom to carry out circuit simulation design, component welding, and program debugging to achieve the purpose of flexible use of knowledge points.

(a) Infrared and wireless handling vehicle (b) Infrared and voice control vehicle (c) Fire fighting vehicle

Fig.2. Smart vehicles

IV. PRACTICAL TEACHING DESIGN BASED ON OBE CONCEPT

The course "Principles and Applications of Single-Chip Microcomputer" is a very practical course. The effect of practical teaching directly determines the mastery and application of the students' knowledge of the course. So, taking the SCM technical ability training of students as the goal, based on the "Conceive", "Design", "Implement" and "Operate" in the CDIO concept, our teaching team has built a practical teaching system centered on experiment, curriculum design, undergraduate innovation and second classroom competition, as shown in Fig. 3.

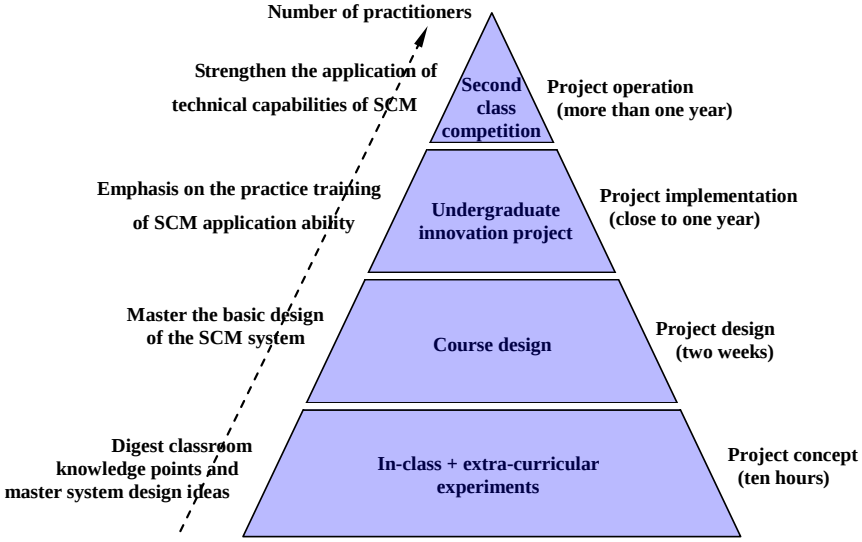

Fig.3. Practice teaching system of SCM based on CDIO

The project-based comprehensive experiment not only mobilizes the students' enthusiasm, but also improves the students' ability to comprehensively apply knowledge to solve practical problems, and enables the students to obtain the basic ideas and methods of the SCM system design, which reaches the first part of the CDIO, namely the purpose of project conception.

The project-based course design allows students to realize the cooperative distribution of hardware resources of the SCM, complete the independent design and software programming of the hardware circuit, and cultivate the design ability and teamwork spirit of the SCM, which reaches the second part of the CDIO, namely the purpose of project design.

The undergraduate innovation project not only enables students to complete the project formulation, circuit schematic design, PCB diagram generation, PCB proofing, component soldering and circuit board debugging, but also shifts students' ability from theoretical design to application practice, and realizes the practice of SCM application capability, which reaches the third part of the CDIO, namely the purpose of project implementation.

The second class competition not only strengthens the students' practical ability, but also stimulates the students' enthusiasm for learning, which reaches the fourth part of the CDIO, namely the purpose of project operation.

V. DESIGN OF ASSESSMENT METHOD BASED ON OBE CONCEPT

In terms of course assessment, combining with the characteristics of the course "Principles and Applications of Single-Chip Microcomputer", our teaching team has gradually carried out diversified comprehensive assessment using knowledge point assessment (final exam), classroom participation, extracurricular assignments, design and production of works, which changed the tradition assessment based on knowledge quantification and memory. The diversified comprehensive assessment takes the mastering and application of knowledge points as the learning motivation, which effectively avoids the unfavorable factors of formal simplification, content unification and utilitarian performance.

VI. CONCLUSION

The course "Principles and Applications of Single-Chip Microcomputer" is a compulsory course for mechanical students. Students' mastery of knowledge and ability to use will directly determine their employment competitiveness. Considering that the course requires engineering application background and is characterized by strong practical performance, our teaching team carried out the reform and practice of the course teaching mode based on the OBE concept. Since the beginning of the teaching reform, our students have participated in six competitions including the National College Students Mechanical Innovation Design Competition, the National Undergraduate "NXP Cup" Smart Car Competition, the China Engineering Robot

Competition and the International Open. The number of participants has exceeded 150 per year. In the past three years, we have won 12 first prizes and 25 second prizes in national competitions. In the provincial competitions, we won 2 special prizes and 22 first prizes. Seven undergraduate innovation programs were established as a practical innovation training program for college students in Jiangsu Province. The students have published 12 research papers by the first author, including 2 Chinese core papers of Peking University; and 3 graduation designs won provincial excellence awards.

The practice teaching results show that the teaching mode of the course "Principles and Applications of Single-Chip Microcomputer" based on the OBE concept is well adapted to the talent training of the mechanical engineering major, which improves the students' understanding and mastery of knowledge, enhances students' practical ability, and cultivates innovative consciousness and team spirit.

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