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Study on Teaching Reform of "Microcontroller Technology" Course Based on OBE-ADDIE

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Abstract: In response to the problems of "unclear outcomes", "emphasis on teaching over application", and "emphasis on results over process" in the current teaching process, an OBE-ADDIE teaching mode is proposed to reform the course "Microcontroller Technology". Taking students as the center, OBE as the guide, and ADDIE teaching model as the starting point, we adopt a reverse design and forward implementation approach to determine the course teaching objectives and content, optimize teaching methods, and insist on continuous improvement to meet the standards of engineering education professional certification, thereby cultivating students' self-learning ability, practical ability, and creative ability.

1. Introduction

OBE (Outcomes-based Education), as an advanced educational concept, is widely applied in teaching reform of engineering education to enhance the quality of innovative talent cultivation. Microcontroller Technology is a compulsory course for the Internet of Things engineering major, which uses STM32 microcontroller as a carrier to provide related technologies of microcontrollers. It is an application-oriented, highly practical and comprehensive course. As a course that emphasizes both theory and application, how to stimulate students' interest in learning, and how to improve their practical and innovative abilities to achieve the goals of talent cultivation programs is a topic that all teachers need to face[1].

2. The shortcomings of traditional teaching

2.1. Outcomes are not clear

The course objectives and content have not fully reflected the outcomes orientation. At present, there is still a subject oriented approach in the process of setting course objectives, emphasizing the inherent knowledge logic and development needs of the subject, without fully considering whether the course objectives are coordinated and consistent with the knowledge, abilities, and qualities required for professional talent cultivation. When designing teaching materials, course content is often designed and implemented according to the selected textbooks, and outcomes orientation is often overlooked, making it difficult to cultivate qualified talents that meet the needs of social development.

2.2. Teachers value teaching over students' application

Teachers attach great importance to theoretical knowledge and use experiments as a supplement to it. The purpose of experiments is only to verify theory. What's more, teachers focus on completing teaching hours and teaching content, without paying attention to whether students have mastered the knowledge points and learned how to apply them, so the cultivation of students' engineering and innovation abilities is relatively insufficient.

2.3. Results are emphasized over the process

The evaluation of learning outcomes lacks process evaluation and the implementation of continuous improvement is not in place. At present, the evaluation methods for learning outcomes are single, focusing only on the final assessment and evaluation mainly based on exams. The assessment of students' knowledge, abilities, and qualities acquired during the teaching process is not given enough attention, so there is a lack of completeness in assessment and evaluation.

In summary, if the Microcontroller Technology course is not reformed and traditional teaching methods are still used, the goal of engineering education will not be achieved[2].

3. Teaching reform based on OBE concept and ADDIE model

Guided by the OBE concept, deepening teaching reform and strengthening curriculum construction are the development trends for improving the quality of teaching and talent cultivation. The OBE concept can be implemented into curriculum goals design, course content selection, teaching mode innovation, and other aspects.

ADDIE is a systematic teaching model that includes the entire process from analysis, design, development, implementation to evaluation, as shown in Figure 1. The ADDIE model mainly includes three aspects: what to teach (setting teaching objectives), how to teach (application of teaching strategies), and how to judge whether learners have achieved learning outcomes (implementation of evaluation).

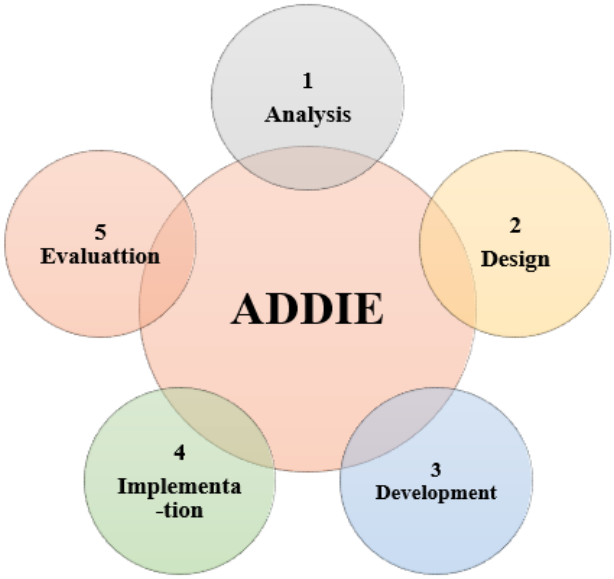

Figure 1: ADDIE model.

3.1. ADD – before class

3.1.1. Analyzing talent training plan

The talent training plan reflects the various elements specified in the professional teaching standards and the main requirements for talent cultivation. There are five indicators of graduation requirements for the Microcontroller Technology course in the talent training program for IoT engineering, they are as follows:

Indicator 1: Be able to utilize systems thinking to apply engineering knowledge to compare and synthesize solutions to engineering problems in the field of Internet of Things engineering, and demonstrate advanced technologies in this field.

Indicator 2: Be able to apply relevant principles of mathematics, natural sciences, and engineering sciences to identify and judge key aspects of complex engineering problems.

Indicator 3: Master the methods and techniques of engineering design and product development, and demonstrate innovative thinking in design.

Indicator 4: Be able to investigate and analyze solutions to complex engineering problems based on scientific principles and methods, through literature research or related methods.

Indicator 5: Be able to select and use appropriate instruments, information resources, engineering tools, and professional simulation software to analyze, calculate, and design complex IoT engineering problems.

3.1.2. Designing course objectives

The course objectives design under the OBE concept adheres to the outcome oriented reverse design principle, that is, based on graduation requirements and indicators, reverse design course objectives to ensure that the knowledge, ability, and quality of a certain aspect in the course objectives and graduation requirement indicators are mutually supportive and correspond to each other. Therefore, it is necessary to revise the teaching syllabus, redesign teaching objectives, and rethink methods for cultivating students' abilities. According to graduation requirements and indicators above，the objectives of the course are as follows.

Objective 1: Students are able to describe and analyze the theories and knowledge involved in ARM embedded systems, and are familiar with the basic structure and external pins of various models of STM32 microcontrollers.

Objective 2: Be proficient in using software development and debugging tools for STM32 processors, combined with hardware development boards, to build an environment for STM32 embedded products, and master the development methods and techniques of STM32

Objective 3: Be able to analyze requirements based on actual application scenarios, select internal resources of microcontrollers such as GPIO, interrupt systems, timers, etc., and design solutions to engineering problems.

Objective 4: Be Capable of comprehensive design and development of IoT products, including software and hardware design schemes, implementation processes, and result analysis, and reflect team and innovation consciousness throughout the entire process.

The corresponding relationship between graduation requirements, indicator points, and course objectives is shown in Table 1.

Table 1: The corresponding relationship between graduation requirements, indicator and course objectives.

Graduation requirements	Indicators of graduation requirements	Course objectives
Engineering knowledge	Be able to utilize systems thinking to apply engineering knowledge to compare and synthesize solutions to engineering problems in the field of Internet of Things engineering, and demonstrate advanced technologies in this field.	4
Problem analysis	Be able to apply relevant principles of mathematics, natural sciences, and engineering sciences to identify and judge key aspects of complex engineering problems.	3
Design and development plan	Master the methods and techniques of engineering design and product development, and demonstrate innovative thinking in design.	3, 4
Engineering research	Be able to investigate and analyze solutions to complex engineering problems based on scientific principles and methods, through literature research or related methods.	2, 3
Using modern tools	Be able to select and use appropriate instruments, information resources, engineering tools, and professional simulation software to analyze, calculate, and design complex IoT engineering problems.	1, 2

3.1.3. Developing teaching resources

The core of OBE concept is student-centered and guided by the abilities acquired by students. For the knowledge learned, students should not only memorize and understand it, but also be able to combine theory with practice to solve practical problems.

The selection of teaching content is closely focused on teaching objectives, and teaching resources with three gradients of "low, medium, and high" have been developed, as shown in Figure 2. The content of "memory and understanding" focuses on the initial mastery of basic knowledge. "Application and synthesis" focuses on training the integration of theory with practice. "Practice and innovation" focuses on the training and improvement of practical ability and innovative thinking. In this way, students gradually approach the course objectives through active participation during the learning[3].

About organization of teaching content: the traditional teaching of textbook chapters in a step-by-step manner is broken, and the content is reorganized in a project-based manner.The course is divided into eight projects, with difficulty gradually increasing and comprehensiveness gradually improving. Every project includes several tasks, for example, mastering basic knowledge, designing programs, implementing simulations, etc.

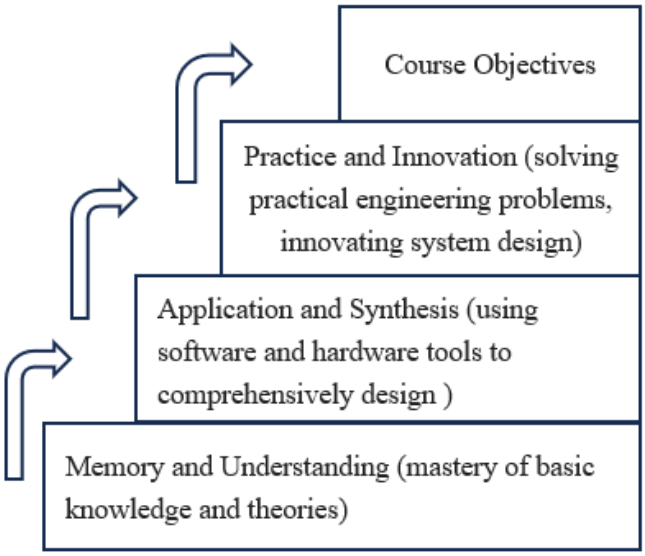

Figure 2: Teaching resources with three gradients.

3.2. Implementation – during class

Six steps of teaching are adopted during class, including brigde-in, pre-assessment, participatory learning, practice, presentation, and evaluation, as shown in Figure 3. A student-centered and teacher leading model is implemented to enhance students' enthusiasm and initiative in learning.

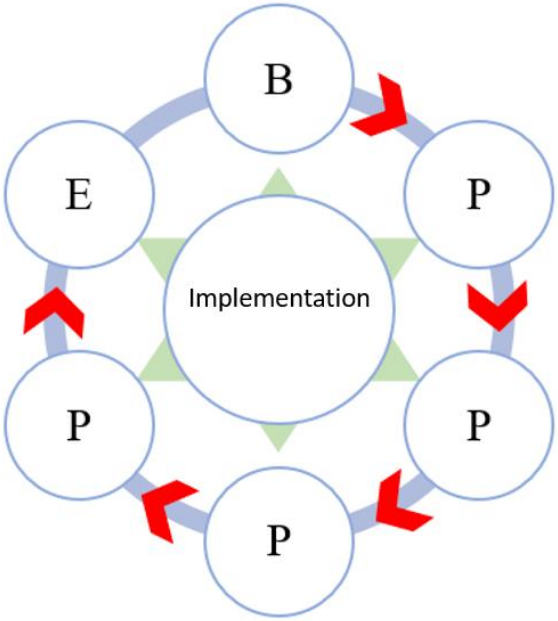

Figure 3: Six steps of implementation during class.

Bridge-in is used to attract students' attention, stimulate their curiosity and enthusiasm for learning, and help them clarify the goals and significance of the course.

Pre-assessment allows teachers to understand students' prior knowledge in order to adjust the depth of teaching content appropriately, making the course objectives more focused.

Participatory learning embodies concept of "student-centered". Guiding students to actively

participate in learning activities further deepens their understanding of the content, and enhances their language expression, communication, and cooperation skills at the same time.

Practice can help students consolidate and apply what they learned, and test their learning effectiveness.

Presentation provides an intuitive way to assess students' learning outcomes and teachers' teaching quality, through comparison and feedback, students can identify and improve their own shortcomings.

Teachers conduct process evaluations of students' knowledge, abilities, and qualities, provide timely feedback on the evaluation results.

3.3. Evaluation -after class

Teachers answer students' questions and publish tasks on the Learning Platform, allowing students to consolidate and expand what they learned, and then evaluate their learning effectiveness in order to optimize teaching methods in the subsequent teaching process.

In addition to completing tasks assigned by teachers, students can participate in various extracurricular scientific and technological activities, such as “College Student Innovation and Entrepreneurship Competition”, "Challenge Cup", “College Student Electronic Design Competition”, etc., to enhance their practical and innovative ability.

4. Conclusions

The teaching reform of Microcontroller Technology based on OBE-ADDIE mode is a reform guided by the OBE concept. It focuses on student development, outcomes oriented, reverse designed teaching objectives, forward implemented teaching processes, and continuous improvement, greatly stimulates students' self-learning ability, gradually cultivates students' innovation ability, engineering practice ability, and social adaptation ability, and cultivates excellent microcontroller talents for national development and social needs.

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