Research on the Reform of Microcomputer Principle Course for the Major of Biomedical Engineering

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Abstract: With the arrival of the development of the Internet and the information age, teaching models are also undergoing profound changes. The online and offline mixed teaching model has become an important direction of teaching reform research. By analyzing the characteristics and teaching problems of the course of microcomputer principle, the paper focuses on the specific application of the online and offline mixed teaching modes during teaching, including the construction of online course resources, the design of online and offline teaching processes, and process-based assessment. This teaching model combines online learning with offline classroom teaching in three stages: before class, in class, and after class, while incorporating knowledge of biomedical engineering (BME) to improve the teaching quality and learning effectiveness.

1. Introduction

Microcomputer principle course is one of the fundamental courses for the students majoring in biomedical engineering (BME), which is an emerging interdisciplinary field that combines biology, medicine and engineering in our university [1-3]. It is the core course for learning subsequent related courses and plays a very important role in the construction of the major and curriculum systems. Many universities, such as Shanghai JiaoTong University, Xi'an JiaoTong University, and Beihang University, also take this course as a professional course in the graduate entrance examination. It is a relatively difficult course to understand, which mainly includes microcomputer architecture, an 80x86 microprocessor and instruction system, assembly language design, and an introduction to various components of microcomputer [4, 5]. Students are required to have a deep understanding of the basic concepts of the microcomputer principle, be able to systematically master the structure of the microcomputer, 80x86 microprocessor and instruction systems, assembly language programming methods, interface circuit design and programming methods of microcomputer system, and have the ability to comprehensively apply the knowledge learned to analyze and solve the practical problems. In our school, this course has a total of 48 class hours and 3 credits. In addition, 16 class hours and 0.5 credits of related experiments are also offered.

It is noted that the discipline of BME uses engineering methods to solve medical problems, and the interdisciplinary characteristics of science, engineering, and medicine are very obvious. The

discipline of BME in our university is a key discipline in Shanghai, with an integrated talent training system of undergraduate, master, and Ph.D. The students cultivated at all levels are highly welcomed and trusted by employers, as it cultivates high-level talents with a solid foundation in natural sciences, strong engineering practical abilities, and a combination of medicine and engineering. Among them, microcomputer principle course is one of the core foundational courses of the BME program. This course plays a very important role in the construction of the curriculum system, professional development, and the cultivation of outstanding talents.

2. Current status of the curriculum

Microcomputer principle course integrates theoretical knowledge of microcomputer software and hardware, requiring students to master both computer hardware theory and the ability to design assembly language programs. For beginners majoring in biomedical engineering, the feeling of this course is that the content is abstract, the instructions are flexible, the logic is strong, and the experimental teaching is difficult to match. The main problems are:

2.1 Difficult understandable contents

The teaching content of the course is relatively abstract and covers a wide range of basic knowledge. However, in actual teaching, the class hours for teaching are often limited, which leads to a heavy learning burden for students. Teachers are also unable to keep a good balance between teaching progress and teaching quality. Contents that are difficult to understand include: binary/decimal/hexadecimal conversion, organization and management of internal storage, management of stack and instruction queues, status of flag registers, allocation of address space for storage and Input/Output ports, etc.

2.2 Many flexible instructions

The 80x86 instruction set has a total of 117 basic instructions, which are divided into data transfer instructions, arithmetic operation instructions, bit operation instructions, string operation instructions, control transfer instructions, etc. Instructions have a flexible format, powerful addressing functions, multiple data processing capabilities, and a multi-processor architecture. Moreover, compared to other high-level languages, code written in assembly language is a low-level language, often lengthy, poorly readable, and prone to errors [6-8].

2.3 With strong logicality, flexibility and systematization

This course is theoretically rigorous, with strong logicality, and closely integrated with engineering practice. A microcomputer is a complex system, and any operation performed by an instruction needs to be decomposed into a series of micro-operations. Some of these micro-operations are carried out simultaneously, while others need to be carried out in a sequential logical order. It is actually a complex sequential logic circuit system, and under the unified control of clock pulses, various tasks are carried out accordingly.

2.4 Difficulty in matching experimental teaching

Experiments can effectively help students understand textbook knowledge. However, in the experimental teaching, microcomputer principle course experimental platforms are used, which mainly realize the verification experiment of chip functions. Students only need to connect a few

important wires according to the wiring diagram and write a small amount of assembly code to obtain results, which completely fails to exert their independent innovation ability and does not achieve the combination of theoretical knowledge and practical operation.

3. Reform exploration

In response to the shortcomings of traditional offline classroom teaching, we adopt an online and offline mixed teaching approach and conduct a process-based assessment. The specific implementation plan is shown in Fig.1. Teacher manages and releases learning resources online, and carries out related teaching activities offline, while students can learn, complete homework, and provide tutoring and Q&A both online and offline simultaneously. Throughout the entire teaching process, a comprehensive and process-oriented assessment is conducted on the learning behavior, performance, and motivation of students.
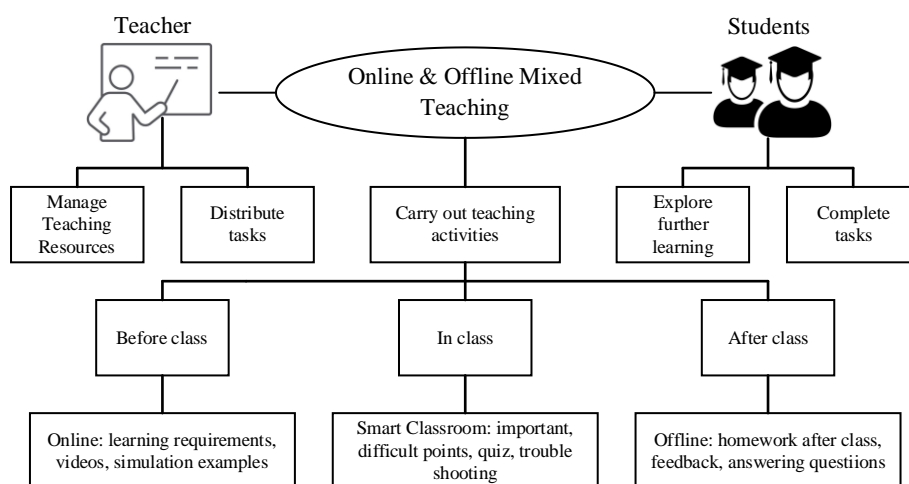

Figure 1: Implementation of mixed online and offline teaching

3.1 Providing online resources

Based on the knowledge points of each chapter, we sorted out the difficulties and key points in teaching and recorded 10-15 minutes of micro videos, covering the knowledge points of the whole book, such as CPU system structure, addressing methods, common instructions, memory and its extensions, parallel interfaces, serial interfaces, and programmable interfaces, timing counters, etc. In addition, it also provides software instruction simulation tutorials based on EMU 8086 and basic tutorials on software and hardware simulation functions based on Proteus, which is a simulation software for electric circuits provided by Labcenter Electronics, and is very popular among electrical, electronics, and computer engineering students, as well as for BME students [9-11].

3.2 Offline teaching reform

1) Regular teaching. Utilizing PPT and micro video MOOCs, and using multimedia and a blackboard in a smart classroom for routine teaching are also necessary. For example, in the course, the teaching of binary/decimal/hexadecimal conversion and signed number complement operations, assembly language flowcharts and their codes, and the allocation of extended addresses for memory and IO ports could be done in a blackboard format.

2) Visualized method. When discussing the structure and pin definitions of a microcomputer system, I bring the microcomputer development board and self-made experimental instrument into

the classroom to explain the packaging (including packaging form, identification of the first pin of the chip, and definitions of each pin) and instrument implementation mechanism.

3) Simulation teaching method. At present, the Proteus software simulation platform is the most effective in teaching microcomputer principle, which can achieve various functions such as schematic drawing, code debugging, and circuit simulation. It can also effectively prevent many drawbacks in traditional experimental teaching, such as a high failure rate and severe loss of experimental instruments.

4) Task driven approach. We assigned a certain task at a certain stage (such as when learning Proteus software), checked after some designated time, and communicated on class or using a Tencent meeting-room, etc. to track and proceed the task.

5) High order and challenging learning. Integrating microcomputer principle course with BME, lets students design medical electronic instruments with any microcontroller, or participate in competitions. These will benefit students to get good practice.

4. Outcomes of reforming

After several years of teaching practice and exploration, this course has achieved the following outcomes including,

(1) Obtaining an excellent curriculum. It is now a key course of Shanghai Municipal Education Commission with rich teaching content, flexible teaching methods, excellent student learning experience and evaluation.
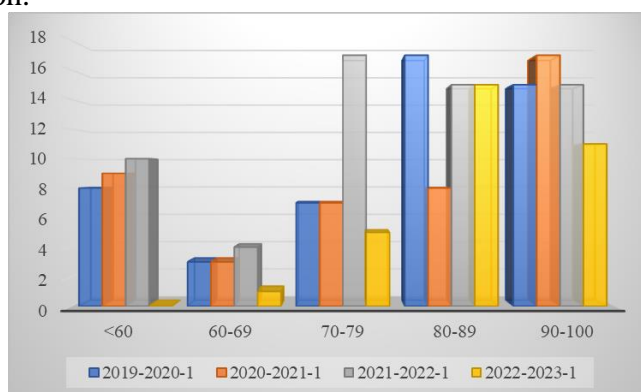

Figure 2: Grades statistics in the past four years

Figure 2 shows the statistics of the final grades of this course in the past four years. From the chart, it can be seen that in the past four years, the number of course selections for this course have been relatively high, and there have been more students with excellent grades (90-100 points). The proportion of students with good grades (80-89 points), medium grades (70-79 points), and other grades has significantly increased. The effectiveness of mixed online and offline teaching has been significant, and the evaluation of teaching by students has been excellent throughout the years.

(2) Establishing a content rich course website. It is built in the school curriculum resource center. On this website, students can check in, watch online videos, submit assignments, and receive teacher's feedback. All related teaching work for process assessment is completed on this platform and kept on the server for subsequent teaching inspections and evaluations.

(3) Welcomed by Students. In the design and arrangement of teaching content, emphasis is placed on cultivating students' abilities to discover, analyze, and solve problems, as well as cultivating their ability to learn knowledge independently; At the same time, exploring the advanced, creative, and challenging nature of the course, and actively exploring teaching methods that are highly integrated with BMEs, have been welcomed by students.

(4) A national project. A project named teaching reform on microcomputer principle course based on Proteus software from the Ministry of Education of the People's Republic of China was approved.

5. Conclusion

This article explores the mixed online and offline teaching modes for microcomputer principle course in the field of BME. It proposes a reform approach for implementing the mixed teaching mode in the course, with a focus on analyzing specific measures such as online course resource construction, online and offline teaching process design, teaching reform based on Proteus software, and reform of process-based assessment and evaluation methods, in order to improve the teaching quality and learning effectiveness of this course.

After practical testing, adopting a mixed online and offline teaching approach that organically integrates online learning with traditional classroom teaching can fully stimulate students' interest in learning, enhance their self-learning and innovation abilities, promote the continuous improvement of teaching effectiveness and quality, lay a good foundation for students' subsequent course learning, and make good contributions to cultivating engineering, applied, and international talents in the major of BME.

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