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Analysis on Online Teaching of Microcontroller Experiment Course

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Abstract: For students majoring in electronics, electrical engineering, and intelligent control, the course "Principles and Applications of Microcontrollers" is an indispensable compulsory basic course. This course requires the integration of theory with practice and hands-on operation, and its practical application is a very important part. Since the COVID-19 epidemic, schools at all levels and in all types have explored and practiced online teaching. During the teaching process of this course, online teaching software such as Chaoxing Fanya and Tencent Conference were used, combined with microcontroller experimental software Proteus simulation analysis, to conduct mixed online and offline teaching, so that some teaching will not be limited by time and space, and students' learning will achieve a relatively ideal effect. Taking a single chip microcomputer experiment class as an example, this paper introduces how to use online and offline teaching methods to teach, and analyzes various indicators such as students' participation in online teaching and the completion of classroom exercises after the whole course, and analyzes the teaching effect of the whole course in combination with offline teaching conditions and the results of the Final examination. Compared with traditional offline teaching methods, its effect is more ideal. The online teaching method of this course also provides a certain reference for online teaching of other courses.

1. Introduction

Microcontroller is a comprehensive product of computer technology, large-scale integrated circuit technology, and control technology [1,2]. After decades of development, its application has been very extensive and in-depth. It can be said that the automation, digitization, and intelligence of any device and product cannot do without a microcontroller. The microcontroller course mainly includes its hardware structure, instruction system, program design, and interrupt and timing. If these contents are only purely theoretical explanations, they are relatively abstract and obscure for learners, so they need to be understood in conjunction with specific practical applications. However, in the past two years, the COVID-19 epidemic has been affecting the education of colleges and

universities, especially the experimental courses that students need to practice [3-5]. Many universities have launched new models of online teaching. Even though offline teaching has resumed, the exploration of online teaching for microcontroller experimental courses is still of great significance.

2. Main Content of Microcontroller Experiment Curse

The purpose of the course "Principles and Applications of Microcontrollers" is to master the working principles of commonly used microcontrollers through learning micro control technology (microcontroller technology), be able to design simple interface circuits, and combine the relevant knowledge of electronic technology and control technology already mastered to learn the basic analysis and design methods of microcontrollers, so that students can have a preliminary understanding of automatic control design and problem-solving ideas. For its experimental part, in conjunction with the needs of theoretical courses, it generally includes the following basic experiments (Table 1):

Table 1: Main Experiments of Single Chip Microcomputer Course

Experiment Name	Experimental class hours	Experimental content
data filling program	2	filling data in continuous address units to gain a preliminary understanding of basic sentences.
BCD code summation	2	completing the addition of two three byte BCD codes.
multi-channel switch status indication	2	AT89S51 microcontroller connected to four lights and four switches, and 2 reflecting the status of the switch to the LED.
number system conversion subprogram	2	completing the mutual conversion between hexadecimal numbers and BCD codes.
cycle program design	2	doing left and right shifts of a single lamp, and writing a delay program for a specified time.
multi branch program design	2	controlling the change of water lamps, which can be divided into three situations: single lamp left cycle, single lamp right cycle, and dual lamp left cycle.
external interrupt experiment	2	press and bounce the button, move the light left once, press and bounce the other button once, move the light right once.
timer experiment	2	use T1 to generate a 0.5 second timer, when the timer is set, the eight LEDs on P1 port will cycle in pairs.
advertising lamp	2	use the method of taking the table to make port P1 change into a single lamp: move left twice, move right twice; all lamps flash twice, and keep cycling.
seven segment code LED display experiment	2	realize cyclic display from 0 to f on Nixie tube.

3. Online Teaching Practice of Single Chip Microcomputer Experiments

If the whole line is used for teaching, physical equipment such as CPU chips, LED lights, connecting lines, seven section Nixie tube and hole boards are generally required to complete the above series of experiments. However, in online teaching, if physical objects are used for teaching

through shooting videos or live streaming, firstly, due to equipment and shooting issues, the integrity of students' viewing and learning cannot be guaranteed; Secondly, students conduct physical experiments on their own, and teachers find it difficult to help students solve various problems encountered during experiments such as welding and adjustment in a timely manner; Once again, it is inconvenient to distribute experimental devices and equipment to students. Therefore, the above online teaching methods are significantly less effective than offline physical teaching. With the increasing application of various multimedia in education and teaching, there are already more and more platforms that can assist us in better completing online teaching. In the online teaching of microcontroller experiments, Tencent Conference, Chaoxing Fanya, and EV screen recording software are used to ensure the smooth progress of the teaching process [6-8]. Proteus software is used to simulate microcontroller experiments, and finally, combined with video explanations of physical debugging, a high-quality experimental lesson can be fully completed.

Tencent Meeting is an audio and video conferencing software under Tencent Cloud, which was launched at the end of December 2019. It has functions such as 300 people online conference, one click access to the entire platform, intelligent noise reduction in audio and video, beautification, background virtualization, locked conference, and screen watermark. This software provides real-time screen sharing and supports online document collaboration. Starting from January 24, 2020, Tencent Conference will provide free conference collaboration capabilities for 300 users until the end of the epidemic. Xuetong is a free application developed by Beijing Century Superstar Information Technology Development Co., Ltd. in 2016, which integrates mobile teaching, mobile learning, mobile reading, and mobile social interaction. During the epidemic, in response to the call of the Ministry of Education to "suspend classes without suspension", the Super Star Learning Platform, as one of the first 22 recommended learning platforms by the Ministry of Education, actively participated in this battle. Super Star Emergency Mobilization has invested over one billion yuan in emergency renovation of computer rooms, network expansion, and software modification, providing free online teaching platform services for various schools. EV screen recording software is a very useful desktop video recording software. This software can help users easily record computer screens, and all functions are free without watermarks. It is a very useful desktop video recording software. The above three types of software are commonly used in online teaching processes in various universities in recent years.

The online teaching process is mainly divided into two forms: live streaming and recorded streaming. In order to achieve good online teaching results, before each class, relevant materials such as word texts, PPTs, and online videos of the theoretical knowledge required for this experimental class are added to the corresponding location through the Chaoxing Fanya (Learning Pass) course website, and students are informed of the viewing location and methods. Students are advised to preview in advance. On the course site, build the student class in advance and add all students to the class. Due to online classes, there may be situations where some students forget to attend classes, remember the wrong time, and lack the internet to attend classes on time. At the beginning of classes, the check-in function of Chaoxing Fanya or Tencent meetings is used to replace the course roll call of offline courses [9-10]. Students who have not attended on time can be informed of the situation through WeChat or phone calls. During the teaching process, Tencent Meeting or Chaoxing Fanya's live streaming function is used for knowledge teaching, and during the teaching process, online interaction with students is carried out, such as Tencent Meeting or Chaoxing Fanya's chat function, Chaoxing Fanya's discussion, selection, and voting functions, to increase students' classroom participation. After explaining each small knowledge point, you can also use functions such as Chaoxing Fanya's classroom practice to check each student's learning situation. Students can also ask questions and provide feedback on the problems encountered in the course in a timely manner during class. Teachers can adjust the teaching content in a timely manner

based on student feedback and classroom practice. After the course is taught, the course playback function is opened, allowing students to revisit unclear or forgotten content after class. After the lecture, use EV recording to provide more detailed explanations of the key knowledge in this section and some knowledge points that were found to be relatively difficult for students to understand during the teaching process. Record the video of the key knowledge on the screen and send it to the students for more detailed learning. Finally, the homework will be released through Super Star Fanya. For objective questions such as selection or judgment, the system can automatically grade them. For short answer or programming questions, students can submit their answers in various ways such as Word or pictures.

After completing the course teaching, the super star and elegant functions can be used to statistics and analyze the participation and learning effectiveness of students throughout the entire teaching process, such as the number and duration of learning for each student on the task point, the completion and scoring of in class tests, the level of participation in classroom discussions, and the submission of homework. Taking the multi branch programming experimental course in the above experiment as an example, through statistical analysis, 100% of students participated in the course and completed the entire course. 39% of students studied twice and 2% studied three times; 93% of students scored above 90 points in the classroom test, while there were no students below 60 points. 75% of students answered the same procedural question incorrectly; 100% of the students completed and submitted their assignments, with a 98% accuracy rate.

4. Simulation Experiment Using Proteus Software

Proteus software is an EDA tool software published by Lab Center Electronics in the UK. It not only has the simulation function of other EDA tool software, but also can simulate microcontrollers and peripheral devices. It is a good tool for simulating single-chip microcontrollers and peripheral devices, and many single-chip enthusiasts, teachers engaged in single-chip teaching, and technology workers dedicated to the development and application of single-chip microcontrollers are very fond of this software. From schematic layout, code debugging, to collaborative simulation of microcontroller and peripheral circuits, one click switch to PCB design, truly achieving a complete design from concept to product. Most related experiments on microcontrollers can be simulated and analyzed through this software.

Taking the advertising light design in the main experimental content of the microcontroller mentioned above as an example, the experiment requires the use of a table taking method to make port P1 change a single light: move left 2 times, move right 2 times; All lights flash together twice (with a delay of 0.2 seconds) and continue to cycle. The key part of understanding the experimental requirements is to use the MOV DPTR, # DATA16 instruction to point the data pointer register to the beginning of the table, and then use the MOVC A, @ A+DPTR instruction to add the value of DPTR to the accumulator value, so that the program counter PC can point to the data to be extracted from the table.

When using Proteus software to complete this experiment, first draw a simulation circuit diagram (Figure 1), and then lead students to complete the program writing according to the requirements of the experimental effect. Compile the written program to check for errors and load it, observe whether the experimental phenomenon is consistent with expectations, and modify and improve any inconsistencies. When drawing a circuit diagram, first open the drawing interface, find the required power supply, ground, resistor, LED light, inverter, and 89C51 microcontroller in the component library, then arrange the positions, connect wires, and set parameters. During the programming process, gradually demonstrate and explain the usage and precautions of each statement to students, and finally allow students to program independently. During the running

process, using Proteus' single step running function, corresponding windows can be called up for analysis, and the changes in the corresponding registers and other contents after each step can be clearly seen, which is more conducive to students' understanding of the program content. After successful simulation, the program can also be loaded into the physical object for experimentation.

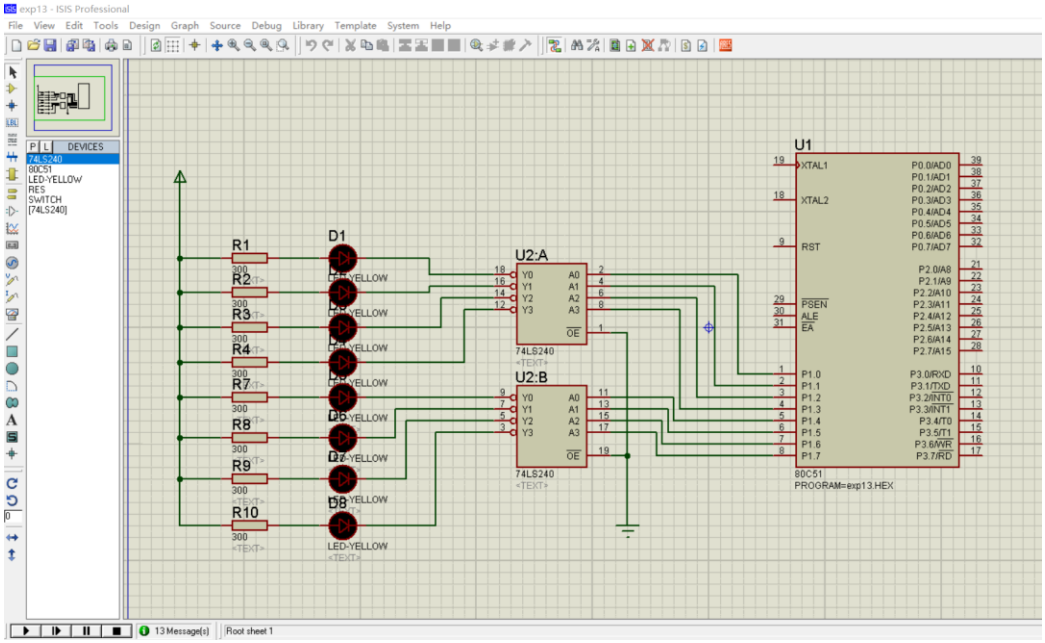

Figure 1: Simulated circuit diagram.

5. Analysis of the Effectiveness of Online Experimental Teaching

Using the combination of online and offline methods mentioned above, we will teach microcontroller experimental courses to six classes. Six teaching classes, each consisting of 25 to 30 students, are evaluated online through the Chaoxing Fanya platform for attendance and check-out during regular classes, discussion of issues during and after class, completion and accuracy of in class exercises, and completion of homework. Offline, students' classroom interactions, completion of classroom exercises, and results of online exams are analyzed to evaluate their learning performance, the results are better than conducting online or offline teaching alone.

6. Conclusions

With the development of science and technology, online teaching has become a very common teaching method. For microcontroller experimental courses, adding online teaching appropriately on top of traditional offline teaching can achieve more ideal teaching results. Adopting a teaching method that combines online and offline teaching can not only improve the efficiency of experimental course teaching, but also enhance students' interest in learning through diversified teaching methods, enabling more students to actively engage in learning, and enabling experimental courses to play a significant role in limited time. Practice has proven that the integration of online and offline teaching is worth further research.

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