

A Study on the Reform of Hybrid Mixed Teaching of Computer Composition Principles in Applied Undergraduate Colleges and Universities

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Abstract: Aiming at the problems of general learning effect and low interest of students in the teaching of the course “Computer Composition Principles” at Chongqing Engineering College, it is proposed to focus on the teaching concept of “student-centered,” make full use of online teaching resources and teaching methods, and reform the offline classroom. The practical teaching program is designed by combining the “experiments in the classroom of the experiment box + online simulation experiments,” and a suitable assessment program is designed by improving the process assessment. This paper proposes a hybrid teaching model for the course “Computer Composition Principles”, which gives full play to the combined advantages of “network and classroom”, “students and teachers,” and improves the teaching quality and efficiency of the course “Computer Composition Principles” in applied undergraduate institutions.

Keywords: Computer Composition Principles; Mixed teaching; Online and offline; Teaching reform

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1. Analysis of curriculum status

In recent years, the concept of Engineering Education in colleges and universities has been constantly updated, mainly including the new engineering concept under the “Internet+”^[1], the concept of application-oriented undergraduate education^[2], and the certification of engineering education in colleges and universities^[3]. The new educational concept will inevitably lead to new teaching reform and new design of related courses.

Computer Composition Principles, as a major professional basic course for computer majors, mainly introduces the composition structure, working principle, and design method of the computer hardware system, and cultivates students’ ability of computer hardware system analysis and design, which plays a connecting role in computer science. It is also the leading foundation for the follow-up study of the core courses of computer majors such as “Operating Systems,” “Microcomputer Principle and Interface Technology”^[4,5].

Computer Composition Principles have many knowledge points and abstract content, which has been considered difficult to teach and learn, and the effect of student feedback is not good, especially in application-

oriented undergraduate colleges ^[6]. Taking the Chongqing Institute of Engineering as an example, the main problems are as follows:

(1) The teaching content and professional development direction are not unified.

(2) There is no prerequisite course for related hardware.

(3) Insufficient class hours. Computer Composition Principles should be 60–72 class hours normally. At present, only 32+16 class hours are arranged for the theory and experiment of this course.

The above reasons lead to students' difficulties in understanding this course because of their weak foundation. On the other hand, learning motivation is insufficient, and interest is not high. To solve these problems, it is necessary to improve the teaching mode and teaching methods, to consolidate the teaching foundation, start the learning motivation and achieve the curriculum objectives. Therefore, it is important to explore the teaching method of combining online and offline, virtual simulation and practical operation, form the curriculum construction mode of "knowledge, thinking, practice and innovation" and cultivate applied talents that meet the construction needs of "Emerging Engineering Education" and "Engineering Certification" of computer specialty ^[7].

2. Online and offline mixed teaching reform strategy

Given the problems in the teaching reform of the course "Computer Composition Principles," according to the teaching philosophy of "student-centered and teacher-led" online network teaching is expanded, offline classroom teaching methods are improved, theoretical teaching is completed according to the three-stage learning framework of "pre-class, in-class and post-class," and practical guidance is carried out through the combination of "experimental box in-class experiment and online simulation experiment." Finally, student learning is assessed according to the assessment criteria, and the teaching content of the hybrid teaching mode of "Computer Composition Principles" is designed to give full play to the rich network of teaching resources and free time. The advantages of mixed teaching of key and difficult points in classroom teaching and effect detection can improve the teaching effect.

The implementation process of hybrid teaching is mainly from four aspects: (1) Online teaching planning and design; (2) Offline theory teaching design; (3) A hybrid experimental teaching design based on an experimental box and online simulation platform; and (4) Reform of assessment and evaluation.

2.1. Online teaching design

(1) Release pre-class tasks and make learning lists

Teachers need to design the learning list of each class in advance, and release the conceptual knowledge points, key and difficult teaching videos, pre-class exercises and other resources to the teaching platform 3–5 days before the class, guide students to self-study the content of the class, track and view student's learning progress through the platform to urge and guide students to complete the pre-class learning, and timely record and answer student's online questions. Through the analysis of the learning situation before class, teachers can flexibly adjust the teaching plan, so that the pre-class, in-class, online and offline teaching linkage, more teaching quality and effectiveness. For example, for the learning of the storage system chapter, the pre-class learning list is shown in **Table 1**. The self-study list should be detailed and supported by supporting resources, such as videos, exercises, project case expansion, etc.

Table 1. Main storage system self-study list

Learning tasks	Main memory
Reading materials	Textbook of Principles of Computer Organization 95–120 pages ^[8]
Watch video	Watch the first two parts of the supporting videos in Chapter 4 during the learning session
Learning tasks and objectives	<ol style="list-style-type: none">1. Understand the hierarchical structure and storage classification of the storage system2. Understand the working principle and characteristics of SRAM and DRAM3. Master the expansion and decoding connection of main memory
Problems and thinking	<ol style="list-style-type: none">1. Where is the hierarchical structure of memory? Why should we divide these levels? How do computers manage these levels?2. What is the working principle of SRAM and DRAM?3. What is memory bit expansion and word expansion?4. How to design a memory? (extended content)
Pre-class test	Complete the online test.

(2) Carrying out online teaching needs the support of rich network resources

The learning online teaching platform needs to include rich functions. It can be used in offline classes at ordinary times to carry out teaching activities, and can also be used as a platform for students' online teaching. Video viewing, online homework exercises, tests, discussions and other activities can be easily carried out. Teachers on the platform can accurately quantify student's learning progress and effect. With the support of the learning through teaching platform, the key task of teachers is to build teaching resources. In addition to the PPT courseware and guidance videos made by teachers themselves, teachers can also select appropriate teaching resources on MOOC ^[9], Baidu Wenku ^[10] and other network platforms ^[11]. The content is required to meet the level of at least 90% of students, and the focus is on whether the coverage of basic knowledge of chapters reaches 100%. At the end of chapters, there should be extended thinking questions and typical cases to trigger students' in-depth thinking and learning. For example, in Chapter 4 ^[8], the case of memory design is given to guide students to think and practice.

2.2. Classroom teaching design

After the knowledge introduction arranged before class, students have preliminarily mastered the contents of this course. Therefore, in the process of teaching in class, teachers should answer students' questions, clarify their doubts, and concentrate on the key and difficult knowledge. The difficulty of online teaching lies in whether the effect of students' self-study meets the requirements, especially the students of ordinary colleges and universities, whose learning enthusiasm needs to be improved. The test of self-study effect before class is normalized as one of the usual assessment methods. The test results can also be used to explain and answer the personalized questions raised in the pre-class learning stage, solve the blind spots of students' knowledge in the process of self-study, and then elaborate on the key and difficult knowledge. They can interact through guidance, questioning and teacher-student discussion. They can also organize group discussions and carry out group activities for pre-class "questions and thoughts" or case analysis. The student interaction form of "group discussion, representative reporting," "student questions and student answers, student lectures and student comments" is used to enable students to participate in the whole process of learning, and cultivate student's ability of independent thinking, cooperation and expression. Finally, the teacher will summarize and strengthen the explanation according to the content of the report, and release the classroom test through platforms such as Learning Pass, to understand the knowledge of all students in real-time and provide guidance and answers

in time. Online and offline mixed teaching enriches offline classroom activities, avoids the phenomenon that teachers fill the room and students are sleepy, and greatly improves the school effect.

2.3. After class design

After class arrangement teachers should pay attention to the consolidation and answering of knowledge points, as well as the extension of extracurricular knowledge. Teachers should release their homework to the network platform in time, and require students to complete the submission within a limited time. Students can be set up to comment on each other or the teacher's correction. Students are encouraged to actively share excellent homework to the platform for secondary consolidation of learning. In addition, teachers can also select some extracurricular learning resources (such as videos, journals, etc.) according to their professional characteristics and upload them to the online teaching platform to publish lectures of famous teachers, grade and certificate examinations, subject competitions and other dynamic information for students' Online Autonomous Learning, to realize the outward extension of the classroom. The addition of extended topic discussion to allow students to answer questions with each other, and teachers to make supplementary summaries to enhance the interest of teaching. In addition, through the learning data of the teaching platform, such as the length of time students watch videos and online learning, the number of times they ask questions and participate in discussions, teachers can timely master students' mastery of chapter knowledge points, and can re-issue learning tasks to students who fail to meet the teaching goals.

Finally, teachers can regularly issue questionnaires on the platform to collect students' opinions on the course teaching from the aspects of learning resources, pre-class learning lists, classroom teaching forms and knowledge mastery, reflect on the problems in the teaching process, and constantly optimize and adjust the teaching design.

2.4. Hybrid experiment design based on experimental box and online simulation

2.4.1. Problems in offline course experiment based on test box

The practice of the course "Computer Composition Principles" involves the comprehensive experiments of arithmetic units, memory, timing generators, microprogram controllers and model machines. The verification experiment of a single module is relatively simple but the comprehensive experiment based on the comprehensive realization of the overall function of each component is complex and difficult, which is often difficult for students to understand. In the current practical teaching of the principle of computer composition, the special hardware experimental box is basically used for experimental design and verification, but there are usually several problems in the experiment of the principle of computer composition based on the hardware experimental box^[12]: (1) The experimental box is usually managed by the university laboratory, which is not convenient for students to preview and review, and there are problems of laboratory sharing and resource shortage; (2) The experimental class hours are few and the course time is short. The students only mechanically carry out the circuit construction and experimental verification according to the experimental guidance, lacking the thinking of independent thinking and innovative design; (3) The internal components of the hardware test box are easy to be damaged, and it is difficult to maintain, with high update cost and slow cycle; and (4) The hardware experimental equipment in some teaching environments is not sufficient, and multiple students work as a group to carry out the course practice content. Student participation is low, and there are many cases of fishing in troubled waters, which affects the evaluation criteria of teacher's practice process assessment and increases the difficulty of assessment^[13].

2.4.2. Application of online virtual experiment simulation platform

At present, many virtual simulation experiments based on software can perfectly replace the physical experiment. The online platform of the EduCoder software provided by the teaching materials used in this course can provide the supporting software and hardware systems for the practice course on principles of computer composition^[14,15]. Through the online experimental platform, students can complete the practice content more often according to the experimental content, and the software platform has no device damage or other conditions. The cost of software upgrading and maintenance is relatively low. Students can safely and boldly design circuits for simulation verification, which can better ensure the participation of each student and improve students' engineering practice ability. However, most of the current training programs for computer majors pay attention to software courses. As one of the few hardware courses in the professional curriculum system, there is no hardware experiment as a practical support, so it is difficult to establish students' systematic view and hardware thinking of software/hardware collaboration in the teaching process. Therefore, in the practical teaching of the principle of computer composition to better exercise the students' practical application ability, the combination of virtual simulation and hardware experiment can be used to strengthen the effect of practical teaching. The experimental verification is carried out offline based on the TW-35 experiment box, and the advanced comprehensive experiments such as experimental training expansion, memory design, and CPU are carried out online based on the online simulation experimental platform.

2.5. Assessment and evaluation reform

Teaching evaluation is a means to reflect and test the teaching effect and teaching state of teachers. It is generally divided into subjective evaluation and objective evaluation. The subjective evaluation includes peer review, teaching supervision evaluation, and student evaluation, and the objective evaluation includes process evaluation, examination results, etc.^[16] At present, the score ratio of objective evaluation of most professional basic courses in the college is 3:7, which is not suitable for the evaluation of online and offline mixed teaching mode. The assessment of the blended teaching mode takes the effect of process learning as the main index and reduces the proportion of the traditional final examination. The course assessment of "Computer Composition Principles" should also be formulated according to the mixed teaching mode, as shown in **Table 2**.

Table 2. Assessment criteria

Process evaluation 50%					Final exam 50%	
Classroom performance 10%		Learning assessment 20%			Experiment 20%	
Problem discussion 5%	Classroom test 5%	Online learning completion rate 5%	Normal operation 5%	Phased assessment 10%	Including confirmatory and comprehensive experiments	Closed book, accounting for 50%

3. Summary

The design of the hybrid teaching mode of "Computer Composition Principles" course is to meet the needs of the era and Technological Development and the reform trend of contemporary higher education. Around the teaching concept of "student-centered, teacher-led", starting from the whole process design of "before, during and after class", combined with the practical guidance of "test chamber experiment + online simulation", relying on the learning smart teaching system, the design of scientific and reasonable evaluation system,

to build a complete hybrid teaching structure, promote the teaching reform and research of “ Computer Composition Principles “ course, and then improve the teaching quality of the course, which can provide a reference for the educational goal of cultivating applied talents in ordinary undergraduate colleges and universities.

Disclosure statement

The author declares no conflict of interest.

References

- [1] Song T, Ye Y, 2023, Analysis on the Teaching Reform of Computer Composition Principle Course under the Background of “New Engineering”. *China New Communications*, 25(4): 72–74.
- [2] Yang X, Li C, Liu M, et al., 2022, Mixed Teaching Mode of Computer Composition Principle Curriculum in Local Colleges and Universities. *Journal of Science of Teacher’s College and University*, 42(2): 92–95.
- [3] Wang L, Wang L, 2023, Research on the Construction of Online-Offline Blended First-Class Course Principle of Computer Composition Based on OBE. *China Modern Education Equipment*, 2023(1): 73–75 + 79.
- [4] Chen Y, Gu H, Liang X, 2021, Research and Practice of Mixed Teaching Mode Based on SPOC: Taking the Course of Principles of Computer Composition as an Example. *Computer Education*, 2021(4): 24–27 + 31.
- [5] Wang Y, Lu L, Chen H, et al., 2021, SPOC Flipped Classroom Teaching Design for Cultivating the Autonomous Learning Ability of New Engineering Students: Taking the Course of “Principles of Computer Organization” as an Example. *Journal of East China University of Technology (Social Science Edition)*, 40(4): 392–396.
- [6] Li Y, Meng S, Wang H, et al., 2022, Design and Practice of Task Driven Hybrid Teaching Mode for the Course of Principles of Computer Organization. *Computer Education*, 2022(8): 20–24.
- [7] Shi X, Ma H, 2022, Exploration on the Teaching Reform of the Principle of Computer Composition. *Computer Education*, 2022(8): 34–37 + 42.
- [8] He G, Li K, Cao W, 2019, Exploration of the Reform of Blended Teaching Mode for Computer Courses Based on Network Teaching Platform: A Case Study of Guangdong Open University. *Journal of Guangdong Open University*, 28(5): 1–4.
- [9] Yang X, 2022, Research and Practice of Blended Teaching Mode Based on Network Teaching Platform: Taking Computer Courses as an Example. *Scientific Consultation (Education and Research)*, 2022(7): 130–132.
- [10] Lv X, Wu W, Yan W, 2024, Research on Blended Online and Offline Teaching Mode Based on Chaoxing Learning Platform. *PR World*, 2024(18): 160–162.
- [11] Tan Z, 2021, Principles of Computer Organization. People’s Posts and Telecommunications Press, Beijing, 95–120.
- [12] Li L, Yang S, Su Y, 2023, The Construction of Experimental Teaching System of Computer Composition Principle by Combining Virtual and Real Facts. *Computer Education*, 2023(6): 184–188.
- [13] Tan Z, Qin L, Hu D, 2017, Practice Teaching Mode of Computer Specialty Oriented to System Ability Cultivation. *China University Teaching*, 2017(9): 80–84.
- [14] Wu Y, Gao Z, Wang Q, et al., 2024, Research on Simulation Experiment Design of Computer Organization Principles for Professional Needs. *Computer Knowledge and Technology*, 20(14): 153–155.
- [15] Liu S, Zhang Y, Peng S, 2022, Reform of Experimental Teaching of Computer Composition Principle Based on Virtual Simulation and Hybrid Teaching Mode. *Modern Vocational Education*, 2022(15): 43–45.

- [16] Yang L, Huang P, Wu L, et al., 2023, Construction and Application of Evaluation Index System of Computer Composition Principle Flipped Classroom Teaching Based on CIPP. *Computer Education*, 2023(6): 174–178.

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