Teaching Reform and Exploration of Principle of Operating System Course under multi-dimensional Driving

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Abstract. In view of the low interest and participation of students in traditional Principle of Operating System course teaching, there are still some deficiencies in training students' system capability and software engineering competence, a teaching reform and exploration of Principle of Operating System course driven by multiple dimensions of student-centered, aspiration and interest, and effect-oriented is proposed in this paper. By reconstructing the teaching contents and process of this course, constructing integrated diversified teaching and multi-dimensional assessment and evaluation methods, integrating theoretical knowledge, practical teaching, curriculum ideology and politics, thinking training, system capability and software engineering competence cultivation, to stimulate students' learning interest, cultivate students' positive attitude and teamwork consciousness, and improve students' ability to analyze and solve complex engineering problems, and guide students to gradually develop innovative awareness and engineering literacy.

Keywords: Teaching Reform, Principle of Operating System, System Capability, Software Engineering Competence.

1 Introduction

On the basis of the previous engineering, the new engineering construction program transforms and upgrades traditional engineering majors, and vigorously trains engineering talents who can solve complex engineering problems [1] to meet the needs and challenges of new economic development [1-2]. Outcome Based Education [3-5] is the basic concept of professional certification of engineering education. Operating System (OS) is the most important system software in modern computer systems. Principle of Operating System course aims to train students to have a comprehensive understanding of OS, master some basic principles, use methods, common algorithms and techniques of OS, and have the ability to analyze and solve practical problems by using the OS platform, as well as software design and development.

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Under the background of new engineering construction and curriculum ideology and politics, it is necessary to explore the teaching reform of Principles of Operating System, arouse students' curiosity, mobilize students' learning enthusiasm, stimulate students' innovative thinking, and cultivate students' computer system ability [6] of analyzing and solving problems and software engineering competence.

2 Problems

Principle of Operating System is a basic compulsory course for undergraduates in our School of Software Engineering. This course involves a lot of knowledge, the contents are complex and abstract, students have a certain difficulty in learning. Some problems exist in traditional classroom teaching of Principle of OS:

(1) The coordination and balance between rich course contents and limited class hours. Before learning the course, students are required to have some knowledge of Computer Composition Principle and some programming languages (such as C, C++, etc.). This course is rich in contents, strong in theory, abstract in principle or mechanism, but limited in offline classroom learning time. The classroom is short of time for student practice, discussion and thinking training. Therefore, students have a certain degree of difficulty in learning, and some even do not have a good understanding of the significance of the principles and mechanisms of the OS.

(2) Traditional teaching is teacher-oriented, the training of students' thinking, values and engineering literacy is insufficient, students' learning initiative and participation are not enough, learning interest is not high, and aspirations are unclear.

(3) Insufficient experimental contents, insufficient training of students' practical ability and systematic ability. Experiments can be used to verify and apply the relevant principles and algorithms of OS. To learn this course, we should not only learn the principles well, but also strengthen the experimental teaching.

(4) Integration and development of unified teaching and hierarchical teaching. Traditional teaching mainly faces all students with uniform requirements and standard teaching. However, in the actual teaching process, there are large differences in the individual learning of students. Therefore, how to carry out the integration of unified teaching and hierarchical teaching is also a challenge for this course.

3 Curriculum Teaching Reform and Exploration

3.1 Framework

Learning some design ideas, algorithm principles, management and implementation mechanisms of OS can help stimulate students' interest, cultivate students' computer thinking and system ability, and lay a certain foundation for subsequent professional learning and solving complex problems. Exploring the potential philosophical principle and potential value of this course, integrating ideological and political content will help to cultivate students' engineering literacy and form correct values.

The teaching of this course mainly focuses on theoretical knowledge, practice, ideological and political elements, thinking, system capability and software engineering competence, forming a framework as shown in Figure 1.

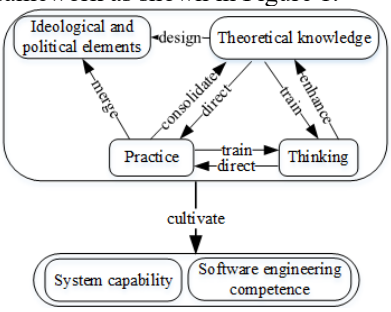

Fig. 1. Framework.

3.2 Teaching Process

The teaching reform of this course aims to stimulate students' curiosity and attention, improve students' interest and motivation in learning, make students recognize the value of this curriculum and their major, build up their tendency and willingness to continue to engage in work related to major in the future and study hard. Therefore, we strive to build the teaching process, which are student-centered, effect-oriented and driven by aspiration and interest, so that students are willing to study deeply, and develop into aspiring learning. The teaching process is shown in Figure 2.

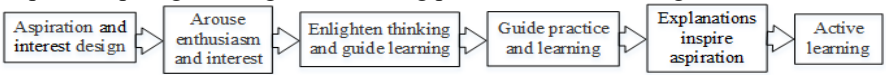

Fig. 2. Teaching process.

3.3 Teaching Mode

Driven by student-centered, aspiration and interest, and effect-oriented, the two-two-four teaching mode as shown in Figure 3 is proposed.

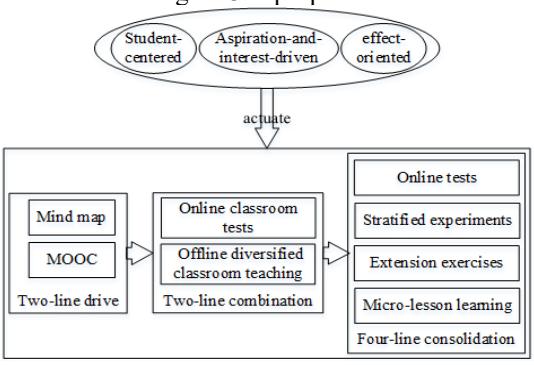

Fig. 3. Teaching model.

(1) Two-line drive mode before class

Before class, students conduct online self-study using chapter mind maps and MOOC resources, which mainly provided by the book Computer OS (MOOC Edition) authored by Tang Xiaodan et al. Students can flexibly use fragmented time to study online through smart electronic devices, and then enter the classroom with basic knowledge and questions.

(2) Two-line combination mode in class

① Offline diversified classroom teaching

In the offline face-to-face teaching, the diversified teaching methods such as problem-oriented, case teaching, disorganized teaching, extended practice, random questioning or explanation, animation demonstration and flipped classroom are adopted. For example, in learning FIFO page replacement algorithm, the diversified teaching methods include problem-oriented learning, case teaching, disorganized teaching, random questioning, comparison exercise, flipped classroom, class discussion, consolidation exercise, extension exercises and challenge learning.

② Online classroom teaching

Online classroom teaching mainly focuses on the knowledge where students are prone to make mistakes and the key and difficult points in the teaching. By integrating the Rain Classroom and Questionnaire Star platforms, teachers set up relevant online test questions in advance. During the class, teachers can release the tests and set the test duration at any time according to the teaching progress. Then, students can answer the questions online within the time limit via their smartphones, tablets or laptops. After that, the teacher randomly selects students to explain the tests by flipped classroom. Finally, the teacher summarizes and comments on the class. This flexible way of releasing test questions in class, allowing students to take timed online tests and providing immediate feedback not only enhances students' participation, but also exercises their thinking and expression abilities. It can also assess students' mastery of knowledge and train their ability to analyze and solve problems.

(3) Four-line consolidation mode after class

① After-school online tests

By constructing the question bank in the Rain Classroom platform, the online chapter tests after school can be set. Question star software can be used for online tests and course questionnaires. Through online testing and flipped classroom, teachers can timely understand students' learning situation and adjust the teaching design.

② Stratified experiments

New engineering talents need to have certain qualities such as innovative thinking, teamwork ability and practical ability [7]. In order to learn this course well, students should not only learn the theoretical knowledge of principle, algorithm and mechanism well, but also strengthen the experimental teaching of OS. Therefore, from the reform of pure theoretical teaching, to the increase of experimental teaching, and to the expansion of extra-curricular experimental contents, the aim is to help students connect theory with experiment, recognize and understand some classic algorithms, principles and design ideas of the OS, and stimulate students' innovative thinking by visualizing and understanding the abstract concepts and principles in the OS. Enhance students' practical ability, develop students' ability to work in teams, analyze and solve problems. In

addition, designing experimental projects of different difficulty, the hierarchical training can be carried out.

To solve the problem of coordination between limited class time and rich knowledge and experimental content, the experimental teaching reform of this course mainly includes: building the parallel mode of basic compulsory experiments and extra-curricular elective experiments. The basic compulsory experiments in class are mainly aimed at the important concepts, and algorithms of OS. It aims to cultivate students' practical ability and deepen their understanding of abstract concepts and principles such as process scheduling, multi-process synchronization, and page replacement. Extra-curricular elective experiments are generally advanced experiments, which can be used as extra-curricular extension and challenging learning for students who have the ability to learn. For example: kernel compilation, increasing system call, multi-process synchronization and communication experiment etc.

③ Extension exercises

Some extension contents are added for students to practice after class. For example, the comparison exercises of different scheduling and replacement algorithms, the conversion calculation between logical address and physical address, solving some synchronization problems such as single-log bridge, barber shop, eating fruit etc., and part of postgraduate examination practices. On the basis of consolidating and deepening the understanding and mastery of theoretical knowledge, we should pay attention to the expansion of knowledge, support stratified teaching and tap students' potential.

④ Micro-lesson learning

After class, students can check the omissions of difficult knowledge by micro-lesson resources provided by the textbook or other reference videos on the Internet, so as to thoroughly understand some core algorithms, mechanisms and principles of the OS and consolidate the theoretical knowledge.

3.4 Adding Some Curriculum Ideological and Political Contents

Engineers should have good professional ability and personal comprehensive qualities such as national feelings, critical thinking and systematic thinking [1-2]. This course should train students to have a solid theoretical knowledge of OS, practical ability and the spirit of exploration and innovation, and also have a good comprehensive quality and correct values. Therefore, focusing on systematic thinking, critical thinking and value guidance, some ideological and political elements such as the development of different OS and related products, corresponding national enterprises of our country, domestic brands and software are integrated to inspire students' patriotic enthusiasm, critical thinking, innovative consciousness etc. Meanwhile, through the system theory and experimental contents of OS to cultivate students' teamwork and serious and rigorous learning attitude, have the courage to analyze and solve complex problems, and gradually establish engineers' sense of responsibility and correct values.

3.5 Multiple Assessment and Evaluation

Multi-dimensional driven teaching has changed the traditional teaching mode, and the course assessment methods have also been adjusted and changed accordingly. The process evaluation of this course includes classroom participation, classroom random question and answer, classroom online or offline tests, offline practice, online chapter tests, homework, course experiments, questionnaire survey and statistics, etc. At the same time, students' learning situation can be understood and analyzed in combination with explanation and evaluation of classroom exercises, flipped classroom, classroom discussion and other situations. Combined with the final examination, we can analyze the achievement of students' ability, and continuously improve the teaching designs.

4 Results and Discussion

For the online classroom teaching, for example, an answer statistic of a single choice question is shown in Figure 4.

Fig. 4. An answer statistic.

After each online test, one student may be named randomly to explain the answer in flipped classroom, the teacher would also timely comment on student's expression. This kind of online timed test and timely explanation can not only improve students' participation and expression ability in class, but also reflect students' mastery of some knowledge points, and then encourage them to work hard after class.

In the semester 23-24 (2), the distribution of students' final scores of an experimental teaching class and a traditional teaching class is shown in Figure 5.

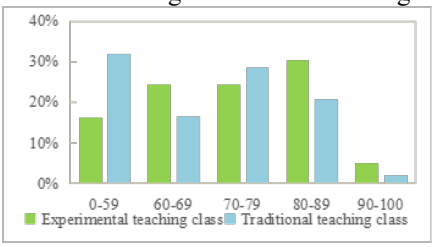

Fig. 5. The distribution of students' final scores.

From Figure 5, in the experimental teaching class, the number of students who scored between 60 and 69, 80 and 89, and 90 and 100 was higher than that of the traditional teaching class. The number of students who scored between 70 and 79 was

slightly lower than that of the traditional teaching class. The number of students who failed the exam was also lower than that of the traditional teaching class. The experimental teaching class had a higher level of classroom participation and activity, and students were also more likely to understand and master the learned content.

5 Conclusion

Under the background of new engineering, the teaching reform of the Principle of Operating System course has been carried out with multi-dimensional driving, and the two-two-four teaching mode has been proposed, which has stimulated students' interest and enthusiasm in learning, improved their classroom participation and initiative, gradually cultivated their ability to analyze and solve problems, and to a certain extent, influenced their patriotic enthusiasm, innovative thinking, teamwork awareness and engineering quality. The teaching effect has been improved obviously. In the future, the course teaching reform will continue to be carried out, constantly exploring new methods and integrating new contents to better cultivate students' innovative consciousness, practical ability and system ability.

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