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Computer Network Course Teaching Reform Based on Flipped Classroom Model

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ABSTRACT. *With the rapid development of information technology, as a new classroom teaching model, flipped classroom has a great impact on the traditional classroom teaching, and provides new ideas and methods for college teaching reform. Combining with the connotation and characteristics of the flipped classroom, this paper proposes the computer network course teaching model under the flipped classroom model, and gives the specific implementation strategy of the flipped classroom in combination with the teaching case, which provides a reference for the teaching reform of computer network course.*

KEYWORDS: *Flipped classroom model, computer network course, PBL, teaching reform*

1. Introduction

Computer network course is a core professional foundation course for computer science and technology major and related majors. By learning the course, students can master the basic knowledge of computer network, have certain computer network basic theory and networking technology, understand the computer network architecture and the relevant protocols of computer network, have the experience of programming and web development, have the ability of network equipment configuration, network management and security maintenance, which will lay the foundation for becoming a high-tech application talent in the network. The traditional teaching model of this course is mainly lectured by teachers and passively listened to by students. In addition, the content of this course is various and complex, which easily leads to the disconnection between teaching and learning, and makes it difficult for students to understand the concepts they are learning [1]. As a result, students lack initiative in the learning process, their independent thinking ability and innovation ability cannot be improved, and the quality of teaching is difficult to effectively improve, so it is urgent to carry out the reform of teaching model.

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In March 2015, Premier Li Keqiang proposed the "Internet +" action plan in the government work report. In 2016, the Ministry of Education issued a notice on the "Thirteenth Five-Year Plan for Education Informationization", which proposed a core concept – "We will unremittingly promote the deep integration of education and teaching work and information technology, and constantly explore new teaching models under the network conditions" [2]. Under such a background, "Internet + education" arises, and the Internet-based teaching model has emerged and developed rapidly. Among them, flipped classroom has the most extensive influence. Turning the flipped classroom as a means of implementing differentiated and personalized teaching, it brings about the reconstruction of educational concepts and teaching thinking. The rise of the MOOC and the flipped classroom has brought new opportunities and challenges to the teaching reform of computer network course.

2. Background Literature

Flipped classroom first originated from the Bangladeshi-American Salman Khan, who used his recorded instructional videos to receive unexpected results in tutoring mathematics for his nieces and nephews. In order to let more children with learning difficulties enjoy these counsel resources, in November 2006, his first teaching video was posted on the YouTube website and quickly attracted people's attention. In 2007, Khan established the non-profit website - "Khan Academy". In 2009, "Khan Academy" was awarded the Education Award in the "Microsoft Technology Award" [3]. In the flipped classroom, the typical classroom teaching time is replaced by activities such as experiments and in-class discussions, and the teaching of course content is completed by students in extracurricular activities in video and other media [4].

As a teaching design method, flipped classroom has become a hot topic in the research and practice of scholars and educators at home and abroad. Its positive effect on the classroom and positive influence on teaching effect has been unanimously recognized by scholars and educators. Only in terms of the application of the scope of colleges and universities, the MS Excel course of the University of Brigham Young Merit Business School and the control system course of the Mechanical Engineering Department of Seattle University have achieved remarkable results by the implementation of the practice of flipped classroom [5] [6]. Some scholars in China have also begun to study flipped classroom teaching model. The literature [7] explores and studies the application of the micro-class-based flipped classroom teaching model in college English teaching. The literature [8] takes the programming course as an example, combined with the network platform and traditional classroom, and the research and exploration of the "double classroom" personalized teaching mode based on flipped classroom is carried out. The literature [9] systematizes teaching activities and their key supports from the macroscopic, mesoscopic and microscopic levels combined with the teaching characteristics of the non-linear learning in the flipped classroom. The teaching design optimization strategies are proposed in three stages: pre-class knowledge transfer, in-class knowledge internalization, and after-class examination and evaluation. The literature

[10] proposes a cloud wisdom education platform solution, which can effectively promote the implementation of flipped classroom. The Literature [11] analyzes the teaching status of computer network principle course and the development status of flipped classroom teaching mode, and then proposes a teaching model of computer network principle course combining traditional teaching with flipped classroom teaching. The literature [12] proposes a flipped classroom of computer network course based on the SPOC platform, comprehensively using active learning, mixed teaching, problem-based teaching, CDIO and other teaching models, fully reflecting the teaching concept of student-oriented teaching. The literature [13] analyzes the connotation and research status of the flipped classroom, proposes the computer network course flipped classroom teaching model, and combines the teaching case to give the specific implementation strategy of the flipped classroom. The teaching evaluation mechanism under the flipped classroom mode is expounded. Based on the characteristics of MOOC curriculum construction, the literature [14] designs an open and flexible micro-lecture teaching system for computer network course. The multiple interactions between teachers and students centered on learners are realized, which have effectively improved the creativity and effectiveness of university teaching activities. Based on the analysis of MOOC, flipped classroom and other teaching modes, the literature [15] gives technical and non-technical thoughts on the design of SPOC+ flipped classroom teaching model for the computer network technology course. Based on the reference to the relevant literatures, this paper discusses how to combine the flipped classroom teaching model and the PBL teaching method to reform the teaching model of the computer network course.

3. Flipped Classroom Implementation Process

Flipped classroom teaching mode is beneficial for teachers and students to use limited time to complete teaching tasks, and then solve problems in teaching and understand the knowledge in the class. At the same time, it also provides a wealth of knowledge and plenty of time for students' self-directed learning. Teachers do not need to spend a lot of time in the classroom to explain the basic knowledge and content for students. Instead, the students can learn by themselves by micro-videos. Therefore, a lot of time is reserved for teachers and students to discuss and explore in class, which is conducive to improving students' learning efficiency. The computer network course flipping classroom teaching model is shown in Fig. 1. It consists of three parts: pre-class preparation, classroom process and after-class summarization. The pre-class preparation activities are mainly teacher-led, and the teachers make and upload the micro-videos of the knowledge points and the corresponding thinking questions. The students learn micro-videos and complete the thinking questions. The teaching process is led by the students. According to the feedback of students on learning micro-videos, the teacher answers the questions, puts forward new questions, and guides students to think deeply, and finally the teacher summarizes and refines the knowledge points. After the class, the teacher collects the feedback from the students and optimizes and adjusts the micro video content and knowledge points according to the students' responses, in order to achieve better teaching results.

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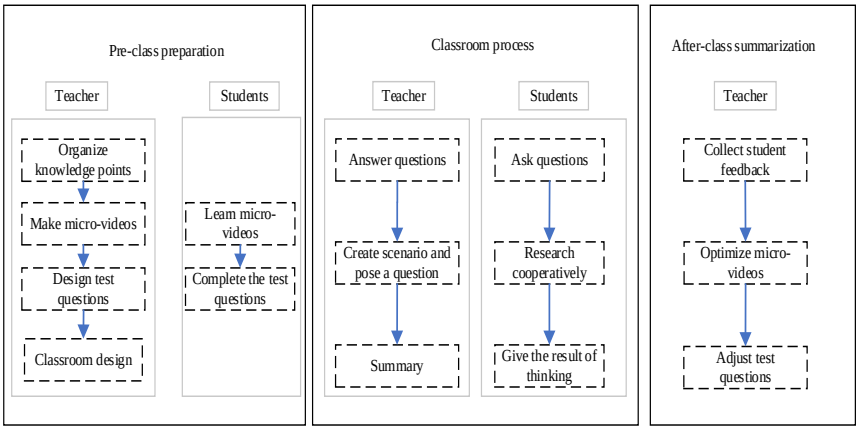

Figure. 1 Flipped classroom teaching model of computer network course

3.1 Pre-class Preparation

Firstly, according to the key and difficult problems in the teaching content of the course, the teacher sorts out the knowledge points needed to make micro-videos and corresponding questions. For the learning points that are difficult to learn and difficult for students to directly grasp by watching micro-videos, the teacher needs to explain them further, such as the mutual comparison and analysis of advantages and disadvantages of subnet division, CIDR and other knowledge points. These contents are difficult to understand, or closely related to each other, which requires the teacher to further deepen their combing in the classroom. For the knowledge points which are not difficult to understand, but play an important role in the course knowledge system, such as CSMA/CD working principle, various routing protocols and so on, can usually be mastered by watching the micro-videos. However, it is necessary to consolidate the learning effect through various ways in classroom teaching and deepen students' understanding of such knowledge points. For the knowledge contents which are relatively easy to understand, students can easily understand the knowledge points through micro-videos, such as the introduction of various transmission media in the physical layer, the introduction of various protocols in the application layer, etc. The teacher can decide whether to explain this kind of contents in class teaching according to the teaching hours and students' actual situation.

Since the theoretical knowledge points are made into micro-videos and uploaded to the network teaching platform, under normal circumstances, the micro-videos corresponding to each knowledge point is less than 10 minutes. Furthermore, the teacher designs the classroom teaching activities according to learning requirements of the knowledge points, such as selecting typical network scenarios, setting up discussion questions specifically, and making comprehensive use of task-driven, problem-oriented, group discussion and other teaching methods.

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From the students' activities, they first log on to the online teaching platform to watch the micro-videos and complete the questions arranged by the teacher. In this process, students can learn in their own way. Students with good foundations can speed up their learning. Otherwise, they should slow down their progress. They can also watch test questions first, watch micro-videos with questions and find answers in them. They may have doubt about the micro-videos and the after-class questions. They may find answers by themselves, which enhance their self-learning ability, and they also can communicate with teachers on the online platform. On the one hand, they can provide opinions and suggestions on the content of micro-videos. On the other hand, they can ask the teacher or other students for problems that they cannot understand, and they can also share their own learning experiences.

3.2 Classroom Process

The teacher firstly takes 5 to 10 minutes to explain the relevant knowledge points according to the test situation before the class or the questions arising before the class. Then, according to the pre-designed classroom activities, the teacher introduces the network scene created in this class, and throw out a few discussion questions to let students think deeply about what will be different in this network scenario. Students can freely form a discussion group from 3 to 5 persons. Each group selects a team leader. The team leader is responsible for coordinating the team members to participate in the discussion and speeches, and should actively mobilize the enthusiasm of each group member to participate in the discussion. The teacher can randomly observe the discussion of a group during the student discussion process, and give appropriate comments and suggestions. During the discussion within the group, students exchange their ideas about the problems with each other, and reach consensus within the group in a debate or complement each other. After the teacher gives the students 5 to 10 minutes of group discussion time, the team leader will make a summary speech as a representative. The members of other groups can debate or supplement with them. The teacher can ask questions in the process to guide students to think about deeper problems. For the common problems of students, teachers can demonstrate and solve collectively. In this way, students continue to improve in the process of "Thinking-Discussing-Statement-Questioning-Inspirating-Rethinking". When the classroom process is flipped, the interaction between teachers and students and personalized contact time will be increased greatly. The classroom has become a place for students to discuss and communicate and solve problems. Students learn theories in an active atmosphere of constant thinking and discussion, and the internalization of knowledge has been completed to the greatest extent.

3.3 After-class Summarization

After the end of a class, the teacher needs to think about and summarize the whole process of the class. According to the feedback from the students, the teacher will adjust and optimize the content of micro video and corresponding test questions

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to optimize the teaching process, perfect the teaching materials, improve the teaching methods, and achieve the purpose of improving the teaching effect.

4. Flipped Classroom Teaching Case

In order to specify how the flipped classroom model is applied to the computer network course teaching process, the author gives a teaching case. Take the working principle of the ARP protocol as the teaching contents, we explain the teaching ideas of pre-class preparation.

4.1 Knowledge Points Arrange

The main knowledge points of the APR protocol are as follows.

- The function of the ARP protocol.
- The working mechanism of ARP in the same network segment environment.
- The working principle of ARP in different network segments.
- Gratuitous ARP.

The teacher prepares two micro-videos, and makes the micro-videos for the first two knowledge points, and arranges the questions as follows.

- Why use two different addresses, IP address and hardware address, to identify a device?
- If the destination IP address is the same as the source IP address, what will happen when an ARP Request broadcast is performed?

In order to help students to understand the abstract concepts in the protocol, the packet-capture can be performed in the micro-videos through the packet capture software - Wireshark [16], so that students can observe the original packets and understand the ARP workflow more intuitively during the self-study process. By watching two micro-videos before class, students can find the answers to the test questions by searching for relevant information and complete the test on the network teaching platform.

4.2 Classroom Process Design

In the classroom, the teacher first answers questions about the micro-videos, and provides targeted explanations according to the feedback of the students' pre-class questions, and officially gives the concept and application of gratuitous ARP. Then the teacher creates a scenario by asking if there is any difference when the switch in the micro-video is replaced by a router. Fig. 2 is the network topology built by the teacher through the Huawei network simulator eNSP in micro-video. Fig. 3 shows the new network topology where the switch is replaced by a router. The teacher

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modifies network topology and resets the IP addresses and gateway addresses of the three hosts in class. Here, the students can review the knowledge about IP address classification and subnet division. When the modification is completed, ask the students how the ARP protocol will work at this time and whether the same ARP packet can pass through different network segments.

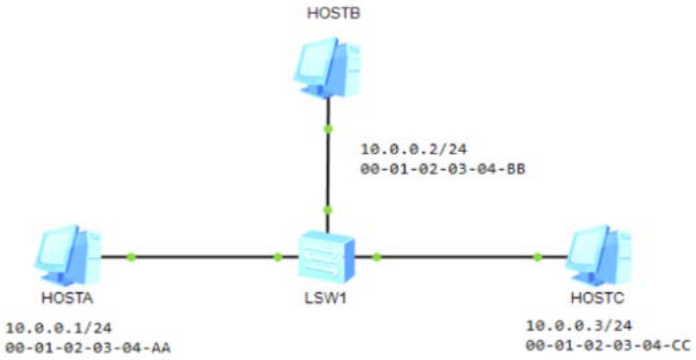

Figure. 2 Topology used in the micro-video

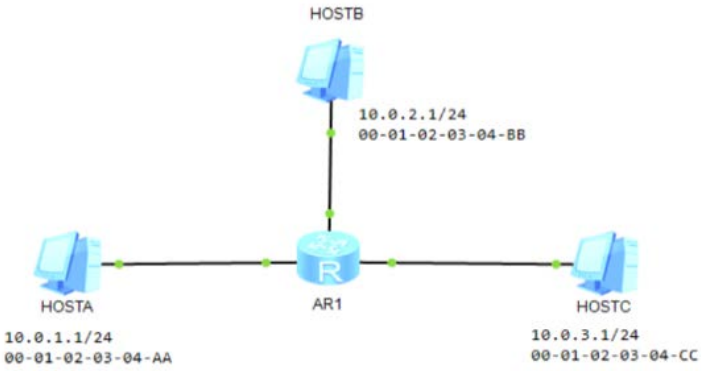

Figure. 3 Topology used in class

Students may freely discuss in groups, and each group selects a team leader to speak on behalf of the group. In order to verify that the students' analysis and discussion is correct, the students can still observe the original data packets by means of packet-capture. By carefully observing the captured data messages, students can fully understand the difference between the ARP protocol working in the same network segment environment and different network segment environment. Finally, the teacher summarizes the relationship between the IP address and the

hardware address. Through packet analysis, the students can see that in the process of packet transmission, the source IP address and the destination IP address are unchanged, but whether the hardware address changes or not will vary according to the actual network environment. The teacher summarizes the functions and benefits of the gateway before the end of the class.

In the above process, the teacher gives the students 5 to 10 minutes to discuss in the group after each question. The teacher randomly listens to the discussion of a certain group, gives appropriate comments and suggestions, and then invites some team leaders to speak. Other members can be opposed or supplemented, the teacher gives appropriate comments. When the answers and supplements of multiple students are relatively complete, the teacher summarizes and evaluates the learning outcomes of the students, and encourages them to make persistent efforts.

5. Conclusion

Practice shows that when the flipped classroom teaching model is applied to the computer network course, students' enthusiasm for learning will be greatly improved. It can effectively stimulate students' interest in learning, optimize the teaching resources, and can also realize the diversification of classroom teaching. The students can deepen their learning through a variety of learning methods in limited classroom time. It also improves students' independent learning ability and innovation ability. Flipped classroom is a process of cultivating students' active learning ability, teamwork ability, and inquiry ability. It is also a good way to promote students' interaction with others, and promote mutual communication between teachers and students.

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