

Design of "Computer Network" Innovative Teaching Method for New Engineering First-Class Talents Training

Ze Wang, Nan Song, Jing Guo

Abstract— T n accordance with the current development of new engineering and new infrastructure strategy for IT personnel training demand, according to the characteristics of computer network course theory and practice of equal importance to put forward the combination of online and offline hybrid teaching and online flipped classroom teaching model. Through offline teaching mixed with the online lesson "flip" teaching model to help students combining theory study and practical engineering problems, to cultivate the students' divergent thinking ability, stimulate interest in collaborative learning, lead the students into active and creative learning situations, and to strengthen the construction of political education course in the learning process, realize the unity of knowledge and value guidance.

Index Terms—Computer network, Innovative teaching, First-class talents training, flipped classroom teaching

I. INTRODUCTION

The development and construction of emerging engineering majors must provide the first productive force -- "scientific and technological talents" for the implementation of major national science and technology strategies and basic projects in the new era. So member of the research group is oriented by the national demand for scientific and technological talents in "new infrastructure and new engineering" , actively explore the production-education integration results of IT professional groups, take the initiative from characteristic development and dislocation development, establish the new engineering characteristic course system group and talent training mode which meet the national strategic talent demand, and serve for the construction of first-class new engineering IT majors. "Computer Network" is an important subject platform course for IT majors of new engineering such as Internet of Things engineering and cyberspace security. The research group took the teaching reform of "computer network" course as the breakthrough point of professional curriculum reform, carried out innovative teaching method design continuously, and provided demonstration cases for the teaching reform and innovation of computer professional courses and the ideological and political construction of courses.

Computer network is an important core course of computer majors, which is directly related to the basic requirements of talent training and plays an important role in professional

teaching. However, there are still some "pain points" in practical teaching, including: the theoretical teaching lacks the overall view of network architecture; Outdated teaching model and poor student participation; Lack of comprehensive design of experimental teaching; The ideological and political construction of the curriculum is weak. In view of the above problems, the research group carried on the reform and innovation to the teaching content, teaching mode, teaching activities, experimental courses and so on. Theoretical teaching focuses on the overall working principle of computer network protocol and builds the overall view of network architecture. The student-centered "flipped class" teaching model was introduced in the teaching process to improve students' participation. Increase the comprehensive design experiment, and adopt the online and offline mixed teaching mode; At the same time, the ideological and political education and professional education organic integration.

II. KEY POINTS OF INNOVATIVE TEACHING

Based on the "output guidance, student center, continuous improvement" philosophy to carry out the new direction of engineering IT to specialty cultivation and the construction of the core curriculum, on the basis of actual teaching cases, complete cultivate first-class talents for new engineering computer network teaching method reform and innovation, promote the professional course teaching content, teaching mode and teaching activities of innovation and development, It not only cultivates students' professional knowledge education, but also cultivates engineering practice ability [1]. It makes full use of practical teaching platform and online teaching platform and resources[2] to implement hierarchical and progressive transformation of students' practice and innovation training.

This innovative course adopts a teaching model combining online and offline mixed teaching and online "flipped" teaching. [3] In this innovative teaching process, the key points of IP protocol technology and design ideas as the clue, let the students solve the problem of computer network planning and routing table design from the perspective of network management. Students personally describe the forwarding and delivery process of a group on the Internet. Through the student to the computer network planning scheme design and the form of group learning, which teachers' explanation and guidance to help students complete the learning of the course content, make the whole learning process around the students as the center. This teaching method combines ideological and political construction in learning activities, and promotes the value concept of division of labor, cooperation and collaborative development of students. [4].

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III. PREPARATION BEFORE INNOVATIVE TEACHING

The main contents of this innovative teaching method include: learning the content of IP network division and routing [5] in the fourth chapter of network layer routing of computer network course. Network layer is the core layer of computing network architecture, which mainly solves the two problems of network addressing and routing[6].

A. Teaching Objectives

In terms of knowledge, students can master the evolution of two-level IP address to three-level IP address, router forwarding packet algorithm and routing table construction, subnet mask, variable subnet division and construction of hypernetwork and other knowledge etc. In terms of ability, it can improve students' abstract thinking ability to solve network addressing and network division problems. Students are equipped with the ability of designing and analyzing IP network partitioning and static routing, as well as the ability of optimizing routing table using partitioning and aggregation methods.

B. Study situation analysis

Before learning this lesson, students should master the key points of routing table and IP packet forwarding algorithm, and the calculation method of IP network division. Before class, they should consolidate the function of IP addressing and subnet mask and review the subnet division and routing and forwarding algorithm. In addition, students are required to complete the homework related to the pre-task.

The homework assignments are as follows:

Aiming at the following problems and topologies, the general methods of IP network division are summarized, and the network division process is sorted out for the following examples.

A unit (TG) is assigned to an address block starting at 211.68.12.0/24. The specific requirements for this unit to use three sub-address blocks are as follows: 120 addresses for subnet N1, 60 addresses for subnet N2, and 10 addresses for subnet N3. Please give the address block allocation scheme.

IV. TEACHING METHOD DESIGN CASES

The exploration of network layer routing in this teaching method case is mainly divided into two implementation processes: offline teaching 1 class hour and online "flipped" teaching 2 class hours .

The offline teaching process is based on the completion of the pre-class tasks. Students work in groups under the organization of teachers to design programs. Through the division of labor within the group, program discussion, and the final teacher's supplement to the program needs, students can realize a comprehensive and systematic understanding and mastery of the course content.

The online "flipped" teaching process is the summary and practical application of offline teaching. Teachers throw out questions and students answer them on the teaching platform. Multiple questions are advanced layer by layer to fully stimulate students' learning enthusiasm [7]. Finally, through the teachers' explanation and summary, students' knowledge is consolidated. As well as the common improvement of the theoretical knowledge learning ability and the ability to solve

practical engineering problems.

A. Implementation process of offline teaching

1 Teachers' teaching organization:

Organize a group of 6 students and determine the division of labor. For example, 3 students are responsible for the network division scheme (Part1), and 3 students are responsible for the routing table construction and packet forwarding (Part2). After grouping, organize student groups to set their own goals and tasks, complete the scheme design before class, and complete the scheme presentation in class. After the explanation, the teacher could randomly supplement the network division requirements on site, ask the students to record the plan change requirements, design new solutions and add them to the plan document.

The reference IP network partitioning prototype (as shown in Figure 1)

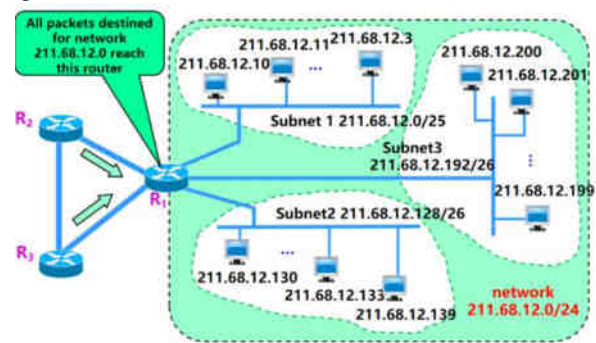


FIG. 1 Reference prototype of IP network partition

2 Students' class tasks (Key indicators) :

On the basis of completing the pre-class tasks, the group leader is responsible for arranging the division of labor and program discussion in advance, and summarizing the discussion results of the group. In class, the design results will be presented on site in groups: (1) Randomly select an effective unicast address block, the size of which is between /24 and /16; (2) Give the basic requirements of the number of subnets and the number of hosts in each subnet. It is suggested that the number of subnets should be 3-5, and the total number of hosts in each subnet should be about 70%-90% of the number of hosts in the original unicast address block. (3) Complete the actual IP subnet division work and represent the result of subnet division in a graphical way (it is recommended to use the course PPT resources or network simulation tools such as Packet Tracer); (4) WAN router R2,R3... Rj, like R1, is the egress router of an enterprise network, which truthfully shows the interconnection of multiple enterprise networks, and gives the interconnection topology and connected IP network. (5) The routing table reachable to the whole network is constructed for the network topology after enterprise network interconnection, and the routing table of each router is given. Explain the forwarding process of IP packets sent from one subnet host to another subnet host (at least through two routers); (6) Before and after subnetwork division, try to describe the changes of the routing entries from R2 to the "TG" network (default router R1), and explain the role of route aggregation through the changes of the R2 routing table.

3 Classroom presentation process (step by step) :

1) A class C network division process;

- 2) a generic partitioning process for networks larger than class C;
- 3) internal router routing table construction and packet forwarding process of enterprise network.
- 4) For example, WAN routers R2 and R3 are also the egress routers of an enterprise network, just like R1, which truthfully show the interconnection of the three enterprise networks and give the address allocation of each interface;
- 5) On the basis of the above, the routing table of R2 or R3 is given, and the IP packet forwarding process is illustrated when the three sites in the enterprise network communicate.
- 6) Before and after subnetwork division, try to describe the routing table from R2 to "some unit TG" network, and explain the function of route aggregation through the change of R2 routing table.

4 Questions for Consideration after reporting:

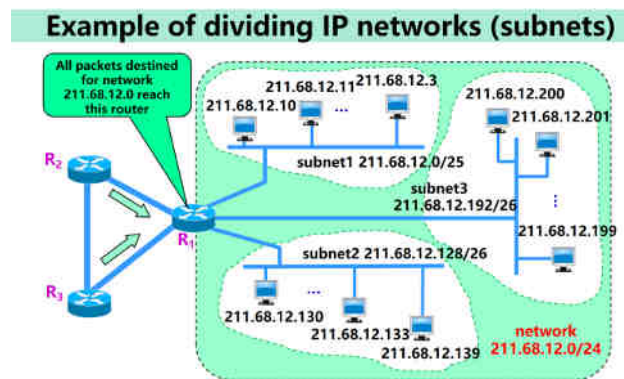
Example of thinking question: This report has completed the IP network division and routing table design for network interconnection of n enterprise departments. If the network demand increases, m enterprise departments need to be added. Try to analyze what work needs to be completed and whether it has any impact on the currently assigned network addresses. Can the routing table be further optimized?

B. Implementation process of online "flipped" teaching

Problem 1: Organize students to think about the problems to be solved in the network layer.

Students review the problem solutions they have learned; Think about solutions to new problems; The teacher randomly calls the roll through the App and asks students to complete the "Lianliankan" operation. Through the introduction of question 1, teacher can understand the students' mastery degree and sort out the learning clues.

Problem 2: Flip Class Report Supplement Problem 1- Network division.



G. 2 Network Partition Supplement problem

The teacher select 1 group of students to review the network partition supplement problem proposed in the class of network partition flipping, and organized them to think about the solution. By ZhiDao App's scramble function, students select one student in a group to answer the solution after the change of network requirements. By supplementing question 2, students are guided to fully consider the potential demand changes in network engineering and improve the adaptability of the solution.

Problem 3: Flip class report Supplement Problem 2- Route aggregation.

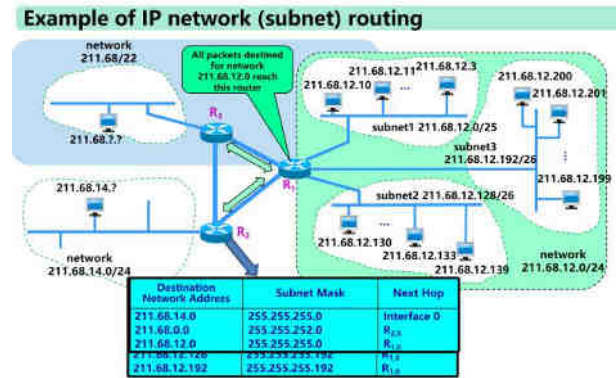


FIG. 3 Route aggregation Supplement problem

The teacher select another group of students to review the routing aggregation addition problem proposed in the class of network partition flipping, and organizes them to think about the solution. By knowing the App's scramble function, students choose one student in a group to answer the effect of route aggregation. Question 3 is used to guide students to understand the method and implementation node of routing table optimization.

Problem 4: From Static route configuration to dynamic routing selection protocol

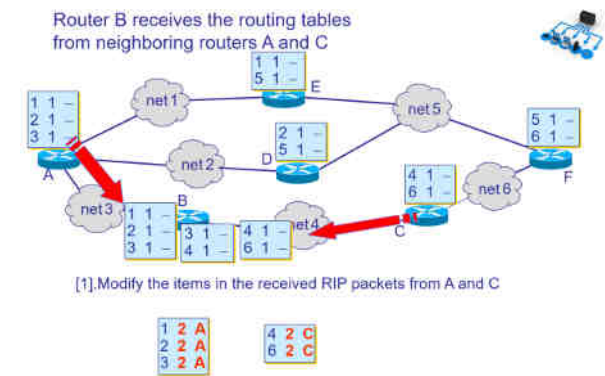


FIG. 4 Dynamic routing protocol based on distance vector

The teacher explains the dynamic routing selection protocol based on distance vector and how the shortest path algorithm[8] based on local perspective can discover the shortest path and establish the routing table through the cooperation of neighboring routers. Through heuristic teaching, students learn how to use the "flow chart" tool to establish the processing process of dynamic routing table construction. The Internet uses the idea of divide and conquer to realize the interconnection of the whole network. Different routing protocols are suitable for different application scenarios. Through teacher's explanation and heuristic teaching[9], students are guided to establish engineering thinking, master process tools, and understand design rules, verification rules and compliance rules in the learning process.

C. Course Ideological and political design:

In the complex network environment, only when routers faithfully exchange network reachable information according to the agreed rules, can the routing table be correctly constructed and rapidly converged, and the whole network access of IP datagram is finally realized.

Taking the routing information protocol RIP [8] as an

example, in a computer network scenario where a considerable number of routers are interconnected with each other, each router sends its own connected network information to its neighbor router "to the best of my ability", and the team collaborates to achieve "full network access".

It shows that the success of a team cannot be separated from the mutual trust and support of each member. In a good team, everyone should "think together and work together". "One for all and all for one" is an excellent value concept to promote the collaborative development of individuals and teams.

D. Teaching reflection:

Students work in groups to complete the actual IP network division and routing table design, and show and report in class, which can combine theoretical knowledge learning with practical engineering problems, and stimulate interest in autonomous learning and collaborative learning.

The students completed the project presentation and report in groups, which evaluated the students' engineering practice ability of analyzing and solving problems, and also tested their non-professional ability such as teamwork. In the process of discussion, it is easy to integrate the ideological and political elements of the course such as love for the collective and serving the country through science and technology

The combination of online and offline teaching and the application of flipped teaching model are convenient for teachers to grasp the learning data and learning outcomes of students, especially the situation of ability attainment.

Flipped teaching and classroom interaction, which mainly focus on students' explanation and presentation, usually take up a lot of time. It is a difficult point to choose the appropriate topic and determine the capacity and difficulty of students' self-completion

V. CONCLUSION

The innovation of teaching content, experimental courses and the application of flipped classroom teaching method have broken the traditional teaching form mainly taught by teachers, redefined the role of teachers and innovated the teaching model. The teaching mode of flipped classroom changes the teaching mode from teacher-lecture-oriented to student-oriented, lays more emphasis on students' complete and in-depth learning experience, greatly improves learning initiative and participation, and improves students' autonomous learning and research-oriented learning ability. The application of group teaching improves students' cooperative learning ability. The deep integration of information technology into classroom teaching has changed the traditional "multimedia + blackboard writing" text and graphics display mode, providing students with a visible, tactile and editable "computer network" environment. At the same time, ideological and political work runs through the whole teaching process, the core values education is detailed, small and implemented in every course, The ideological and political work should be integrated into education and teaching to realize the turn from "ideological and political course" to "curriculum ideological and political course".

This teaching mode is first implemented in the Internet of Things major. On this basis, it is extended to other majors

such as computer science and technology, software engineering, and network engineering. In the process of promotion, the teaching content is constantly enriched, and the promotion effect is good. Since the implementation, the teaching effect has been praised by students and teachers alike.

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