Exploring the Reform of Teaching Methods in Computer Network Courses

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Abstract. In today's world, as a core area of information technology, computer networks are extremely significant for cultivating high-quality human resources that fulfill the needs of current society. As information technologies advance swiftly, the investigation and implementation of innovative teaching strategies have emerged as a pivotal factor in enhancing the quality of computer network instruction. This paper analyzes the interdisciplinary, rapid technological updating and powerful practical features of the course, and at the same time, it argues the necessity of reform in view of the current status quo of outdated teaching content, single method, weak practice and imperfect assessment mechanism of the current course. On this basis, this article proposes a string of specific reform initiatives, including refining learning content, innovating teaching methods, strengthening experiential learning and changing evaluation methods. Ultimately, this paper summarizes the full text and analyzes the subsequent reform trends, which will provide a highly informative path for teaching reform.

Keywords: Computer Networks; Teaching Methodology Reform; Practical Teaching; Reform Measures

1. Introduction

In today's digital era, computer network technology has become a key force for social progress, with a wide range of applications in various fields such as online office, distance education and intelligent transportation. The convergence of 5G, IoT, cloud computing and other technologies is increasing the demand for computer network professionals in society, requiring not only solid doctrinal knowledge and excellent practical ability, but also innovative mindsets, teamwork and interaction skills. However, the conventional instructing method has been tough to fulfill these requirements. Accordingly, it is particularly prominent to promote the change of instructing methods in the curriculum, which can not only improves teaching quality and the fostering innovative talents in networks, but also sets the benchmark for education reform and promotes the adaptation of the education system to current times, thus fueling social development [1].

2. Characteristics of the Course and Current Status of Teaching

2.1 Course Characteristics. The computer network course is characterized by comprehensiveness, practicability, dynamics and systematicity. On the one hand, it integrates the knowledge of computer science, communication engineering, electronic engineering and other disciplines, including data transmission, network protocols, network architecture, network security, etc. With the aim of thoroughly apprehend its working principles and applications, students ought to acquire numerous doctrinal knowledge and expertise. Another aspect, the course emphasizes the close combining doctrine and practice, students not only need to learn network protocols, network equipment and other theoretical knowledge, but also need to carry out practical operations, such as building a small local area network, configure network equipment, network troubleshooting, etc. What's more, because of the prompt progression of computer network technology, new protocols, equipment, applications continue to emerge, the course content needs to be continuously updated, the teacher must understand and explain the latest network technology and cases to the class, so that students can master the current mainstream network technology and development trends. Finally, course content organization needs to comply with a certain logical sequences, starting from the

basic concepts of the network, the framework, and then gradually to the network protocols, network equipment, network applications and other levels, which will assit students to construct a extensive learning system.

2.2 Teaching Current Situation. In the teaching exploration of computer network courses, many colleges and universities are attempting to combine theory and practice closely, concentrating on practice-based teaching of theoretical knowledge rely on real project cases. However, the swift development of network technology makes it difficult for teachers to be in parallel with the latest trend.Consequently,it challenging to find a balance in current educational reforms. Thereafter, we will analyze the status of teaching, as shown in Fig. 1.

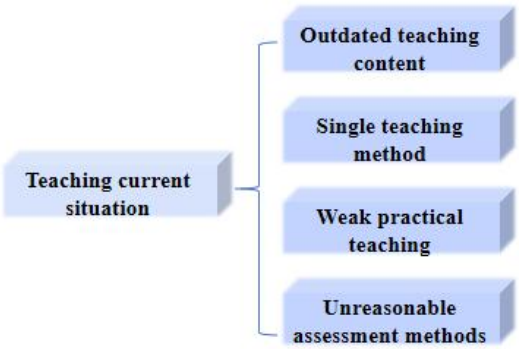

Figure 1. Teaching current situation

2.2.1 Outdated Teaching Content. Against the background of the speed development of today's technology, existing curriculum materials are generally slow to update content. Many textbooks still use a lot of space to introduce traditional network theories, protocols and technologies. However, for the popular cloud computing, Internet of Things and other cutting-edge knowledge, the textbooks only briefly mentioned or not involved at all. This makes students find that the knowledge they have learned cannot be applied to their work when they enter the society.Thus, they must expense much time to re-learn the extending ahead technologies who can adjust to the development needs of the work. In the teaching process, some teachers are overly dependent on textbooks and do not closely integrate theoretical knowledge with current practical applications. For example, in the explanation of network architecture construction related content, if only stay in the theoretical level, such as topology drawing and protocols, but not the introduction of actual engineering projects in the case, such as large-scale data center network architecture, intelligent factory network layout, etc., students have difficulty understanding the criteria for selecting different network architectures, the crucial points of performance optimization and effective strategies for dealing with failures in real scenarios, which can lead to a serious disconnect between theory and practice. Therefore, students are often at a loss when confronted with practical problems.

2.2.2 Sigle Teaching Method. In the teaching of computer network courses, the traditional lecture method is still the mainstream teaching method. In class, the teacher mainly imparts the theoretical knowledge, while the students are not actively absorbing content. This monotonous teaching mode makes the classroom atmosphere dull, and students' learning enthusiasm and initiative are inhibited to a certain extent, which makes it easy for students to produce an aversion to learning. For example, in teaching network protocols, if the teacher simply explains the principles of the protocol, field composition and workflow, without guiding students through actual case studies or simulation experiments to explore the protocol in different network environments and interactive processes, students can’t truly apprehend the core of the protocol.Although the theoretical knowledge has a certain understanding, the hands-on ability is weak, and unable to apply the theoretical knowledge flexibly to practical projects.After graduation, for the requirements of practical skills in the workplace, they can not quickly adapt.

2.2.3 Weak Practical Teaching. Some colleges and universities due to financial constraints, not enough attention to practical teaching and other reasons, computer network laboratory equipment

appears old and aging. For example, in the development of cloud computing, SDN and other experimental teaching, the laboratory lacks high-performance servers, professional SDN switches and other key equipment, students can only stay at the theoretical level and cannot experience practical points, and the cultivation of manual dexterity is challenging to implement. Bound by traditional instructing concepts and the confines of the cumulative course hours, the practical hours isn’t generally enough, and students lack sufficient time for hands-on practice and skill-building exercises. This leads to students in the limited practical hours can only rush to complete some simple experimental projects, can not explore complex network technology problems, and it is difficult to achieve the teaching goal of mastering practical skills below [2].

2.2.4 Unreasonable Assessment Methods. Currently, most of the curriculum evaluation is primarily rely on the conventional theoretical examination, the examination content focuses on the memorization of learning points and simple understanding, such as the concept of network protocols dictated, network topology drawing, etc. This way of a evaluation overlooks students' practical skills, capacity for innovation, and ability to apply knowledge to address questions, resulting in students to cope with the examination, rote memorization of theoretical knowledge, is not facilitate the cultivation and enhancement of the overall quality of students. In the current course evaluation framework, the assessment pertaining to students' learning process lacks sufficient comprehensiveness and granularity, and the ordinary grades are often based on attendance, homework completion, lack of participation in classroom discussions, group project collaboration, experimental performance and other process indicators of in-depth consideration. This makes part of the students usually study perfunctorily, before the test, can also make good results in the assessment, can not truly reflect the effectiveness of students' learning and ability level, loss of assessment of fairness and science [3].

3. The Need for Reform of Teaching Methods

3.1 Adaptation to Social Needs. In today's era, computer network technology develops rapidly and becomes the core driving force to promote the forward development of society.In the intelligent transportation system, the application of vehicle networking technology enables instantaneous sharing of data and intelligent scheduling between vehicles, effectively alleviating traffic congestion; in the field of industrial Internet, factory machinery is interconnected via the network, realizing precise control and optimization of the production process, thus enhancing production efficiency; in the case of telemedicine, the real-time transmission of high-definition images and physiological data provides powerful support for the consultation and surgical guidance of experts in other places, breaking through the geographical limitations of medical resources. In the remote medical scenario, the real-time transmission of high-definition images and physiological data provides powerful support for consultation and surgical guidance of experts in other places, breaking through the geographical limitations of medical resources. The utilization of computer networks is extensive and profound. These rapidly developing industrial applications have put forward high requirements for computer network talents.

3.2 Refining the Teaching Quality. The conventional instructing mode has largely impeded the improvement of educational quality . In the theoretical teaching, teachers continue to elaborate network principles, protocols and other abstract knowledge, and students can only be in a passive acceptance of the state, busy recording notes, there is no opportunity for active thinking and interactive exchanges, which leads a monotonous classroom atmosphere, and the students' enthusiasm for learning has been significantly impacted. Experimental teaching also faces many problems. Owing to the scarcity of equipment, cramped space, and stringent time limitations, experimental projects are frequently designed in a relatively straightforward and fragmented manner, most of which are verification experiments, such as basic network configuration commands, simple network topology construction. This kind of experiments can't effectively stimulate students' enthusiasm for exploration and innovation potential, and can't enable students to deeply understand the practical application of technology and problem solving methods in complex network environment.

4. Reform Measures for Teaching Methods

In this current age, the realm of education is encountering unparalleled transformations and trials. To more effectively fulfill the demands of societal progress and nurture talents of high caliber who possess both innovative spirit and practical capabilities, the urgency of reforming teaching methodologies is palpable. Next, the specific measures of teaching method reform will be discussed in depth from four aspects: optimizing teaching content, innovating teaching methods, strengthening practical instruction and innovating evaluation approaches, as shown in Fig. 2.

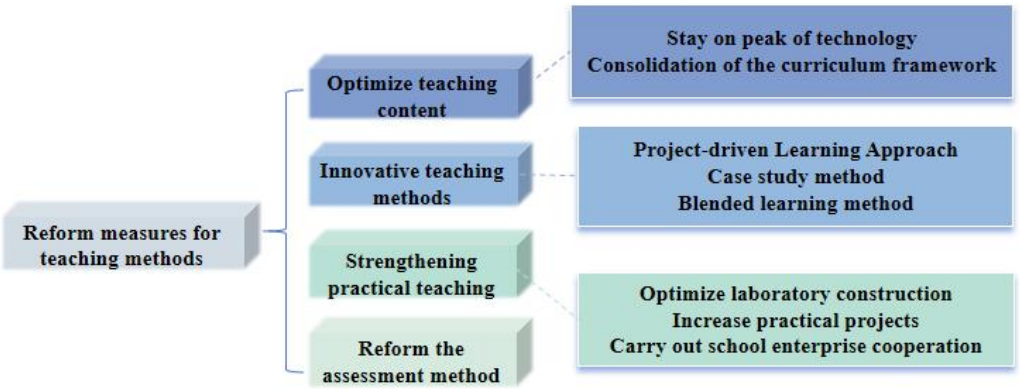

Figure 2. Reform measures for teaching methods

4.1 Optimizing Teaching Content.

4.1.1 Stay on Peak of Technology. Computer network technology is advancing at a breakneck pace, with a constant stream of novel theories, cutting-edge technologies, and innovative applications coming to the fore. So as to make the teaching content run parallel to the development of the sector, teachers must pay constant attention to the latest developments of international authoritative academic journals, top industry conferences and famous technology enterprises, and grasp the research hotspots of frontier technologies such as quantum communication networks in a timely manner; at the same time, they should pay close attention to the innovative practices of Google, Microsoft, Huawei and other technology giants in the field of networking, and analyze in depth the information of their technical white papers and product launches, and integrate the frontier knowledge into the teaching content [4].

When teaching network architecture, cutting-edge concepts such as software-defined networking (SDN) should be introduced and contrasted with conventional network architecture; and how SDN technology can be utilized to build an agile and intelligent network infrastructure to meet diversified business needs in scenarios such as 5G and industrial Internet should be explored. In terms of network security teaching, it should follow the industry hotspots and analyze the principles and applications of emerging security technologies such as artificial intelligence-driven malware detection, etc., so as to facilitate students to comprehend the cutting-edge dynamics of network security defense.

4.1.2 Consolidation of the Curriculum Framework. The knowledge system of computer network course contains many interrelated knowledge points. However, traditional teaching methods often show these knowledge points in a piecemeal manner, resulting in students can only see one isolated knowledge point, but can not see the whole picture of the entire knowledge system, and it is challenging to construct a systematic and complete knowledge framework. Therefore, it becomes necessary to integrate the course system [5]. When imparting network topology, we should introduce the characteristics of traditional topologies such as star, bus, ring, etc., and conduct students to choose the appropriate topology by considering various factors such as reliability, scalability, cost, etc. Moreover, it is necessary to further explore the key points of IP address allocation scheme and routing protocol configuration that match the selected topology, so that students can understand the intrinsic connection between the knowledge points and learn to plan the network architecture from a holistic point of view.

Theoretical knowledge and practical operation complement each other and are indispensable. During the process of integrating the curriculum framework, there should be a significant enhancement in the share of practical teaching, and a series of practical projects covering the whole life cycle of the network should be designed from easy to difficult. For example, in the introductory stage, students can be arranged to build a small home LAN project, so that they are familiar with the connection of network devices and basic configuration commands; in the advanced stage, carry out the enterprise branch network construction project, which involves the division of multiple subnets, dynamic routing configuration, deployment of network security policies, etc.; In the advanced phase, the incorporation of analog for extensive data center network operation and maintenance initiatives, leveraging SDN technology to attain automated network management and flexible resource allocation. Through these practical projects, students intensify their apprehension of abstract concepts, exercise their operational capability to tackle complicated network problems, and ensure that students can swiftly adjust to the work require.

4.2 Innovative Teaching Methods.

4.2.1 Project-driven Learning Approach. The project-driven teaching method is use the real or simulated projects as the key driving force that permit students to take the initiative explore in the process of project practice, so as to achieve the synchronous improvement of learning and ability [6]. Teachers should first carefully select suitable projects, which can originate from actual network engineering projects commissioned by enterprises, such as building office networks for native small and medium-sized enterprises (SMEs); they can also carry out cutting-edge exploratory projects based on scientific research topics, for example, researching distributed network storage based on the blockchain; what's more, they can also choose ingenious practical projects approach daily life, such as designing a wireless network coverage program for campus, building network control system for smart home, etc.

Taking the construction of an enterprise office network project as a case in point, the instructor directs the students to establish a project team and proceed in accordance with the operational procedures of a corporate project. Starting from the demand research in the project initiation stage, students go into each department of the enterprise to comprehend amount of office workers, service types, application situations of the network, and collect the demand for network performance; Subsequently, the project transitions into the planning and design phase. Leveraging insights gleaned from the demand analysis, we apply expertise in network topology, IP address allocation, network security protocols, and other pertinent areas, to design a detailed planning Then in the implementation and deployment phase, students personally install and debug network devices, configure VLANs, routing protocols, firewall rules, and turn the planning blueprint into an actual network; finally, during the test optimization phase, network testing tools are used to measure the network performance indicators, and network optimization techniques are used to adjust and optimize the problems found, such as blind areas of signal coverage and congested nodes of the network, to ensure that the network can operate stably and efficiently.

During the whole project implementation, teachers play the dual role of mentor and coach, they will give students technical guidance and resource assistance at the right time, and at the same time control the speed and overall direction of the project. The students, driven by independent learning and teamwork, can not only master the configuration of network equipment, troubleshooting techniques and performance optimization strategies and other professional skills, but also develop good cooperation capacity, problem addressing skills and active innovative mindset, thereby developing a range of comprehensive qualities in the process, so as to realize the transformation from simple knowledge learners to qualified network engineers with professional qualities. In this way, you can successfully realize the transformation from a mere knowledge learner to a qualified network engineer with professional qualities.

4.2.2 Case Study Method. Case teaching method refers to the teaching process, the teacher takes the case as a clue to guide students in conducting through analysis and discussion . First of all, throw out questions, such as "In the evolution of data center network architecture, what are the advantages of SDN technology over traditional architecture? What are the challenges?"

“E-commerce enterprises 'double eleven' network traffic surge, how to predict the traffic trend in advance, accurate deployment of network resources?” etc., to stimulate students' interest; then organize students to discuss in groups, encouraging each group to analyze the problem from different perspectives and put forward their insights; finally, each group will report the results of the seminar, and the teacher will comment and summarize, sorting out the knowledge contained in the case, the technical methods, and instructing the students to ponder over the initiatives under similar scenarios.

4.2.3 Blended Learning Approach. As a new trend in the development of education, blended teaching integrates the dual advantages of online and offline instruction, and injects strong vitality into the innovation of teaching methods [7].

On the one hand, in terms of course resource integration, the online platform integrates a large number of high-quality learning resources. For example, it provides high-definition online course videos, cutting-edge academic papers and electronic teaching materials, etc., which students can independently choose and study at any time according to their own learning progress and needs. The offline link focuses on providing students with in-depth practical experience, such as in the computer network training courses, students can operate real network device, intuitively feel the whole process of network architecture and data transmission, so as to better understand the theoretical knowledge.

On the other hand, in terms of the organization of teaching activities, online teaching through live broadcasts, recordings and other forms of theoretical knowledge, the use of online forums, instant messaging tools to promote interaction between instructors and pupils, breaking the space-time constraints, to ensure the timeliness of knowledge transfer. The offline classroom conducts team cooperative study, project practice reporting and other events, teachers can observe students' performance in close proximity, and provide targeted guidance to enhance learning effect. For example, in the web application development course, students first grasp the framework, and then to complete the actual project development offline. In this process, students routinely use the online platform to record the project advancement, discuss the issues encountered, and the teacher follows up and guides the whole process online and offline, thereby enabling this integrated educational model to allow students to fully reap the advantages of both learning approaches and significantly enhance the efficacy of learning [8].

4.3 Enhanced Practical Teaching. Enhancing practical instruction is pivotal to boosting students' capabilities. First of all, Enhancing the development of laboratories, which serve as crucial venues for hands-on instruction, is imperative. The quality of their physical infrastructure directly impacts students' practical skills.Colleges and universities are supposed to enlarge financial investment, update network laboratory equipment, and introduce high-performance routers, switches, firewalls, etc., in order to meet the practical needs of students for high-speed networks, SDN, network security and other cutting-edge technologies. In addition, it is necessary to equip sufficient server resources. In terms of laboratory layout, it should simulate real network scenarios and deploy network management systems, traffic monitoring tools, and simulated attack platforms to provide students with a full range of practice scenarios.

Secondly, it is necessary to increase the number of practical projects, which should be both comprehensive and innovative in design, covering network planning, equipment configuration, protocol analysis, performance refinement and additional dimensions of the whole life cycle of the network. For example, the campus network upgrading project requires students to use a variety of knowledge and skills, starting from the research of the existing network architecture, user needs, business traffic characteristics, and designing an upgrading plan to meet the needs of the next five years of campus information technology development, including equipment selection, IP address planning, network redundancy link deployment, etc. Students are also required to implement equipment installation and commissioning, protocol analysis, performance optimization, security protection and other network life cycle aspects. Students also need to implement equipment installation and commissioning, configure VLANs, routing protocols, access control lists, and use network testing tools to monitor performance and solve practical problems during implementation.

Finally, a comprehensive security protection system is developed from a network security perspective. At the same time, students are encouraged to innovate independently and incorporate elements of emerging technologies in their projects.

Finally, school-enterprise cooperation serve as an significant bridge between the campus and the workplace. Colleges should establish intensive partnership with network equipment manufacturers, Internet enterprises, etc., to build off-campus internship bases. During the internship period, students can participate in actual projects of enterprises, such as 5G network deployment, cloud data center operation and maintenance, industrial Internet platform research and development, etc., so as to experience cutting-edge practices and understand industry needs and technology trends. Schools and enterprises can also jointly carry out order-based talent training, customize the curriculum system based on the needs of the enterprise, the enterprise selects engineers to serve as part-time teachers, and university teachers go to the enterprise to work as part-time teachers, forming a good pattern of teacher interaction and collaborative training, so that students can quickly become practical network talents urgently needed by enterprises after graduation [9].

4.4 Reform of Assessment Methods. Transforming the evaluation approach holds immense significance in enhancing the efficacy of teaching. The traditional theoretical examination method is difficult to comprehensively assess the comprehensive quality of students, therefore, it is necessary to construct a diversified assessment system [10]. The diversified assessment is shown in Fig. 3. In order to reflect students' learning achievements more comprehensively, the assessment indicators should contain theoretical knowledge, hands-on capability,creative mindset and other dimensions. In the assessment of theoretical knowledge, it should also increase the forms of stage quizzes, classroom interactive quizzes and knowledge competitions, which examines the students' proficiency of the elementary knowledge of the network principles, protocols, algorithms and other basic knowledge, but also avoids the students' exams on a temporary basis. Practical ability assessment should be carried out throughout the entire practical teaching process, by observing the performance of students in the experimental operation and project practice, assessing their proficiency in network equipment configuration, troubleshooting accuracy, the rationality of the program design, and the standardization of the practice report, etc., to insure that the students can comprehend the knowledge,and apply it adeptly in practical situations. The inventive mindset assessment encourages students to introduce new technologies and propose innovative solutions in course design.

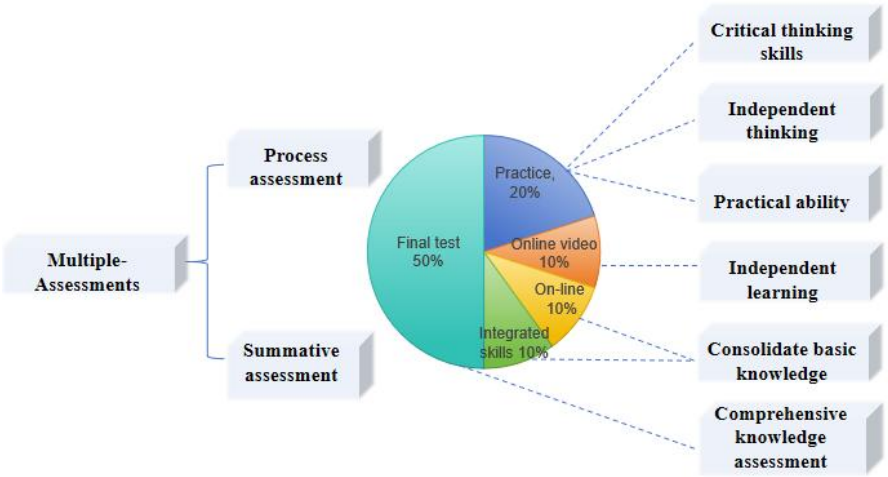

Figure 3. Multiple-Assessments

5. Summary

This paper discusses the complex issues concerning the innovate of instructing methods, expounds the significance for such reform, and devises and carries out a range of concrete reform initiatives. In the age of digitalization, the social demand for computer network professionals is increasingly diversified and high standards, the shortcomings of the traditional guidance mode is highlighted, the

reform is imperative.

The reform of the teaching method faces both new challenges and unlimited opportunities. Accelerated technology iteration, quantum communication and other cutting-edge technologies are developing rapidly, requiring rapid updating of course teaching content, so that what students learn is closely synchronized with the forefront of industry development. Meanwhile, the thorough integration of AI, big data, and computer networks has set forth elevated demands regarding teachers' reserves of interdisciplinary knowledge and their pedagogical competencies, and teachers need to continue self-advancement to lead students to explore cutting-edge knowledge in depth. To further advance the reform, the teaching mode should be innovated, and the capability of virtual reality (VR), augmented reality (AR) in teaching should be explored, so as to create immersive and interactive learning scenarios, make abstract knowledge tangible, and enhance the learning experience.

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