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Research on the Teaching Reform of Computer Network Courses Based on OBE Concept

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Abstract: The computer network course is a fundamental professional course in the School of Computer Science, with strong theoretical and practical significance. In order to improve teaching quality and student motivation, the team teachers of computer network courses must constantly try to adjust teaching methods and techniques. Therefore, the OBE concept is integrated into this course, with the core of solving the problem of "disconnection between teaching and learning, and separation between theory and practice" in traditional teaching, making teaching more focused on improving students' abilities and practical needs. According to feedback from students after teaching practice, the application of OBE based teaching design in the "Computer Network" course can focus on teaching outcomes, improve the teaching process, cultivate students' self-learning ability, and achieve good teaching results.

Keywords: Computer Network; OBE Concept; Teaching Reform.

1. Introduction

Through investigating the teaching quality and students' enthusiasm in class, it was found that there are two main problems in the traditional course teaching of "Computer Networks", which directly affect the teaching quality and students' ability to adapt to their positions. On the one hand, there is a disconnect between theory and engineering practice, and the ability to apply knowledge is weak. Traditional teaching focuses on imparting theoretical knowledge, and practical activities are often limited to "confirmatory experiments" - such as completing router basic configuration according to fixed steps, capturing TCP packets according to preset processes, etc., which can be completed by simply mechanically repeating operations. There is a significant gap between this and real computer network engineering scenarios, such as multi network segment routing optimization, complex network fault diagnosis, and protocol selection in business scenarios. In this mode, although students can memorize theoretical knowledge points such as IP address partitioning and TCP three-way handshake, it is difficult to transform them into the ability to solve practical problems [1]. In addition, when students enter the workforce after graduation, they often need a long adaptation period to face engineering tasks such as network equipment cluster deployment and network security protection system construction, which makes it difficult to quickly meet job requirements. On the other hand, there is a lack of student subjectivity and insufficient ability for independent innovation. Traditional classrooms are dominated by teachers, with the teaching process often consisting of "teachers explaining knowledge points, students passively recording, and completing theoretical exercises after class". Students lack space for active thinking and exploration. This passive learning approach leads to a lack of motivation among students to independently research new technologies such as IPv6 deployment and SDN software defined networks. This passive learning mode not only fails to stimulate students' interest in learning, but also restricts the cultivation of self-directed learning ability and innovative thinking. When encountering new network failures or technological needs outside of textbooks, students often lack exploration awareness and methods, and are unable to independently develop solutions [2].

2. OBE Teaching Philosophy

Outcome Based Education (OBE), also known as Outcome Based Education, is a modern teaching philosophy that originates from reform practices in the field of education and focuses on the ultimate learning outcomes of students. The core logic is "starting from the end" - abandoning the traditional teaching model of "teacher lectures and knowledge coverage as the center", and instead first clarifying the "knowledge mastery, proficiency, and adaptability" that students should possess after the course ends, and then reverse designing the teaching content, methods, and evaluation system to ensure that all teaching processes serve the "achievement of student outcomes" [3].

2.1. Core of OBE Teaching Mode

OBE education and teaching reform is an educational philosophy and teaching mode reform guided by student learning outcomes, following the principles of "reverse design", "student-centered", and "continuous improvement", which points out the direction for China's education and teaching reform from "what to teach", "how to teach", and "how to teach" to "what to learn", "how to learn", and "how to learn" [4]. Based on the OBE educational philosophy, classrooms can transform students from simple listeners or passive receivers into participants in the classroom. This can fully mobilize students' enthusiasm and subjective initiative to participate in the classroom, thereby cultivating their ability to actively think and solve problems.

(1) Outcome oriented: Focus on "what students learn" rather than "what teachers teach"

The "outcome" in OBE is not a single "exam score", but a three-dimensional goal that includes knowledge, ability, and literacy, and must meet the "specific, measurable, achievable, relevant to reality, and time bound" (SMART) principle. For example, in the course of "Computer Networks", the traditional teaching objective may be to "explain TCP/IP protocol", while the achievement objective of OBE is to "be

able to independently use Wireshark packet capture to analyze TCP three-way handshake and troubleshoot network failures caused by TCP connection abnormalities" - the former focuses on "teaching content", while the latter focuses on "what students can do".

(2) Reverse design: Pushing the entire teaching process backwards from the "results"

The implementation of OBE starts from the "final outcome" and breaks down the "sub objectives" that support the outcome in reverse. Then, corresponding teaching content, practical activities, and evaluation methods are designed to avoid a disconnect between teaching activities and objectives. For example, logical chain: clarify core achievements (such as "being able to build a small enterprise LAN") → decompose sub objectives (requiring mastery of IP subnet partitioning, router configuration, and firewall rules) → design teaching content (corresponding theoretical modules and practical experiments for sub objectives) → develop evaluation methods (LAN building practical assessment+ configuration plan report).

(3) Student Center: Respect differences and ensure that all staff meet the standards

OBE emphasizes that 'every student can achieve core outcomes' rather than' uniform progress and standards'. Provide layered tasks and personalized support (such as tutoring and resource packages) for students with different foundations, allowing those with weak foundations to achieve core goals and those with spare capacity to challenge advanced goals. For example, in programming courses, the core achievement is "being able to write basic functional code". Basic level students complete the designated functional writing, while advanced level students can add code optimization, exception handling, and other extension tasks. Both must meet the core standards of "code runnability and logical correctness".

(4) Continuous improvement: closed-loop optimization, dynamic adaptation to requirements

OBE is not a fixed "once and for all" model, but a closed-loop approach of "outcome evaluation → data feedback → teaching adjustment" to continuously optimize teaching plans. Evaluation data (such as student achievement achievement rate and enterprise feedback) will be used to adjust teaching content (such as adding new industry technologies) and methods (such as optimizing experimental difficulty), ensuring that achievement goals always match educational policies and social needs.

To further clarify the core of OBE education philosophy, differences can be highlighted by comparing traditional education concepts, as shown in Table 1.

Table 1. Comparison between OBE Education Concept and Traditional Education Concept

Comparing dimensions	Definition orientation of traditional educational concepts	Definition orientation of OBE educational philosophy
Subject of Results	Centered around the 'teaching process' (teachers completing teaching tasks)	Centered around 'student outcomes' (achieving learning goals)
Achievement setting logic	Starting from the textbook/outline, set the content first and then set the goals	Starting from "needs" (society/students), determine the results first and then determine the content
Achievement measurement standards	Focus on "knowledge memory" (such as written test scores)	Focus on "knowledge application+ ability implementation" (practical operation, projects)
Inclusiveness in achieving results	Require all students to follow a 'uniform standard' with low differentiation	Respect student differences, provide tiered support, and ensure that core outcomes meet standards

2.2. Content of Computer Network Course Reform

Introduce the Outcome Based Education (OBE) concept in the teaching of Computer Networks, benchmarking the requirements of "learning centered and teaching led", and identifying gaps and filling gaps. We will carry out teaching reform activities from the aspects of curriculum system, classroom teaching, and teaching evaluation [5]. At the same time, when designing teaching, we should study the internal logic of ideological and political education in the curriculum, cleverly integrate ideological and political elements into classroom teaching, and achieve both teaching goals and ideological and political education goals in teaching. The specific reform contents include:

(1) Reverse design curriculum system. The current concept of higher education is to first establish a curriculum system, and then determine whether students can meet the graduation requirements and established training objectives based on their learning situation. However, the reverse design of OBE is opposite to the current mainstream curriculum oriented education, starting from the ultimate goal and conducting curriculum design and teaching activities in reverse. The course design is reverse engineered from the final outcome (peak design) to determine the adaptability of all teaching towards the peak outcome. The starting point of teaching is not what teachers want to teach, but what is needed to achieve peak results. Internal and external needs determine goals, goals determine graduation requirements, and requirements determine the curriculum system [6].

For example, in order to achieve the achievement of "network security protection capability", a progressive content of "data link layer security network layer security application layer security" is reverse designed, synchronously integrating ideological and political goals such as "network space sovereignty" and "data security responsibility", so that the curriculum system not only adapts to the cultivation of capabilities, but also carries the function of ideological and political education.

(2) Set clear learning outcomes and reconstruct the learning objectives of the course. Breaking the limitation of traditional teaching that emphasizes knowledge over literacy, guided by the OBE concept, we reconstruct the three-dimensional learning objectives of "knowledge+ability+quality" in the

"Computer Network" course, deeply integrating ideological and political education objectives into various dimensions, and forming a goal system of "resonance between professional objectives and ideological and political objectives":

1) Knowledge objective: Master the core theories of TCP/IP four layer model, IP address partitioning, routing protocols, network security, etc; Synchronize understanding of ideological and political related knowledge such as "the development process of China's network technology" and "laws and regulations on cyberspace sovereignty", and establish "technological confidence" and "legal awareness".

2) Ability objective: Possess practical skills in small-scale network construction and configuration, packet analysis, common troubleshooting, network security protection, etc; At the same time, cultivate the ability of "teamwork to solve complex engineering problems" and "critical thinking to analyze technical solutions", and strengthen the engineering literacy of "striving for excellence".

3) Quality objective: With ideological and political elements as the core, cultivate three major qualities - first, a sense of social responsibility, such as establishing a sense of responsibility to "safeguard data security and resist network attacks" in the network security module; The second is the awareness of moral norms, such as strengthening the bottom line thinking of "respecting user data and adhering to professional ethics" in privacy protection content; The third is the spirit of innovation, such as inspiring the ideal belief of "serving the country with science and technology and independent innovation" through the development cases of 5G and IPv6 technologies in China.

(3) Design teaching content and activities that are challenging, interactive, and practical, combining OBE concepts and ideological and political education. Introduce specific cases, problem discussions, and team projects to promote students' critical thinking and teamwork abilities.

(4) The assessment of the "Computer Network" course based on the OBE concept focuses more on evaluating students' learning outcomes, emphasizing the evaluation of the learning process, and adopting a diversified assessment method based on the learning process and learning outcomes. During the assessment process, the entire learning process of students is recorded and evaluated multiple times and in various forms. Course evaluation is not only a summary evaluation of the final stage of course implementation, but also a flexible evaluation that runs through the entire process of the course. The assessment of the learning process accounts for 40%, and the score can be converted based on the statistical results of the Learning Platform. The Learning Platform can track students' learning progress in this course, including video learning, quizzes, visits, homework assignments, and more. The assessment of learning outcomes accounts for 60%, mainly based on the results of course exams.

(5) Around the core module of the "Computer Network" course, which includes the physical layer, data link layer, network layer, transport layer, and application layer, we systematically explore ideological and political elements, establish a "clearly classified, clearly defined, and directly reusable" ideological and political case library, provide stable resource support for teaching, and avoid the integration of ideological and political elements into "rigid and forced" situations.

In addition, establish an update channel of "teacher research+enterprise feedback+student suggestions", regularly supplement new technologies and cases, such as adding cutting-edge content such as "artificial intelligence big models and network data security" and "network ethics in the metaverse scenario", to ensure the timeliness and pertinence of ideological and political education and continuously empower teaching reform.

2.3. Design Teaching Reform based on OBE Teaching Philosophy Using the Chapter "IP Address and MAC Address, Network Address and Host Address" as an Example

2.3.1. Design Concept

This chapter closely follows the core logic of OBE's "outcome oriented, reverse design, and student-centered" approach, with the goal of achieving three-dimensional outcomes of "knowledge mastery, ability implementation, and literacy shaping", and optimizing teaching processes and evaluation methods in reverse. Deeply integrating ideological and political education into courses, integrating online ethics and legal awareness into knowledge learning and practical training, achieving the dual achievement of "professional competence" and "value guidance".

2.3.2. Learning Outcomes (Measurable and Implementable)

(1) Knowledge achievements

1) Accurately understand the concepts, structures, and core functions of IP addresses and MAC addresses, and clarify the differences and associations between the two.

2) Master the definitions of network address and host address, proficiently use the core methods of "IP address and subnet mask AND operation" to calculate network address and "IP address and subnet mask reversed AND operation" to calculate host address.

3) Understand the basic norms of network address allocation and the relevant requirements of laws and regulations, and establish the awareness of "compliant use of addresses".

(2) Ability achievements

1) Capable of independently calculating the network address and host address corresponding to any valid IP address (including subnet mask) with an accuracy rate of over 90%.

2) Can combine the principle of ARP protocol to analyze the collaborative working mechanism between IP address and MAC address, and have the preliminary ability to explain the problem of "network communication address matching".

3) Being able to identify potential risks of address abuse, malicious attacks, and other violations, and forming a basic idea for network troubleshooting.

(3) Achievement of Literacy

1) Establish a sense of network rule of law and morality, consciously abide by the norms of network address usage, reject violations such as address abuse and malicious attacks, and safeguard network order.

2) Cultivate rigorous and pragmatic engineering literacy, pay attention to details in address calculation and configuration, and develop professional habits of "precise operation and compliant use".

3) Strengthen awareness of information security protection and understand the importance of standardized address usage for personal and organizational information security.

2.3.3. Key Points and Difficulties of Teaching

Key points: The difference and synergy between IP address and MAC address; The core calculation method of network address and host address.

Difficulty: Logical operation application of subnet mask and IP address; The flexible application of address calculation in actual network configuration.

2.3.4. Teaching Process Design (Reverse Adaptation of Learning Outcomes)

(1) Self directed learning before class

1) Clarify the objectives of the preview results: master the concept of IP/MAC address, network/host address definition, and have a preliminary understanding of calculation ideas; 2) Push core videos and preview task sheets, requiring completion of basic tests.

(2) In class teaching

1) Activate interest and associate achievements

2) Anchor the direction of achievements

3) Diagnostic Fundamentals, Targeted Teaching

4) Breakthrough in core achievements

5) Inspection results achieved

6) Sort out the results system

(3) Course Q&A and Expansion (Deepening Results)

Core Question 1 (Student Question): "What is the most common reason for address calculation errors?" → Teacher's Answer: "Binary conversion errors, subnet mask inversion omissions, and confusion in operation logic. The solution is to leave a trace at each step and perform reverse verification after calculation.

Expanding Question 2 (Teacher's Guide): "Why can NAT technology save public IP addresses? What does it have to do with the address knowledge we learned today? ”Combining the principle of "private IP to public IP", associate the ideological and political points of "reasonable utilization of address resources".

2.3.5. OBE Diversified Evaluation System (Focusing on Achievement Rather Than a Single Score)

Table 2. OBE Diversified Evaluation System

Evaluation dimension	Proportion	Evaluation content	Evaluation tool
pre-class preparation	15%	Completion rate of video learning, note quality, and pre-test scores	Learning App Data+Teacher Review
classroom performance	35%	Pre test/post test scores (20%), contribution to group discussions (5%), quality of on stage presentations (5%), expression of ideological and political viewpoints (5%)	Learning quiz data+teacher records+group peer evaluation
homework	20%	5 address calculation questions (completeness of steps)	Teacher review, calculate points step by step
unit quiz	30%	Theoretical answer (10%)+practical calculation (15%)+literacy judgment (5%)	Closed book testing, standardized scoring

2.3.6. Continuous Improvement Mechanism (OBE Closed Loop Core)

(1) Data collection. Calculate the achievement rate of each evaluation dimension (such as "post test calculation accuracy of 85%" and "insufficient depth of ideological and political question answering"), and student feedback ("which link is the most difficult" in the collection of the Learning Pass questionnaire).

(2) Targeted optimization. If the calculation accuracy is low, add one "special calculation training"; If the integration of ideological and political education is rigid, update the "Cybersecurity Law Case Library" and strengthen cognition with scenarios that are closer to students.

3. Summary

At present, the reform of ideological and political education based on the OBE (Outcome Based Education) concept has accumulated a solid research foundation. The successful practice of integrating professional courses with ideological and political education in many colleges and universities provides a reference experience paradigm and scientific basis for subsequent curriculum construction and reform. This educational philosophy centered on "student learning outcomes" achieves the organic unity of "professional ability cultivation" and "ideological and political literacy shaping" through systematic teaching design. Its diverse values are fully demonstrated in multiple dimensions such as school development, personal growth, social progress, and enterprise needs [7].

The OBE concept is guided by the principle of "competency based", focusing on students' solid mastery of professional knowledge and skills, while also emphasizing the deep cultivation of practical abilities and professional qualities. By integrating abstract ideological and political goals into specific professional teaching processes, students can not only hone their analytical and problem-solving skills through case analysis and project practice, but also gradually shape excellent moral qualities, rigorous professional ethics, and a strong sense of social responsibility under the guidance of values. In computer courses, cultivate a sense of responsibility to safeguard data security by incorporating network security incidents. This integrated training model of "knowledge+ ability+literacy" enables students to not only master their professional hard skills, but also possess the "soft power" of workplace competition, making them more competitive in the job market.

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