Journal of Contemporary Educational Research, 2025, Volume 9, Issue 12
http://ojs.bbwpublisher.com/index.php/JCER
ISSN Online: 2208-8474
ISSN Print: 2208-8466

Research on the Teaching Mode of Computer Network Course Based on the Concept of Deep Learning

Yushi Guo*, Mengxue Chen

Henan Vocational University of Science and Technology, Zhoukou 466000, Henan, China

Author to whom correspondence should be addressed.

Abstract: Traditional teaching of computer network courses faces problems such as the disconnection between theory and practice, insufficient cultivation of students' higher-order thinking abilities, and the lag of teaching resource updates behind technological development. These issues result in students having shortcomings in mastering core skills such as network protocol analysis and troubleshooting, making it difficult for them to meet the demand for compound technical talents in the digital transformation of industries. Based on this, this paper deeply explores the significance and strategies of researching the teaching mode of computer network courses based on the concept of deep learning. It aims to improve students' ability to analyze complex network scenarios through strategies including constructing a "three-dimensional integrated" teaching objective system, implementing problem chain-driven hybrid teaching, creating an intelligent learning environment integrating virtual and real elements, establishing a "dual-tutor system" project-based teaching mechanism, building a diversified dynamic evaluation system, and promoting the iteration of curriculum resources through "integration of production and education." This study provides valuable references for the teaching reform of similar courses.

Keywords: Concept of deep learning; Computer network course; Teaching mode

Online publication: December 31, 2025

1. Introduction

The *Opinions of the State Council on Further Implementing the "Artificial Intelligence +" Action* clearly states the need to accelerate the exploration of new scientific research paradigms driven by artificial intelligence and speed up the process of major "from 0 to 1" scientific discoveries; accelerate the construction and application of large scientific models, promote the intelligent upgrading of basic scientific research platforms and major scientific and technological infrastructure, build open and shared high-quality scientific datasets, and improve the ability to process cross-modal complex scientific data; strengthen the interdisciplinary leading role of artificial intelligence and promote the integrated development of multiple disciplines; promote the integrated and coordinated development of technology research and development, engineering implementation, and product landing driven by artificial intelligence, accelerate the "from 1 to N" technology landing and iterative breakthroughs, and promote the efficient transformation of innovative achievements; support the promotion and application of intelligent R&D tools and platforms, strengthen the collaborative innovation between artificial intelligence and technologies in fields such as bio-manufacturing, quantum technology, and the 6th Generation Mobile Communication (6G), support the landing of scenario applications with new scientific research achievements, and drive scientific and technological innovation breakthroughs with new application demands [1]. Colleges and universities should follow the path consistent with national development in accordance with national policy documents to better cultivate talents.

2. Significance of research on the teaching mode of the computer network course based on the concept of deep learning

2.1. Promoting the upgrade of cognitive dimensions and constructing a system for cultivating higher-order thinking

The concept of deep learning emphasizes the in-depth understanding of the essence of knowledge and its transferable application, which provides theoretical support for computer network courses to break through the traditional "memorization-recall" teaching mode. Traditional teaching often focuses on the transmission of fragmented knowledge, such as protocol fields and configuration commands, making it difficult for students to form an overall cognition of network systems. In contrast, the teaching mode based on deep learning guides students to shift from superficial cognition of "what is it" to in-depth understanding of "why" and "how to use it" through strategies such as problem chain driving and concept map construction [2]. For example, when explaining TCP congestion control mechanisms, students no longer mechanically memorize algorithm steps such as slow start and fast retransmit. Instead, they analyze the law of window growth through mathematical modeling, explore performance differences in different scenarios through network simulation experiments, and finally form an abstract summary of the essential characteristics of "reliable transmission." This upgrade in cognitive dimensions not only helps students master the design logic of network protocols but also cultivates their higher-order abilities, such as systematic thinking and critical thinking, laying a foundation for solving complex engineering problems.

2.2. Promoting the transformation of teaching paradigms and realizing personalized learning support

The core of the deep learning concept lies in achieving precise teaching through data-driven approaches, which provides a technical path for computer network courses to break through the dilemma of "one-size-fits-all" teaching. Limited by time and space, traditional classrooms struggle to accommodate individual differences among students, resulting in situations where students with weak foundations "cannot keep up" and those with strong abilities "cannot be challenged enough." In contrast, the teaching mode based on deep learning can collect students' learning behavior data in real time (such as video viewing duration, experimental operation trajectories, and quality of forum speeches) through technical means such as learning analysis systems and intelligent tutoring tools. It then constructs learner profiles using machine learning algorithms to accurately identify their knowledge blind spots and ability shortcomings [3]. On this basis, the system can dynamically push differentiated learning resources (such as adjusting the depth of protocol explanations and providing layered experimental tasks) and generate personalized learning path recommendations. This intelligent support for "teaching students in accordance with their aptitude" can not only help underachievers consolidate their foundations but also stimulate the innovative potential of top students, ultimately realizing the transformation of all students' learning methods from "passive acceptance" to "active construction" [4].

2.3. Strengthening in-depth integration of production and education and cultivating compound network talents

The emphasis on practical ability in the concept of deep learning is highly consistent with the "engineering-oriented" training goal of computer network courses, providing a practical framework for solving the problem of "disconnection between learning and application." Traditional teaching often separates theoretical explanation from practical operation, resulting in students who master protocol principles but lack the ability to solve actual network problems [5]. In contrast, the teaching mode based on deep learning converts real enterprise projects (such as data center network planning and SDN controller development) into teaching cases by building a "virtual-real integrated" practice environment (such as VR network laboratories and SDN testbeds). It requires students to complete the full-process practice of demand analysis, scheme design, and system deployment in both simulated and real scenarios. At the same time, enterprise mentors are invited to participate in teaching evaluation, and learning outcomes are assessed against industry standards (such as network availability and security compliance) [6]. This training mode of "learning by doing and innovating through learning" can not only improve students' engineering practice abilities but also help them adapt to workplace culture in advance, enabling them to grow into compound network talents with both theoretical depth and practical breadth, thus meeting the urgent demand for high-quality technical talents in the digital economy era [7].

3. Strategies for research on the teaching mode of computer network courses based on the concept of deep learning

3.1. Constructing a "three-dimensional integrated" teaching objective system

Teachers can establish a three-dimensional teaching objective system encompassing knowledge, ability, and emotion to comprehensively enhance students' overall capabilities. In the knowledge dimension, teachers can deeply explain content such as mathematical modeling of TCP congestion control algorithms and details of protocol implementation, enabling students to gain an in-depth understanding of network protocol stacks. In the ability dimension, tools like Packet Tracer can be used to simulate enterprise network architecture design, allowing students to complete steps such as network topology planning, VLAN division, and QoS policy configuration through continuous learning. In the emotional dimension, network attack cases can be analyzed to cultivate students' awareness of network security responsibilities [8]. For example, when teaching the "SDN Network Programming" unit, teachers not only require students to master the OpenFlow protocol data structure but also to develop programs for traffic scheduling based on the Ryu controller, and further to deeply understand the principle of network neutrality, thereby promoting students' all-round development [9].

3.2. Implementing problem chain-driven hybrid teaching

Teachers can adopt a three-stage hybrid teaching model of "pre-class MOOC self-study–in-class in-depth discussion–after-class project expansion" to comprehensively understand students' learning status. Before class, teachers can release structured learning resources on platforms like China University MOOC, such as 3D animation demonstrations of protocol working principles, Wireshark packet capture analysis videos, and self-assessment question banks, enabling students to preview the content in advance [10]. During class, teachers can adopt the "5E teaching model" (Engage, Explore, Explain, Elaborate, Evaluate) to help students gain a deep understanding of the knowledge. For instance, when explaining the BGP routing protocol, teachers can first pose the question "How to realize network interconnection for multinational enterprises," prompting students to explore path selection independently through protocol simulation experiments, and then conduct enterprise-level routing configuration practice using Huawei's eNSP platform. After class, teachers can assign open-source network controller development projects, allowing students to learn custom routing and deepen their understanding of the knowledge [11].

3.3. Creating a virtual-real integrated intelligent learning environment

Teachers can deliver practical content to students through a composite practice platform integrating "VR Network Laboratory + SDN Testbed." On one hand, in the VR laboratory, teachers can use the Unity3D engine to develop 3D interactive models of network devices, enabling students to simulate high-risk operations such as switch port configuration and fiber optic fusion through gesture operations, thereby identifying their knowledge gaps [12]. On the other hand, in the Mininet simulation environment integrated into the SDN testbed, teachers can explain the full-process practice of single-node experiments and distributed system deployment. For example, in the "Data Center Network" unit, teachers not only require students to build a Fat-Tree topology in the VR environment but also to deploy an OpenFlow-based load-balancing solution through the SDN testbed. Through such methods, teachers can clearly understand students' learning status and continuously adjust teaching strategies to better instruct students [13].

3.4. Establishing a "dual-tutor system" project-based teaching mechanism

Colleges and universities can improve students' comprehensive abilities by establishing a guidance team consisting of "academic tutors + enterprise tutors." Among them, academic tutors are responsible for explaining theoretical frameworks to ensure students have a solid theoretical foundation. For example, when teaching the "Network Measurement and Performance Analysis" unit, teachers should not only explain content such as Tshark parsing QoS indicators like packet delay and jitter, but also cover the development of network detection tools using the Scapy library [14]. Enterprise tutors are responsible for explaining practical engineering cases, enabling students to better apply theoretical knowledge to practical scenarios. For instance, enterprise tutors can assign students to complete tasks such as demand analysis, equipment selection, and migration plan formulation in data center network upgrade projects, thereby comprehensively assessing students' knowledge mastery.

3.5. Constructing a diversified dynamic evaluation system

Teachers can evaluate students through a three-dimensional evaluation method of "process evaluation + outcome evaluation + developmental evaluation," which allows for corresponding adjustments to teaching strategies [15]. In process evaluation, teachers record data such as students' MOOC video viewing duration, experiment operation accuracy, and quality of forum speeches; in outcome evaluation, they record indicators including the quality of students' project reports, code implementation complexity, and system test pass rate; in developmental evaluation, they document students' performance in experiments, collaborative abilities, and innovative thinking, thus promoting students' comprehensive development. For example, in evaluating the "Network Security Offense and Defense" project, teachers will assess students' proficiency in using vulnerability scanning tools, speed in discovering attack paths, validity verification data of defense schemes, and team collaboration capabilities.

3.6. Promoting the iteration of curriculum resources through "integration of production and education"

Colleges and universities establish a resource update mechanism of "enterprise demand-driven–teaching team development–industry expert review." For example, universities can collaborate with enterprises such as Huawei and Cisco to build "courses aligned with network technology certification systems," breaking down HCIE/CCIE certification exam points into teaching modules to enhance students' comprehensive abilities. The teaching team collects data on enterprise network architecture changes every semester to update the experimental case library, such as upgrading traditional STP protocol experiments to EVPN-based VXLAN overlay network experiments. Industry experts conduct a forward-looking technical review of the course content every academic year to ensure coverage of emerging technologies such as SD-WAN and AIOps. For example, the newly added "Intent-Based Networking (IBN)" unit in 2025 is derived from Gartner's predicted trend of network automation development.

4. Conclusion

The research on the teaching mode of computer network courses based on the concept of deep learning provides an innovative solution to the dilemmas in traditional teaching, such as "abstract and difficult theories, single practical scenarios, and lagging ability evaluation." In the future, with the continuous evolution of AI technology, this mode can further integrate adaptive learning systems and digital twin technologies to achieve accurate delivery of personalized teaching paths, providing sustained impetus for cultivating compound network talents who can meet the needs of national strategies such as "Eastern Data and Western Computing."

Disclosure statement

The authors declare no conflict of interest.

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