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Exploration of the Design and Implementation Mode of a Comprehensive Ideological and Political Model in the Computer Network Course

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Abstract:

Based on literature research and according to the trinity goals of knowledge, skill, and value in the computer network course, this paper proposes a comprehensive ideological and political model for the computer network course. It explores how to integrate five ideological and political elements: the exploratory spirit of new network technologies, the sense of mission to serve the country through the network, the craftsmanship spirit of network design, network security and legal awareness, and the innovative consciousness of network design. Based on the reconstruction of teaching content and the development of teaching resources, this paper elaborates on the key points of implementing five modes of ideological and political integration: teaching content, teaching resources, practical teaching, classroom flipping, and network project development. Finally, through six assessment methods including online learning, in-class tests, experimental teaching, special reports, extracurricular assignments, and final exams, the effectiveness of ideological and political teaching in the course is demonstrated.

Keywords:

Computer Network
Course objectives
Comprehensive
Ideological and political elements
Teaching design
Evaluation

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1. Introduction

Integrating ideological and political education into computer network courses can effectively address the issues of traditional ideological and political education, such as insufficient radiation, acceptance, and influence. Simultaneously, it enables students to distinguish truth from falsehood and establish correct values. In the study by Wang *et al.* [1], "socialist core values" are regarded as the content supply for ideological and political education in courses and matched with concepts in the field of computer networking, providing two examples of teaching plans. Zhang *et al.* [2] summarized the target framework of ideological and political education in network courses into four main aspects: political theory,

national consciousness, fighting spirit, and network ethics, and elaborated on the entry points of course knowledge and ideological and political elements in teaching. Fan *et al.* [3] explored the relationship between course knowledge and ideological and political education. In Jiang's study [4], an educational planning table for ideological and political education in computer network courses is established, focusing on introducing three key ideological and political aspects: loving the party and the country, dedication to work, and abiding by laws and regulations. Based on the background of professional group construction, Li [5] proposed a target framework for ideological and political education in courses, including three levels: national, social, and individual. On this basis, it elaborates on the correspondence between the key points of each chapter's knowledge and the entry points of ideological and political education. Cheng and Xu [6] established entry points and elements for ideological and political education in courses based on nine network knowledge areas. Additionally, scientific career planning [7] can also help students establish long-term goals. China's Huawei Technologies Co., Ltd. occupying the world's largest share of the core router market demonstrates the significant enhancement of China's independent innovation capability.

In summary, existing literature has focused on studying the goals and educational entry points of ideological and political education in courses, introducing many examples in terms of network power and network security. However, there are several common deficiencies: the ideological and political elements in courses tend to emphasize theoretical teaching methods and are relatively lacking in other teaching approaches; the effects of ideological and political education in computer network courses are mostly qualitative descriptions and are not integrated into course objective evaluations. Analyzing these reasons, firstly, the course objectives are not precise enough, and ideological and political elements are not uniformly designed as basic elements of talent training objectives, which cannot correspond to the teaching activities and assessment methods that the course should have, affecting qualitative and quantitative evaluations. Secondly, ideological and political elements are not combined with the thematic content and characteristics of the courses being taught, but simply and repetitively apply other ideological and political cases, making it difficult to implement them into specific practical activities and affecting the implementation effect.

To address the integration and evaluation issues of ideological and political education in courses, a comprehensive integration approach is adopted: starting from the design of course objectives through top-level planning, integrating ideological and political education into the course; integrating ideological and political education into course construction and various teaching links; and integrating ideological and political education into the multi-faceted assessment methods of the course.

2. Optimal design of computer network course objectives

Computer networks are one of the core courses in China's computer science and technology program and are among the four courses in the comprehensive examination for national postgraduate entrance examinations in computer science and technology. Besides meeting the requirements of computer science majors and postgraduate entrance examinations, the design of its teaching objectives can vary greatly depending on the school's positioning and professional training goals.

2.1. Analysis of course nature

Taking Beijing Institute of Petrochemical Technology as an example, it is positioned as a high-level applied university with the educational philosophy of "advocating practice, emphasizing both knowledge and action." Our computer science and technology program, based on national engineering education professional certification standards and national first-class undergraduate professional standards, aims to cultivate high-quality applied engineering and technical talents for the software and service industries. As a platform course, computer networks are offered to six majors, including computer science and other electrical and information engineering disciplines. Two courses, "Computer Networks A" and "Computer Networks B," are provided. The former is targeted at computer science and technology students, with four credits and 64 hours; the latter has two credits and 32 hours for other majors. As a core course in our national first-class undergraduate computer science and technology program, Computer Networks A is followed

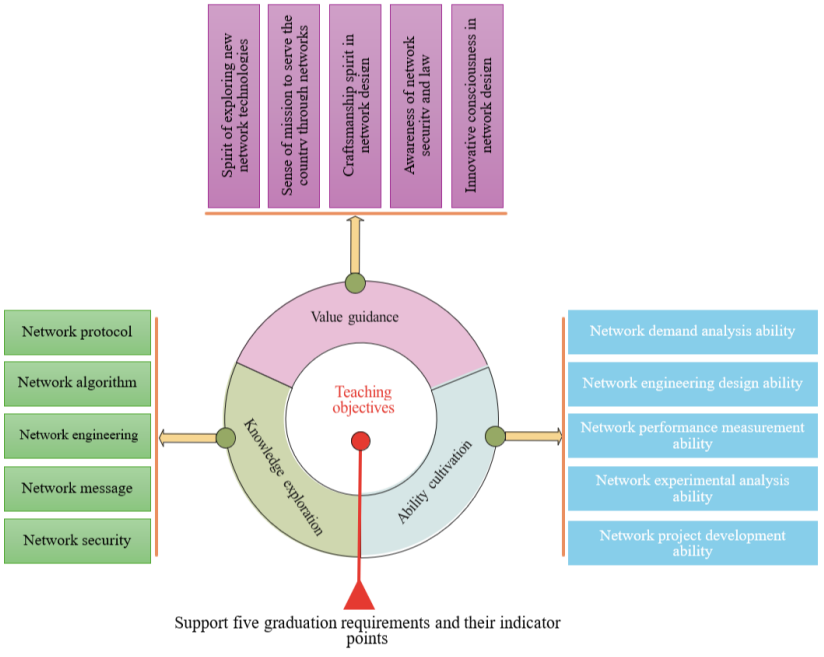
by courses such as Computer Network Course Design, Network Communication Programming Technology, and Computer System Security, forming a network curriculum system. Therefore, Computer Networks A has a broader range of course objectives and higher construction requirements.

The analysis of teaching pain points is as follows: (1) There are many layers of network protocols, and the principles are abstract and difficult to understand. In network transmission, the content of protocol packets changes dynamically, and data needs to go through layers of packaging and unpacking processes, making it difficult for students to understand deeply. (2) Network engineering is concealed, and there are few public industry cases. Students have limited practical experience in comprehensive network applications and cannot meet the high-level requirements of network collection, network programming, and security verification in real-world cases. (3) The value guidance is one-sided, and students have a weak sense of mission. Many textbooks and cloud resources mainly introduce classic computer network knowledge or cite foreign original textbooks, with little description of China's network needs and scientific and technological achievements, which is not enough to guide students to pursue the dream of a powerful network country.

Therefore, integrating ideological and political education into the curriculum requires not only revising course objectives but also innovating course construction and teaching methods. When designing the course syllabus, it is necessary to consider extracting ideological and political elements with network characteristics from the teaching objectives to facilitate implementation and evaluation. Although the two computer network courses mentioned above are targeted at different majors, they should be unified in terms of ideological and political education.

2.2. Design of trinity course objectives

Based on the professional certification standards for engineering education, this course needs to support five graduation requirement indicators in the support matrix design for computer science graduation requirements. To this end, five course teaching objectives are correspondingly designed in the course syllabus and decomposed into three aspects: knowledge exploration, skill cultivation, and value guidance (as shown in **Figure 1**).



1- Engineering knowledge	1.5 Have knowledge of network principles and engineering application methods
2- Problem analysis	2.4 Problem analysis and validation through literature research
3- Design/development solutions	3.3 Network system design and implementation with innovation and security
4- Research	4.1 Design of feasible experimental schemes
5- Use of modern tools	5.1 Conduct network project modeling and simulation analysis

Figure 1. Trinity teaching objective design for computer network courses

As can be seen from **Figure 1**, the network knowledge of this course mainly covers network protocols, network algorithms, network engineering, network message analysis, and network security technology. Skill cultivation includes network demand analysis, engineering design, experimental analysis, performance measurement, and project development. The exploration of new network technologies around value guidance, reflecting China's network engineering needs, the safety and independent innovation awareness of network design, and the craftsmanship spirit of network design are the basic ideological and political elements that embody the computer network course.

Achieving these teaching objectives and ideological and political requirements is impossible by relying solely on classroom teaching. It is necessary to expand the design horizon to the entire course construction process and teaching methods, integrating ideological and political elements into every teaching link to achieve the unity of moral and intellectual education.

3. Design of the comprehensive ideological and political model for computer network courses

Comprehensive ideological and political integration in courses refers to the organic incorporation of ideological and political elements into every aspect of course development, aiming to achieve comprehensive cultivation of knowledge, skills, and quality. This integration spans textbook development, classroom teaching, experimental teaching, special topic research, and extracurricular activities. Based on the concept of "unity of knowledge and action," the goal is to cultivate a scientific and rigorous craftsmanship spirit, enhance the sense of mission and safety awareness in serving the country through networks, and foster innovative consciousness and the spirit of exploration in network technology. The design model for the comprehensive ideological and political integration in computer network courses is shown in **Figure 2**.

The evaluation of ideological and political education in courses is integrated into six assessment methods, including in-class tests, online quizzes, experimental scores, special research reports, homework scores, and final exams. This achieves a comprehensive qualitative and quantitative evaluation. In particular, the final exam method requires students to analyze the relationship between China's cutting-edge network technology and the prosperity of the country and the well-being of its people through self-exploration questions on network technology. This enhances their self-confidence and sense of mission and guides students to pay more attention to national network events and have a heartfelt desire to

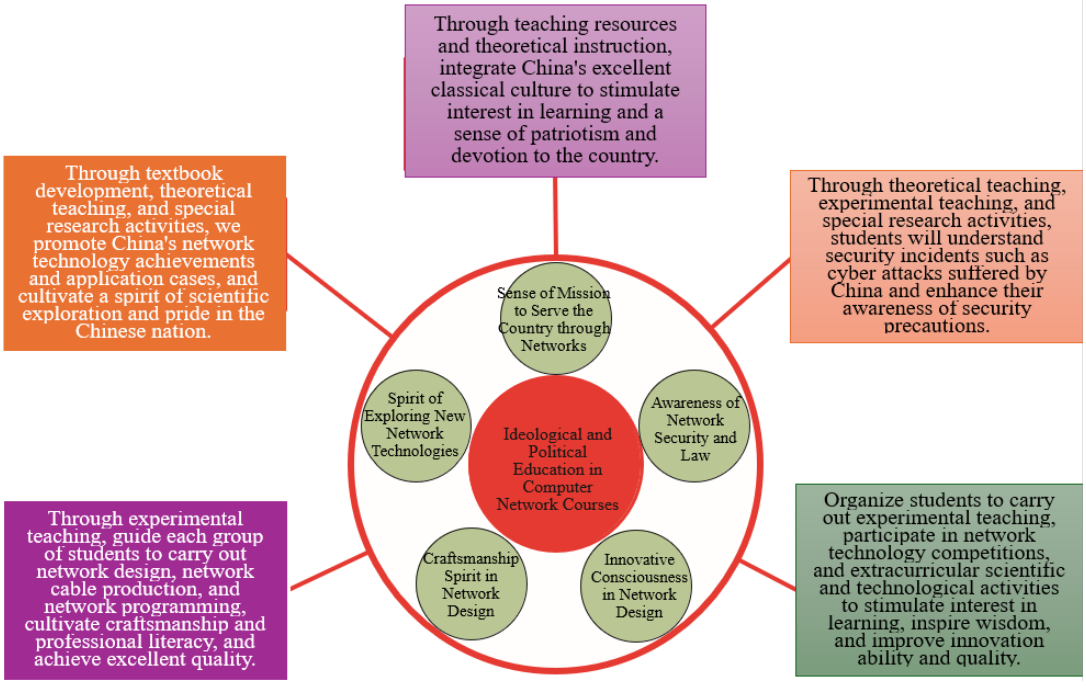


Figure 2. Comprehensive ideological and political design model for computer network courses

serve the country through networks.

4. Implementation model of integrating ideological and political education into teaching links

Guided by five teaching objectives, ideological and political education is integrated into the course through dozens of online teaching themes, and implemented in teaching resource development, theoretical teaching, experimental teaching, special research, and extracurricular activities, facilitating both teaching and evaluation.

4.1. Integrating ideological and political education into teaching content with a focus on a series of network themes

Computer networks possess a typical network architecture and have profoundly influenced various aspects such as society, economy, health, law, and security. When conducting computer network courses, we utilize the principles of TCP/IP protocols and security technologies as the foundation to optimize the design of teaching content. This includes introductions, the physical layer, data link layer, local area networks and wide area networks, network layer, transport layer, application layer, and network security, with the addition of topological content and advanced topics. Excellent entry points for ideological and political education can be found at each level, allowing the integration of concepts like network harmony, inclusivity, service, equality, seeking common ground while reserving differences, and complementary attack and defense into classroom teaching. Emphasis is also placed on incorporating elements of ideological and political education from China.

The knowledge domain and teaching content of computer networks are reconstructed and optimized from the perspectives of protocol algorithm analysis, engineering project practice, and case studies of ideological and political education in the curriculum (as shown in **Figure 3**). By continuously expanding cutting-edge content and applications, such as introducing typical protocols from the industrial field, information hiding techniques, and network programming technologies commonly found in postgraduate entrance examinations for computer science, students' comprehensive application abilities in network design and implementation are cultivated.

From the perspectives of protocol algorithm analysis, engineering project practice, and case studies of ideological and political education in the curriculum, the knowledge domain and teaching content of computer networks are reconstructed and optimized (as shown in **Figure 3**). By continuously expanding cutting-edge content and applications, such as introducing typical protocols in the industrial field, information hiding techniques, and some network programming techniques for the computer science postgraduate entrance examination, students' comprehensive application abilities in network design and implementation are cultivated.

4.2. Integrating teaching resources into ideological and political education through the internet and textbooks

We develop online teaching resources for network courses, utilizing SPOC (Small Private Online Course) and cloud-based classroom resources as the carrier to cultivate students' focus on China's network engineering needs and clarify the responsibilities and commitments of design tasks.

We also compile a series of "1+X" textbooks for computer networks, covering network principles, network programming, protocol applications, and secure development techniques, along with case studies. We promote China's latest scientific and technological achievements in networking, showcase research progress in network security, stimulate students' scientific innovation awareness, and inspire their motivation for network security technology research and development. For example, in the main textbook "Computer Network Tutorial (3rd Edition)," we add content reflecting China's achievements in network communication technology and applications, and expand the comprehensive questions and partial analysis of the graduate entrance examination for computer networks in the past 10 years, providing students with problem-solving ideas for complex network systems.

4.3. Implementing ideological and political education in practical teaching through student group project-driven approach

We adhere to the idea of practical education and carry

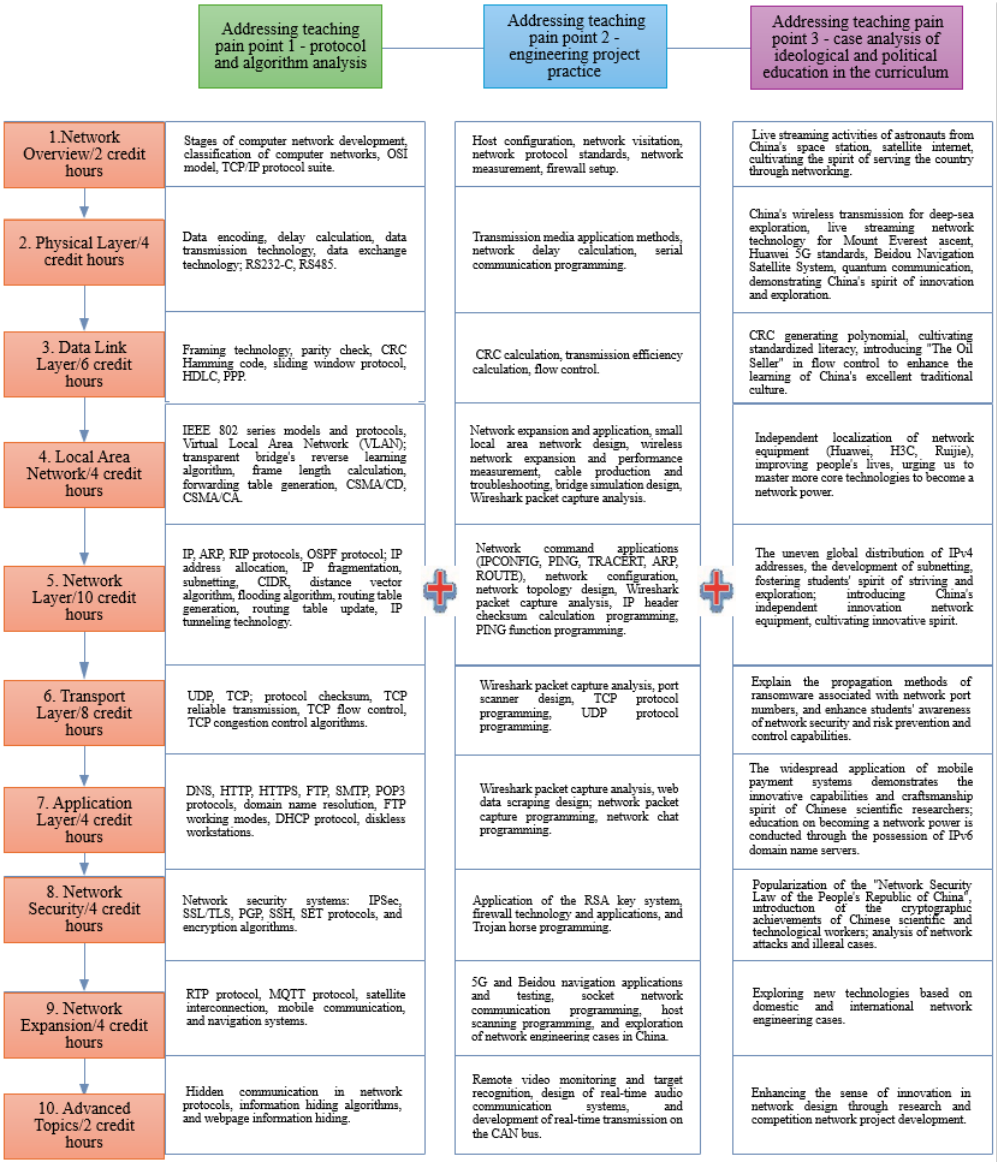


Figure 3. Optimal design of computer network teaching content

out experimental and scientific activities. Through four experimental projects, students' network design capabilities are enhanced while strengthening their sense of mission in network design, cultivating craftsmanship, network security awareness, and innovation consciousness. **Table 1** shows specific design details.

Taking the experiment of small local area network design as an example, the educational concept of the full lifecycle of CDIO (Conceive, Design, Implement, Operate) is adopted [8]. The design tasks include analyzing project requirements, conceiving solutions, designing network topology diagrams, designing laboratory layout diagrams, making network cables, selecting and configuring network equipment, calculating engineering costs, and writing design reports. By explaining design ideas and showcasing the design achievements of previous students, students are guided to develop new ideas and design new solutions in network system layout design. The following two steps are taken to implement the training requirements of the craftsmanship spirit in network design: (1) Each group of two students is guided to make network cables according to standards, and then the quality of the cables is checked and tested individually. Based on the acceptance results, different grades are given for the production, and those who fail are required to redo it. (2) Based on the internet e-commerce platform, each group of students selects and purchases specific network equipment and engineering materials, estimates engineering costs, and optimizes the network design plan.

Table 1. Practical teaching supporting curriculum objective design

Experimental project name	Course objective number	Experimental points	Ideological and political elements of the course	Entry point for ideological and political education
Small Local Area Network Design	3	Network cable production and testing, network topology design, layout design, network engineering equipment selection, and cost estimation.	Craftsmanship spirit in network design; Innovation awareness in network design.	Produce and accept network cables according to standards, select equipment, and estimate project costs; The layout design has a novel theme and practical solutions.
Wireless Network Setup	3	Wireless Router Configuration, Wireless Network Performance Testing and Calculation, Wireless Network Extension, Wireless Network Password Cracking.	Network Security Awareness	RSA Parameter Setting, Password Setting, Wireless Network Cracking Test.
Network Protocol Packet Capture Analysis	4	Focus on network attack and defense strategies, conduct packet capture analysis of major protocols (IP, ICMP, TCP, UDP, FTP, HTTP, etc.), host scanning, port scanning, and packet capture.	Sense of mission to serve the country through networking	Layered analysis of complex systems, selected host attack and defense experiments, and security analysis.
IP Protocol Checksum Calculation Program Design	5	Module Design, Interface Design, Coding and Testing, IP Protocol Packet Capture Verification.	Craftsmanship Spirit in Network Design	Programming according to the structure of the IP protocol and real packet capture verification.

4.4. Implementing flipped classroom teaching integrated with ideological and political education through student group thematic research

Focused on cultivating the spirit of exploring new technologies, thematic research activities and processes are designed [9], including project analysis, network research, report writing, classroom presentations, teacher reviews, report improvement, and grade evaluation. All student groups start with topic selection and project analysis. Based on internet resources, they search for and analyze the latest scientific and technological achievements in networking, incorporating the wisdom and achievements of Chinese people, with themes such as China's satellite internet and Chang'e deep space exploration. After completing the PPT report and Word document, students conduct classroom presentation activities under the organization of teachers to obtain presentation grades. After teacher reviews, students further improve their document materials to obtain report grades. Finally, the grades for these two parts are combined to complete the grade evaluation for the thematic research.

4.5. Developing network project development integrated with ideological and political education through extracurricular activities

Combining industry characteristics, students are organized to design systems such as protocol packet sending and receiving simulation tools, network multi-threaded scanning, industry instrument inspection, equipment anomaly diagnosis, and remote video target detection through extracurricular scientific research projects, academic competition training, and other activities. This develops network application software and expands students' comprehensive design capabilities.

5. Evaluation and effect promotion of computer network courses

Adhering to the comprehensive cultivation of computer network knowledge, abilities, and qualities, and fully integrating ideological and political education into the curriculum has achieved significant results.

5.1. Teaching effectiveness evaluation

Various evaluation methods such as course construction assessment, peer classroom observations, leadership classroom observations, and student evaluations of teaching have been adopted, and the evaluation results have all been excellent, with a student satisfaction rate of 99%. The achievement of course objectives in the past three years is shown in **Figure 4**. It can be seen that the most significant improvement is in Objective 1, which has been elevated from a medium state to a good level.

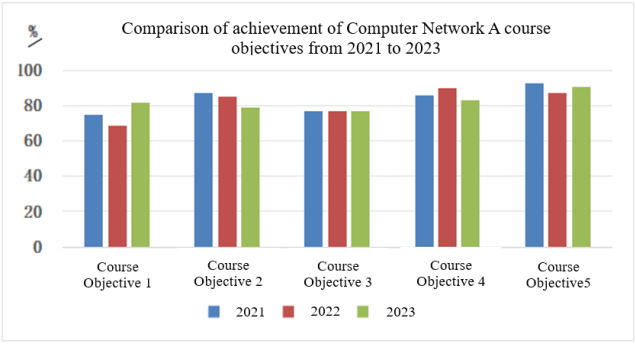


Figure 4. Comparison of achievement of Computer Network A course objectives in the past three years

5.2. Application examples of teaching effectiveness

First, delivering science popularization on network intelligence technology to primary schools for many years. We have partnered with the Daxing District Science and Technology Association in Beijing to participate in the "Rural Revitalization" action plan. This activity has been promoted and reported by multiple mainstream media outlets such as "Learning for a Strong Country." The computer student party branch and the joint student party branch have successively won the second prize of the Red "1+1" activity among Beijing universities in 2021 and 2022.

Second, winning awards for innovative applications of network technology. In the past five years, the participation rate of computer science students in competitions has reached over 90%. We have guided students to win the second prize in the 2023 China College Computer Contest Network Challenge National Finals and the third prize in the 2023 China University Student Computer Design Competition Finals. Many students under our guidance have been honored with the title of Beijing Excellent Undergraduate Graduation Design Thesis for their network technology projects.

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Disclosure statement

The authors declare no conflict of interest.

References

[1] Wang B, Jin H, Hei X, 2021, Ideological and Political Teaching in Computer Network Courses Reflecting Socialist Core Values. Computer Education, 2021(11): 89–92.

[2] Zhang X, Ma J, Xia B, et al., 2020, Exploration of Ideological and Political Teaching in Computer Network Technology and Equipment Courses. Journal of Air Force Early Warning Academy, 34(2): 131–134.

[3] Fan T, Xie H, Huang Q, 2020, Construction and Practice of Ideological and Political Education in the Teaching of "Foundation of IoT Communication Technology." Education Teaching Forum, 2020(39): 65–66.

[4] Jiang Z, 2020, Construction and Practice of the "4321" Teaching Model for Ideological and Political Education in Computer Network Principles Courses. Education Teaching Forum, 2020(49): 82–84.

[5] Li H, 2021, Research and Practice of Ideological and Political Education in "Computer Network Technology" Courses under the Background of "Double High" Professional Group Construction. Electronic Component and Information Technology, 5(7): 135–137.

[6] Cheng K, Xu M, 2021, Research on the Construction of Ideological and Political Education in Computer Network Courses in Universities. Journal of Henan Institute of Education (Philosophy and Social Sciences Edition), 40(4): 89–92.

[7] Gong L, Yang S, 2020, Exploration and Practice of Ideological and Political Education in Information Transmission Courses: Taking the "Computer Network" Course as an Example. Information Systems Engineering, 2020(9): 173–174.

[8] Zhang X, Zhang S, 2022, Research and Practice of Hybrid Teaching Mode for Computer Networks Oriented to Golden Course Standards. Computer Education, 2022(1): 139–143.

[9] Zhang X, Dai B, Zhao G, et al., 2016, Design of Computer Science Professional Ability Architecture and Its Application in Network Teaching. Computer Education, 2016(20): 60–69.