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The Practice of the "Three-Stages and Four-Dimensions" Curriculum-Based Political and Ideological Education Model in the Teaching of "Computer Networking" Course

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Abstract: In the context of the nationwide implementation of "curriculum-based ideological and political education" and the construction of "Emerging Engineering Education", the seamless integration of ideological and political cultivation into technically oriented courses, such as Computer Networking, has become a pivotal issue in higher education reform. The prevailing problems of "technique-heavy yet value-light" instruction and the superficial "ideological label-sticking" phenomenon are targeted in this paper, which proposes a "Three-stages and Four-dimensions" model of curriculum-based ideological and political education. The model systematically excavates advanced ideological elements embedded in the Computer Networking curriculum and constructs a closed pedagogical loop of "pre-class value arousal - in-class symbiotic inquiry - post-class reflective transfer", covering the four dimensions: (1) National Sentiment, (2) Ethics and the Rule of Law, (3) Scientific Spirit, and (4) Global Vision. The instructional effectiveness was quantitatively evaluated through the implementation of an OBE-based achievement assessment instrument. Empirical evidence has demonstrated that the proposed model significantly enhances students' value identification and professional competence. It offers a replicable and scalable pathway for the systematic design and assessment of ideological and political education in emerging engineering courses.

Keywords: Curriculum-based Ideological and Political Education, Computer Networking, Third-Stages and Four-Dimensions, Outcome-Based Education.

1. Introduction

As national strategies such as "Cyber Power" and "Digital China" continue to advance, computer networking courses, as core subjects in university computer science programs, bear the crucial responsibility of cultivating students' network technology competencies. These courses are also becoming key platforms for implementing the fundamental mission of fostering virtue through education and advancing ideological and political education within the curriculum. The Ministry of Education's "Guidelines for Ideological and Political Education in Higher Education Courses" explicitly state that all courses must align with ideological and political education to achieve the organic integration of "knowledge transmission and value guidance", thereby permeating the talent cultivation system. In light of this policy, the systematic integration of ideological and political elements into technical courses such as computer networking has become a pressing practical challenge for higher education teaching reform.

However, in practice, computer networking courses often prioritize technology over values. Traditional teaching models focus on technical knowledge such as the 'five-layer protocol stack', 'three-way handshake', and 'routing algorithms', emphasizing an understanding of protocol mechanisms and network device configuration, while neglecting the social significance, ethical considerations and national needs underlying these technologies. Students may become proficient in network configuration commands yet lack a deep understanding of critical issues such as 'network sovereignty', 'data security', and 'technological self-reliance'. They struggle to develop a sense of mission and responsibility to serve national development through technology. This 'technological neutrality' perspective not only weakens the course's ideological guidance function, but also significantly deviates from contemporary higher education talent cultivation goals.

Most current computer science majors were born in the 2000s. Having grown up during the era of rapid internet development, they have an innate affinity with and curiosity about network technology, as well as strong practical skills and technological receptivity. However, previous teaching surveys indicate that only 31% of students can accurately explain the relationship between 'root server distribution and network sovereignty', while over half believe that 'network technology itself is neutral and unrelated to politics'. This reveals a significant disconnect between students' technical understanding and their value judgements. They lack critical awareness of Western 'technological neutrality' theories and have not developed an alignment of values with the national strategy of building a cyber powerhouse. Effective intervention and guidance through course instruction are urgently required to address this situation.

Furthermore, while some universities have attempted to integrate ideological and political elements into computer networking courses, these efforts often remain fragmented and superficial. Some teaching materials merely mention hot topics such as the 'Huawei incident' or 'Snowden leaks' without integrating them deeply into course content. Some instructors treat ideological content as an 'add-on module' inserted into classes, which disrupts technical logic and fails to evoke deep emotional resonance or value alignment among students. This 'labeling-style' integration fails to achieve a subtle, pervasive educational effect and risks provoking student resistance, thereby undermining the effectiveness of course-based ideological education.

Therefore, key challenges in current curriculum reform include systematically identifying advanced ideological elements within computer networking courses, designing teaching activities that are 'visible, tangible and evaluable' to synchronize ideological education with professional skill development, and implementing quantitative assessments of ideological outcomes based on OBE (Outcomes-Based Education) principles. Based on this, this paper proposes a 'Three-Stages and Four-Dimensions' ideological and political education teaching model. This model aims to construct a teaching pathway that progresses from technical knowledge to value recognition, and from classroom participation to competency attainment. The model explores a new paradigm for systematic, actionable and evaluable ideological and political education in computer networking courses. It provides practical examples and theoretical support for advancing such education in engineering curricula in higher education institutions in the new era.

2. Theoretical Framework

The theoretical framework of this paper includes the following three dimensions:

(1) Curriculum Theory Level: Biggs' "Constructive Alignment" + OBE. Biggs proposed the principle of alignment among "expected learning outcomes - instructional activities -assessment tasks," while OBE emphasizes reverse-engineering instructional design from "measurable outcomes." Integrating these ensures ideological and political objectives transition from "implicit additions" to "explicit outputs," directly aligning with engineering accreditation and graduation requirements.[1]

(2) Moral Psychology Level: Kohlberg's "Three Levels and Six Stages" of Moral Cognitive Development. This theory indicates that college students typically transition from the "conventional level" to the "post-conventional level." They require "moral dilemma discussions" to trigger cognitive dissonance, enabling advancement toward higher-order "universal ethical principles." Accordingly, this paper designs dilemmas such as "root server shutdown" and "DNS hijacking responsibility attribution" to guide students from "law-abiding compliance" toward "rational construction."

(3) Communication Studies Level: Lasswell's "5W" Model (Who → Says What → In Which Channel → To Whom → With What Effect). Transposed to classroom ideological education, it systematically addresses five interlinked elements - "Instructor Identity - Ideological Content - Media Context - Student Audience - Value Effect" - mitigating channel fatigue caused by traditional "lecture-style" teaching. The "Effect" component in this model corresponds to quantitative evaluation, aligning precisely with OBE's requirement for "measurable outcomes."

In summary, this paper establishes a theoretical framework grounded in OBE as the overarching design, Kohlberg's moral development theory as the cognitive driver, and Lasswell's communication chain as the classroom implementation framework. This three-stages system- Goals → Activities → Evaluation - provides a coherent theoretical foundation, laying the academic groundwork for subsequent construction and validation of the "Three-Stages and Four-Dimensions" model.

3. Design of the "Three-Stages and Four-Dimensions" Model

3.1. Model Overview

The "Three-Stages and Four-Dimensions" model employs a four-tier backward design logic - "Graduation Requirements → Course Objectives → Classroom Activities → Assessment Evidence" - to integrate the value shaping chain, knowledge construction chain, and competency attainment chain into a unified teaching process. The meaning and operational mechanism of the "Three-Stages and Four-Dimensions" model are as follows:

- Three Stages: Pre-class "Value Awakening," In-class "Symbiosis Inquiry," Post-class "Reflection and Transfer," corresponding to Biggs' "Constructive Alignment" framework: Situational Pre-set, Deep Processing, and Metacognitive Reflection.
- Four Dimensions: Patriotic Sentiment (NI), Ethical Rule of Law (EL), Scientific Spirit (SI), Global Vision (GV). These dimensions cover the value requirements for engineering majors outlined in the "Guidelines for Ideological and Political Education in Higher Education Courses" while aligning with ABET's "Ethical Responsibility" and ACM's "Responsible Networking" provisions.
- Operational Mechanism: Employing a "Scenario-Task-Reflection" closed-loop as the minimal teaching unit, each unit generates dual evidence of "technical output + value output."

3.2. Exploration of Ideological and Political Elements

Following a four-step exploration method-"knowledge points → technological history → national affairs → ethical cases"-we systematically scanned the TCP/IP five-layer model to generate the mapping matrix shown in Table 1. The "expected student value outputs" in the table represent measurable ideological and political outcomes that directly match the graduation requirement indicators supported by the course.[3]

Table 1. Ideological–Political Element Mining Matrix for the "Computer Networking" Course

Teaching Module	Key Knowledge Points	Ideological and Political Mapping Points	Primary Dimensions	Expected Student Value Output (Assessable)
Physical Layer	Modulation Techniques	Huawei invented 5G polar codes breaking through patent barriers	Patriotic Sentiment	Use data in reports to demonstrate the necessity of "self-reliance and strength in science and technology"
Data Link Layer	Ethernet Evolution	Transition from "Catching Up" to "Leading the Way"	Scientific Spirit	Summarize the driving effect of "standard competition" on industrial upgrading
Network Layer	BGP Routing Hijacking	Twitter Outage Incident	Ethics and Rule of Law	Write a ≤600-word policy summary evaluating the incident's impact on network sovereignty
Transport Layer	TCP Congestion Control	"Net Neutrality" Debate	Ethics and Rule of Law， Scientific Spirit	Position statement must cite ≥2 FCC regulations
Application Layer	DNS Recursive Resolution	Cross-Border Data Compliance	Global Perspective， Ethical Rule of Law	1. Capture DNS over HTTPS traffic using Wireshark; 2. Develop compliance verification script based on the "Measures for the Security Assessment of Data Outbound Transfer"

3.3. Reengineering of Teaching Activities

Adopt the closed-loop route of context-task-reflection.[4] Taking the "IPv4 Root Server Distribution" unit (2 hours) as an example, it shows how the "Three-Stages and Four Dimensions" can be implemented.

(1) Pre-class "Awakening of Values" (Online, 30 min)

- Context: The teacher pushes a short video titled "What if the Root Server Stops Overnight" (3 min) and poses the question "How long can the global Internet survive?" for interactive discussion through bullet comments. The backend of the Learning App captures the keyword cloud from students, with high-frequency terms such as "DNS," "USA," and "Internet outage," creating a value suspense.
- Technical Warm-up: Students use Packet Tracer to build a three-level resolution tree of "root-top-level domain—authoritative" and observe the phenomenon of local recursive resolution failure.
- Four-dimensional Entry: National Sentiment (network sovereignty) + Global Perspective (governance system).

(2) In-class "Symbiotic Inquiry" (Offline, 90 min)

Task Chain Design:

- Role-playing (20 min): Students are divided into three groups-"Chinese IETF Engineers," "ICANN Board of Directors," and "Representatives of Small and Medium-sized Countries"-to debate based on the IPv6+ draft proposal released before the meeting.
- Data Verification (40 min): Each group receives a real BGP snapshot from RouteViews, extracts IPv4 prefix/AS mappings using Python, and verifies the imbalance that "geographical distribution of root servers ≠ address ownership."
- Ethical Conflict Escalation (20 min): The teacher introduces the news of "root zone files being revoked during the Russia-Ukraine conflict" and asks each group to quickly provide a policy response using Lasswell's "5W" model.
- Formative Assessment (10 min): On-site scoring using the Rubric four-dimensional scale via QR code, with immediate feedback from the teacher.

(3) Post-class "Reflection and Transfer" (Online + Offline, 1 Week)

The post-class "Reflection and Transfer" phase no longer continues the "task chain" format, but instead has students return to real-world social scenarios to solidify values through "one in-depth conversation, one technical public welfare activity, and one self-assessment."

Firstly, within three days after the course ends, students are required to independently contact a practitioner related to Internet governance (this could be an engineer from the local communications administration, an IP network maintenance staff from a carrier, or an alumnus engaged in cybersecurity entrepreneurship) and conduct a semi-structured interview of no less than 30 minutes on the topic of "root server distribution and network sovereignty." The interview outline is uniformly provided by the teacher and includes six open-ended questions such as "What is your view on China's discourse power in the global root governance system?" "Have you encountered any failures caused by root zone anomalies in your daily work?" and "What suggestions do you have for college students participating in root mirror deployment?" After returning to school, students transcribe the recording into a 5,000-word verbatim manuscript and use NVivo for three-level coding: open, axial, and selective. They ultimately extract three types of nodes-"technology-policy-ethics"-and write a 1,500-word qualitative research report. The report must cite the Lasswell communication model learned in class to explain the interviewee's value stance and, in the conclusion section, compare it with their pre-class questionnaire to examine whether their personal cognition has shifted.

The second step involves students forming groups of three to select multiple students from other faculties within the university and conduct a "one-hour IPv6 popular science on campus" public welfare lecture: They demonstrate the process of building a mini root mirror test bed with a Raspberry Pi and show the audience the three-level resolution process of "root-top-level domain-authoritative" in their browsers. They also use simple animations to explain "why there are only 13 Named Roots globally" and "why China is promoting the 'Yeti Plan'." After the lecture, the audience is required to fill out a five-question quiz. Students then reflect on their ability to "explain complex technology to laypeople" based on the accuracy rate and classroom interaction, record a 3-minute Vlog of the activity highlights and self-assessment, and upload it to their social media for comments.

The final step is "a letter to myself before graduation": Students write a long letter on social media platforms like WeChat Moments, starting with "On the day of graduation, I

hope to remember today's root server discussion in this way," and freely write about their re-understanding of technological neutrality, re-affirmation of national mission, and re-imagination of future career choices. The system will automatically push back and display this letter in the second semester of their senior year, forming a longitudinal self-comparison over three years. Teachers will extract keyword clouds in the background, and if the frequency of words like "responsibility," "China," and "governance" is significantly higher than at the beginning of the course, it will be considered a successful awakening of values.

4. Teaching Practice and Effectiveness Evaluation

4.1. Overview of Teaching Implementation

To test the feasibility and effectiveness of the "Three Stages, Four Dimensions" curriculum ideological and political (course ideological and political) teaching model in the university computer networking course, we selected two teaching classes of the School of Computer Science and Technology in Zhaoqing university, with a total of 110 students as the subjects of the teaching practice. The teaching practice lasted for one semester, totaling 16 weeks, covering all core content of the computer networking course, including modules such as the physical layer, data link layer, network layer, transport layer, and application layer.

The teaching practice adopted a hybrid teaching model of "online + offline," relying on the school's self-built online teaching platform for pre-class preview, post-class homework submission, and interactive communication. The offline classroom focused on interactive teaching activities such as case analysis, group discussion, role-playing, and experimental verification. The course teaching team consisted of one main lecturer (associate professor) and two graduate teaching assistants. Before the implementation of teaching, the team conducted two rounds of collective lesson preparation and case discussion on ideological and political education to ensure the scientific nature of the teaching design and the consistency of value orientation.

4.2. Methods for Assessing Teaching Effectiveness

To comprehensively evaluate the integrated effectiveness of the "Three-Stages and Four-Dimensions" teaching model in knowledge transmission, capability enhancement, and value shaping, we employ a mixed-methods approach combining "quantitative + qualitative" research methods,[5] which specifically include:

(1) Quantitative Assessment Tools

The primary focus is on analyzing the achievement of OBE course objectives. In line with the OBE assessment framework, five course objectives are established (including two ideological and political objectives). These objectives are evaluated through final exam scores, course project reports, and regular assignments.

(2) Qualitative Assessment Methods

- Classroom Observation Records

The teaching team conducts structured observations of each class session, documenting students' participation levels, quality of interaction, emotional responses, and expressions of values. Special attention is paid to students' performance in activities such as ethical debates and role-playing.

- Student Reflection Logs

Each student submits a "Course Learning Reflection Report" at the end of the course, covering aspects such as knowledge gained, value insights, and suggestions for teaching. A total of 118 valid logs were collected and analyzed using thematic analysis.

- Teacher Teaching Reflection

At the end of each round of teaching, the teaching team holds a teaching reflection meeting to document highlights of the teaching, issues encountered, and suggestions for improvement. Three teaching improvement logs were generated as a result.

4.3. Analysis of Teaching Effectiveness Results

According to the OBE assessment framework, the course has set five objectives, two of which are ideological and political goals (Goal 4: Possess the ability to make ethical judgments in the field of networking;[2] Goal 5: Establish a sense of mission to serve the national strategy of building a strong cyber nation). As shown in Table 2, at the end of the course, the achievement level of all course objectives has significantly improved compared to before.

Table 2. Comparison of Course Objective Achievement

Course Objective	Achievement Level (Pre-test)	Achievement Level (Post-test)	Improvement
1: Master the basic principles of networking	0.73	0.86	+17.8%
2: Possess the ability to analyze and design networks	0.69	0.84	+21.7%
3: Be able to use tools for network simulation and testing	0.71	0.88	+23.9%
4: Possess the ability to make ethical judgments in networking	0.64	0.775	+21.1%
5: Establish the awareness to serve the national strategy of building a strong cyber nation	0.68	0.856	+25.9%

Analysis results show that approximately 92% of students mentioned that the course "made me realize the responsibilities and missions behind technology," 86% of students stated that "through role-playing and case analysis, I have a better understanding of cyber sovereignty and ethical issues," and 78% of students felt that "the course format is innovative, with a strong sense of participation and great gains."

5. Conclusion

This paper has implemented the "Three-Stage and Four-Dimensions" course-based ideological and political teaching model in the "Computer Networking" course, proving that technical courses can effectively achieve value leadership. This model, through a three-stage closed loop of "before class - during class - after class," systematically integrates the

above model elements around four dimensions: patriotism, ethical and legal awareness, scientific spirit, and global vision. It has effectively addressed the common challenges of ideological and political teaching model integration in engineering courses, which are "difficulty in mining, difficulty in integration, and difficulty in evaluation." It has significantly enhanced students' sense of national mission and the achievement of course objectives, forming a replicable practice paradigm.

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