Instructional Design for Curriculum Ideology and Politics in Emerging Engineering: A Three-Dimensional Competency Model for Faculty——A Case Study in Communication Engineering

Xue Lin*, Changzhi Wei, Xiaoqing Jiang, Nianqiang Li, Hua Yuan, Jinmei Liu, Shiyao Cui, Dong Wang, Yue Zhao, Lu Zhang, Chao Li, Weixin Li

School of Information Science and Engineering, University of Jinan, Jinan 250022, China

*ise_linx@ujn.edu.cn

Abstract. Instructional design for curriculum ideology and politics bridges educator spirit with classroom practice. This study constructs a three-dimensional competency model, encompassing curriculum-based ideological-political integration, research ethics guidance, and the application of ideological-political elements in engineering practice. Building on this model, it further proposes a four-stage instructional design framework that integrates competency objectives, ideological-political elements, pedagogical methods, and effectiveness evaluation. A single-group pretest-posttest experiment (n=86) in the Data Communications course shows that students' posttest scores on the ideology-integration teaching effectiveness scale significantly exceeded their pretest scores. This study offers a replicable methodological reference for curriculum ideology instructional design in emerging engineering education.

Keywords: Educator Spirit, Curriculum Ideology and Politics, Instructional Design, Three-Dimensional Competency Model, Communication Engineering.

1 Introduction

Curriculum ideology and politics constitutes a central mechanism for fostering virtue through education in the new era [1]. In 2023, the distinctive spirit of Chinese educators was articulated, encompassing firm ideals, moral integrity, pedagogical wisdom, dedication to practice, benevolent care, and commitment to edification [2]. A persistent gap remains between these macro-level ideals and classroom practice [3].

This study administered a five-point Likert-scale survey (1=very weak, 5=very strong) to all Communication Engineering faculty. Self-rated ideology integration design ability averaged 3.17±0.70 (mean±SD): curriculum ideology integration ranked highest (3.45±0.67), engineering practice ideology transformation was intermediate (3.16±0.74), and research ethics guidance was lowest (2.91±0.79). Among respondents, 68.4% reported difficulty in "inaturally identifying entry points for ideology content within disciplinary knowledge", and 70.6% indicated a "lack of referable instructional

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design templates". These data reveal a pervasive predicament: ample awareness of the importance of curriculum ideology coupled with a lack of effective methods. It should be noted that, although full coverage ensures internal representativeness, the 21-instructor single-program sample limits cross-program generalizability of the three-dimensional competency model. Nevertheless, the model maintains its applicability in cognate disciplines (electronic information, automation, computer science, etc.), which requires only minor recalibration of indicator weights to accommodate discipline-specific differences in the availability of ideology-relevant materials and industry orientations.

2 Theoretical Framework: Three-Dimensional Ideology Competency Model

Pedagogical Content Knowledge (PCK) and Technological Pedagogical Content Knowledge (TPACK) frameworks reveal how disciplinary content is transformed into instruction, but both treat value guidance as implicit rather than structured. As engineering education shifts from producing technically skilled graduates to cultivating practitioners with ethical judgment, faculty competency models must elevate the value dimension to explicit, assessable competency. This study articulates three dimensions. Curriculum ideology integration ability identifies ethical tensions embedded in disciplinary knowledge while constructing instructional representations. Research ethics guidance ability embeds technology ethics and academic integrity norms into student research supervision. Engineering practice ideology transformation ability translates professional standards into experiential teaching events within training and internship settings. This dimension aligns with international accreditation standards such as ABET Student Outcomes (2024-2025), which require graduates to address societal and ethical factors, and EUR-ACE framework, which further designates social responsibility as a core competency. These three dimensions form a progressive structure of knowledge transmission→value guidance→practice formation, corresponding to pedagogical wisdom, commitment to edification, and dedication to practice (see Table 1).

From October to December 2025, three rounds of collective deliberation were conducted with full faculty participation, following a four-step process comprising thematic presentations, group discussion, focused debate, and written feedback. Behavioral indicators for each dimension received mean importance ratings above 4.2 on the five-point scale. After two rounds of iterative revision, the proportion of faculty endorsing all indicators rose from 71.4% to 90.5%, and the progressive consensus indicates strong endorsement of the indicator system by frontline instructors [4].

Table 1. Three-Dimensional Ideology Competency Model for Emerging Engineering Faculty.

Dimension	Educator Spirit Mapping	Observable Behavioral Indicators
Curriculum Ideology Integration Ability	Pedagogical Wisdom Benevolent Care	Identifies ideological entry points in disciplinary knowledge; translates abstract ideology requirements into concrete instructional resources; designs fusion pathways between ideology and discipline.
Research Ethics Guidance Ability	Commitment to Edification	Integrates academic integrity education into research supervision; guides students to reflect on the social

	Moral Integrity	implications of technology; cultivates engineering ethics judgment.
Engineering Practice Ideology Transformation Ability	Dedication to Practice Firm Ideals	Mines ideology elements from enterprise practice; embeds national strategic needs into practical teaching; cultivates craftsmanship and professional responsibility.

3 The Four-Stage Closed-Loop Instructional Design Framework

The proposed framework follows a four-stage closed loop: competency objective setting→ideology element mapping→teaching method matching→effectiveness evaluation feedback. Taking the three-dimensional ideology competency objectives as the logical starting point, the framework derives teaching plans from competency goals. In Stage 1, ideology competency objectives comprising integration, guidance, and transformation are specified for each class session, forming a progressive structure from shallow to deep, and from knowledge to action. In Stage 2, ideology entry points——nodes where disciplinary knowledge naturally connects with value guidance——are identified through course content analysis and developed into instructional materials and discussion topics. To address this, Stage 2 employs a five-column template (knowledge point, ideology element, educator spirit dimension, teaching method, assessment method) for systematic instructional design. Once constructed, the template enables instructors to retrieve and reuse design cases as needed. In Stage 3, one of three gradient methods——immersive instruction, subtle infusion, or peripheral exposure——is selected flexibly according to the strength of association between ideology elements and core knowledge (see Table 2). The three methods are distinguished by the strength of association between ideology elements and core knowledge: immersive instruction for tight coupling, subtle infusion for moderate association, and peripheral exposure for indirect relation. Stage 4 collects data through a four-dimensional evaluation system——student feedback, peer review, self-reflection, and enterprise assessment——and refines improvement plans through collective deliberation, forming a self-sustaining optimization mechanism [5].

Table 2. Tiered Instructional Design Strategies.

Method	Applicable Context	Classroom Time	Core Operation	Evaluation
Immersive	Ideology elements tightly coupled with core knowledge	20~30 min	Scenario design → Group collaboration → Structured dialogue → Meaning making	Explicit (included in course assessment)
Subtle Infusion	Partial association, non-core dependency	3~5 min	Brief case narrative + post-class reflective exercises	Semi-explicit (optional homework)
Peripheral Exposure	Indirect association with teaching objectives	Extracurricular	Pre-class readings+ MOOC clips +online discussion	Implicit (not mandatory)

4 Teaching Practice and Effectiveness Testing

A semester-long tracking study was conducted in the “Data and Computer Communication Net” course. Taking the topic of “Error Control and Reliable Transmission” as an illustrative example, a single-group pretest-posttest design (n=86) was employed, with the scale administered one week before and after instruction. The scale comprises three sub-dimensions: knowledge internalization (4 items), value identification (5 items), and behavioral intention (4 items). Data were analyzed using paired-sample t-tests and Cohen’s d effect sizes.

The one-week interval was chosen for three reasons. First, an immediate posttest inflates effect sizes through memory retention. Second, a longer interval risks additional history and maturation confounds. Third, the one-week interval is widely adopted in educational pretest-posttest research. No related coursework was scheduled during the interval, and the instructor and teaching environment remained constant. For triangulation, six blinded peer reviewers independently evaluated the instructional plan at pretest and reassessed the revised plan and teaching recordings at posttest two weeks later and without knowledge of the research purpose, providing third-party cross-validation.

The specific instructional design appears in Table 3. At the competency objective level, we cultivated rigorous engineering thinking through redundancy checking, technology ethics awareness through communication protocol security vulnerabilities, and professional pride through China’s contributions to 5G standardization. Three ideology entry points were selected: error-detecting code design wisdom as an instance of pedagogical wisdom, the ARQ-to-5G HARQ evolution as a case of commitment to edification, and protocol security cases as an example of moral integrity. Methodologically, immersive instruction was used for code design, with students designing error-detection schemes under a “protocol designer” scenario, peer-testing each other’s designs [6], and understanding the redundancy-efficiency trade-off through comparison (25 min); subtle infusion was used for 5G contributions, via “The China Story of Polar Codes”(3 min); and peripheral exposure was used for protocol security ethics, through pre-class MOOC clips with guided ethical deliberation questions.

Table 3. Pretest-Posttest Comparison for the Data and Computer Communication Net Course.

Stage	Professional Knowledge	CIP Touchpoint	Method	Pretest M±SD	Posttest M±SD
Introduction (5 min)	Error phenomena in communication	“Fault tolerance” as engineering philosophy	Light-touch: submarine cable repair case	2.93±0.70	3.49±0.84
Core Lecture (25 min)	Error-detecting/ correcting codes; ARQ protocol	Design as choice: efficiency vs. reliability trade-off	Immersive: “Protocol designer” scenario task	2.95±0.47	3.62±0.59
Extended Discussion (15 min)	5G HARQ protocol evolution and China’s contribution	From follower to leader: China’s standard-setting journey	Light-touch: “Polar codes: A Chinese story” video	2.69±0.51	3.30±0.68

Table 4. Pretest-Posttest Comparison of Three Subscales.

Subscale	Pretest M±SD	Posttest M±SD	Δ(M±SD)	t	Cohen's d
Knowledge Internalization	3.24±0.57	3.77±0.82	0.53±0.68	7.30	0.79
Value Identification	2.69±0.49	3.33±0.74	0.64±0.62	9.54	1.03
Behavioral Intention	2.72±0.50	3.45±0.82	0.73±0.72	9.32	1.00

Results (see Table 3) show that posttest scores exceeded pretest scores across all three segments ($p<0.001$), with the immersive segment producing the largest effect (posttest 3.62±0.59 vs. pretest 2.95±0.47; $t=11.05$, Cohen's $d=1.19$, large effect). Detailed pretest-posttest comparisons for the three subscales appear in Table 4. Peer evaluation of ideological and political instructional design by six blinded reviewers rose from 3.08±0.67 to 3.85±0.48, with the "integration naturalness" item showing notable improvement, suggesting the framework effectively mitigates the disconnect between ideological content and disciplinary instruction [7].

5 Discussion

Empirical data indicate that the framework produced positive effects across knowledge internalization, value identification, and behavioral intention. Behavioral intention showed the largest gain, suggesting that systematically embedding industry-academia integration resources and scenario-based tasks prompted a statistically significant improvement in students' willingness to translate values into practice ($\Delta M=0.73$, Cohen's $d=1.00$, large effect). However, several limitations must be acknowledged. First, although the semester-long design provides a long observation window, it remains insufficient to capture stable shifts in deeply held values——multi-semester tracking is needed. Second, the boundaries among immersive instruction, subtle infusion, and peripheral exposure are currently delineated along a single dimension (the strength of association between ideology elements and core knowledge), without specifying their applicability across contextual variables such as students' prior knowledge, class size, and instructional hours. Future research will conduct multi-semester longitudinal tracking, and clarify the boundaries of the three methods through factorial experiments.

6 Conclusion

Instructional design is the critical bridge between educator spirit and the classroom. Grounded in a full-sample survey and collaborative faculty consultation, this paper constructs a competency-model-driven framework and validates it through classroom implementation. The study operationalizes educator spirit as concrete, measurable activities and provides quantified evidence to inform engineering curriculum reform.

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Disclosure of Interests

The authors have no competing interests to declare that are relevant to the content of this article.

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