

Research Article

Construction of the Ideological and Political Education System for Cultivating Outstanding Engineering Talents Under the Work-Study Alternation Paradigm

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Abstract

As a key pathway for cultivating excellent engineers, the Work-Study Alternation model strengthens students' engineering practice, professional competence, and workplace adaptability. However, in local universities, this model also poses new challenges to Ideological and Political Education because it involves multiple educational stakeholders, complex mentor–student relationships, and frequent changes in students' learning and working identities. These factors often lead to insufficient coordination, incomplete educational coverage, and weak integration between value education and engineering practice. To address these problems, this study aims to analyze the practical dilemmas and underlying causes of Ideological and Political Education under the Work-Study Alternation model and to construct an integrated educational framework for excellent-engineer training in local universities. Grounded in collaborative governance theory, this paper adopts policy analysis and case studies to examine the roles, responsibilities, and collaborative mechanisms among universities, enterprises, mentors, and students. The study finds that the main difficulties arise from fragmented governance structures, unclear role boundaries, insufficient mentor collaboration, and inadequate evaluation and incentive mechanisms. On this basis, this paper proposes a new educational framework guided by the “one root and three veins” spiritual lineage as the core value system and supported by the three-wide education approach of “all-staff, all-process, and all-around” engagement. It further develops a five-pronged implementation path consisting of Party-building leadership, competence enhancement, mentorship innovation, career guidance, and institutional support and incentive mechanisms, together with a multidimensional evaluation mechanism. The proposed framework promotes the deep integration of Ideological and Political Education with engineering practice and supports the coordinated development of engineering competence and value shaping, thereby providing a practical reference for cultivating excellent engineers in local universities.

Keywords

Work-Study Alternation, Excellent Engineer, Ideological and Political Education, Collaborative Governance, Three-Wide Education

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1. Introduction

Currently, as profound global transformations unseen in a century accelerate alongside the deepening of a new round of technological revolution and industrial transformation, the national demand for engineering and technical talent—particularly excellent engineers—has become increasingly urgent. General Secretary Xi Jinping has repeatedly emphasized the necessity of deepening reforms in master's and doctoral engineering education to cultivate a contingent of engineers who are patriotic, dedicated, equipped with exceptional technological innovation capabilities, and adept at resolving complex engineering problems, thereby charting the course for engineering talent cultivation in China's new era. Against this backdrop, the Work-Study Alternation (WSA) model, serving as the core pathway for nurturing excellent engineers, has garnered unprecedented attention from the higher education sector [1].

Furthermore, the Accreditation Standards for Excellent Engineer Education, promulgated in 2025, established Work-Study Alternation as an independent core indicator, systematically constructing a full-process, closed-loop framework that encompasses Ideological and Political Education (IPE), project repository development, training schemes, professional practice, and graduation criteria [2]. This profound shift signifies a fundamental transition in China's engineering education, evolving from a predominantly university-centric model toward a paradigm of robust university-enterprise collaborative education.

The Work-Study Alternation model emphasizes the continuous rotation between on-campus academic learning and practical enterprise experience, effectively transitioning the cultivation of engineering talent from the conceptual "ivory tower" to authentic engineering environments [3]. However, while this educational paradigm significantly enhances students' proficiency in resolving complex engineering problems, it concurrently precipitates profound structural shifts: the transition of training entities from singular to diversified, the evolution of mentor-student dynamics from a traditional binary to a multi-polar university-enterprise nexus, and the complexification of student identity, which expands from a conventional "student" to a dual "student and quasi-employee" status. Consequently, these transformations pose formidable challenges to the traditional, predominantly campus-centric framework of Ideological and Political Education, manifesting in critical systemic deficiencies such as inadequate coordination, fragmented coverage, and superficial integration [4].

In recent years, domestic scholars have conducted extensive research centering on the Ideological and Political Education of graduate students and the reform of excellent engineering talent cultivation, yielding a substantial body of significant findings. Zhang Yuping et al. underscore the core role of Ideological and Political Education guidance in cultivating engineering talent by conceptualizing a five-dimensional, integrated graduate training system—comprising "ideological and

political leadership, international outreach, project-driven initiatives, base synergy, and process safeguards"—which embeds Ideological and Political Education throughout the entire continuum of coursework, scientific research training, and practical cultivation [5]. Focusing on the core elements and practical logic of Ideological and Political Education in graduate courses, Cao Zhenxi et al. [6] propose actionable pathways for its deep integration with professional education; similarly, Gao Shan et al. explore the construction of a curriculum-based Ideological and Political Education framework within a "macro-ideological and political" context, providing robust theoretical support for infusing this education into all pedagogical phases [7]. Grounded in the university-enterprise collaborative training model, Qian Ting et al. systematically construct a five-faceted operational framework that includes Party-building leadership and mentor-student Ideological and Political Education engagement, thereby offering a crucial reference for joint Ideological and Political Education endeavors between universities and enterprises [8]. Furthermore, Wang Qian [9] investigates pathways for embedding Ideological and Political Education elements into the graduate curriculum system, while Guo Yong advances the development of a mentor-student Ideological and Political Education framework by fortifying the core educational role of academic advisors [10]. Internationally, the cultivation of excellent engineering talent is prominently represented by the German Dual System, the American engineering education accreditation framework, and the British university-enterprise cooperative model, all of which have generated a wealth of mature experiences in shaping engineering ethics and professional competencies. In the German Dual System, enterprises are deeply involved throughout the entire talent cultivation process, seamlessly integrating professional ethics and craftsmanship into on-the-job practice to foster students' dedication and sense of responsibility [11]. The Accreditation Board for Engineering and Technology (ABET) in the United States institutionalizes "ethical responsibility" as a core standard for engineering talent, reinforcing students' ethical literacy through dedicated courses and practical projects. Meanwhile, British universities establish robust partnerships with enterprises to weave industry norms and professional conduct into academic instruction and practical training, thereby achieving the synchronous enhancement of professional literacy and technical proficiency [12].

While the aforementioned studies establish a crucial theoretical foundation for cultivating excellent engineering talent amidst university-enterprise integration, existing achievements predominantly adopt a single-actor perspective, focusing primarily on either the university or the government. There remains a notable paucity of research addressing the synergistic Ideological and Political Education conducted jointly by the dual entities of universities and enterprises under the Work-Study Alternation para-

digm; consequently, current approaches struggle to effectively resolve practical issues in local universities, such as inadequate coordination, fragmented coverage, and superficial integration. Grounded in Collaborative Governance Theory (CGT) and employing a comprehensive methodology that encompasses policy analysis and case studies, this paper systematically dissects the practical predicaments and underlying determinants of Ideological and Political Education within the Work-Study Alternation model. Ultimately, it proposes the construction of a novel Ideological and Political Education framework that seamlessly integrates the "one root and three veins" value paradigm with a "three-dimensional collaborative" structural framework, thereby providing a robust theoretical foundation and actionable practical references for local universities seeking to advance the educational reform of excellent engineers.

2. Practical Dilemmas and Causal Analysis

2.1. The Dilemma of Diversified Training Entities and Ideological and Political Education Synergy

The Work-Study Alternation model expands the educational entities from traditional faculty into a diversified structure comprising "university teachers + enterprise mentors + corporate management personnel," thereby forging a "dual-actor" landscape of university-enterprise Ideological and Political Education [13]. However, empirical investigations reveal a conspicuous void in the "all-staff" dimension of education: despite being crucial educational actors, enterprises generally exhibit a pervasive lack of enthusiasm for participating in Ideological and Political Education. The phenomenon characterized by "university enthusiasm contrasted with enterprise apathy" is prominently displayed, frequently reducing university-enterprise collaboration to superficial and perfunctory engagements [14]. Furthermore, an effective synergistic mechanism has yet to be established among academic departments, student affairs offices, subject-specific faculty, and enterprise mentors. Particularly within the realm of university-enterprise cooperation, the boundaries of responsibility for enterprise mentors engaging in Ideological and Political Education remain profoundly ambiguous. Exploring the underlying causes, on one hand, enterprises—functioning as market entities driven by economic imperatives—lack the intrinsic motivation to invest in Ideological and Political Education, an endeavor characterized by prolonged commitment cycles and difficult-to-quantify outcomes. On the other hand, universities have not yet instituted an effective university-enterprise collaborative mechanism for Ideological and Political Education, leading to manifest discrepancies between the two parties regarding educational philosophies, operational methodologies, and evaluation criteria.

2.2. The Dilemma of Shifting Educational Domains and Process Coverage

Under the Work-Study Alternation model, the educational environment frequently oscillates between the university and the enterprise, with the duration of students' practical engagement within enterprises often constituting over one-third of their total academic hours [15]. This spatial transition results in tenuous cohesion within Ideological and Political Education, rendering the educational chain highly susceptible to rupture. The articulation between foundational theoretical instruction in the lower grades and advanced professional practice in the upper grades remains largely disjointed; furthermore, the integration of Ideological and Political Education within the curriculum often manifests as superficial labeling, thereby impeding the realization of the unity of knowledge and action. Once students transition into the enterprise phase, temporal and spatial constraints obstruct seamless communication with faculty, precipitating delayed, fragmented, and imprecise information acquisition. Consequently, efforts to accurately gauge students' ideological dynamics are invariably characterized by high subjectivity, high redundancy, low foresight, and low precision. These resultant lacunae within the continuum of all-process education effectively preclude Ideological and Political Education from achieving a seamless transition at the critical inflection points inherent to the Work-Study Alternation paradigm.

2.3. The "Two Skins" Dilemma: The Disconnect Between Theory and Practice

The entrenched disconnect between Ideological and Political Education and professional instruction is a malady that has long plagued engineering education reform. Under the Work-Study Alternation model, this issue becomes even more pronounced. On the one hand, Ideological and Political Education courses remain confined to traditional classroom settings, failing to achieve deep integration with professional education, thus isolated. On the other hand, professional courses disproportionately overemphasize knowledge transmission at the expense of value guidance, exhibiting a distinct tendency toward "de-ideologization." Furthermore, certain subject-specific faculty members possess a superficial understanding of collaborative education; consequently, curriculum-based Ideological and Political Education suffers from convoluted objectives and a detachment from academic disciplines—a problem researchers have vividly characterized as the "silo effect." Within the context of Work-Study Alternation, students deployed to enterprise sites primarily undertake technical duties and production tasks. Enterprises, in turn, focus predominantly on students' technical proficiency and occupational adaptability, generally exhibiting insufficient attention to and guidance of their Ideological and Political Education literacy. As a result, it remains exceedingly difficult for Ideological and

Political Education to genuinely take root and flourish within authentic engineering practice.

2.4. A Multidimensional Examination of Causes

The emergence of the aforementioned predicaments is the culmination of multiple, compounding factors. At the institutional level, contemporary universities lack a systematic institutional design for Ideological and Political Education under the Work-Study Alternation model; consequently, the delineation of rights and responsibilities between universities and enterprises remains ambiguous, and a normalized operational coordination mechanism is conspicuously absent. Furthermore, the collaborative educational mechanism for comprehensive Ideological and Political Education is beset by practical issues, including divergent objectives among collaborative entities, asymmetrical information flow, unstable motivational safeguards, and fragmented institutional frameworks. At the cognitive level, universities, enterprises, and students alike exhibit an insufficient appreciation for the critical significance of Ideological and Political Education within the Work-Study Alternation paradigm. Enterprises often demonstrate a diluted awareness of their active role as educational entities, while a segment of the student body perceives enterprise practice merely as isolated technical training, thereby neglecting the profoundly embedded resources for Ideological and Political Education—such as professional ethics, craftsmanship, and patriotic devotion. At the resource level, the respective Ideological and Political Education resources of universities and enterprises have not been effectively integrated. There remains a profound deficit of collaborative educational platforms capable of bridging intra- and extra-curricular activities, spanning on-campus and off-campus boundaries, and seamlessly merging into authentic engineering environments. Ultimately, these intertwined factors collectively constrain the enhancement of the practical efficacy of Ideological and Political Education under the Work-Study Alternation model.

3. Collaborative Governance for Ideological and Political Education in Work-Study Alternation

3.1. The Core Tenets of Collaborative Governance Theory

Collaborative Governance Theory originates from Synergetic, a discipline founded by the German physicist Hermann Haken in the 1970s that primarily investigates the synergistic effects generated through non-linear interactions among various subsystems within complex systems [16]. Governance theory, in turn, emphasizes the egalitarian participation, consultative co-governance, and networked interaction of diverse entities. Collaborative Governance Theory organically integrates these two domains; its fundamental tenet posits that

within complex systems, the consultative cooperation, information sharing, and resource integration among multiple actors generate a synergistic effect wherein the whole is demonstrably greater than the sum of its parts [17]. This theory places particular emphasis on defining characteristics such as the multiplicity of actors, process interactivity, network-based structures, and the forging of goal consensus. Consequently, it provides a robust analytical framework for dissecting the multi-actor synergy issues that currently confront Ideological and Political Education under the Work-Study Alternation model.

Within the realm of engineering education, the cultivation of excellent engineers is intrinsically a systematic endeavor demanding the profound engagement of diversified stakeholders—spanning government, industry, academia, research, and application. The core objective of this endeavor is the construction of a collaborative educational community resolutely centered on student cultivation [18]. The multifaceted participation, consultative co-governance, and holistic synergy championed by Collaborative Governance Theory resonate profoundly and align seamlessly with the intrinsic requirements of Ideological and Political Education under the Work-Study Alternation paradigm.

3.2. Analysis of Theoretical Applicability

Introducing Collaborative Governance Theory into the research of Ideological and Political Education under the Work-Study Alternation model exhibits a profound threefold applicability, articulated as follows.

First, it addresses the imperative to resolve the dilemma of multi-actor synergy. Under the Work-Study Alternation model, Ideological and Political Education involves a multiplicity of entities, encompassing university party committees, academic departments, student affairs offices, Ideological and Political Education faculty, subject-specific faculty, enterprise mentors, and corporate management personnel. Collaborative Governance Theory emphasizes the systemic integration of diverse resources—spanning policy, education, industry, practice, and culture—by explicitly delineating the boundaries of rights and responsibilities for each respective actor and by establishing operational parameters for consultative co-governance. This conceptual paradigm provides robust theoretical guidance for resolving contemporary deficiencies within university enterprise collaborative efforts, effectively mitigating persistent issues such as the dichotomy of "university enthusiasm contrasted with enterprise apathy" and the profound ambiguity surrounding the boundaries of educational responsibility.

Second, it fulfills the necessity of achieving procedural continuity. Collaborative Governance Theory focuses extensively on the procedural mechanisms and dynamic synergy inherent within system operations.

Within the specific context of Work-Study Alternation, the

educational continuum traverses two distinct spatial domains—the university and the enterprise—while oscillating between two pedagogical modalities: foundational theoretical instruction and applied engineering practice. By drawing upon Collaborative Governance Theory, institutions can systematically construct a comprehensive, all-process collaborative educational chain that extends continuously from initial enrollment to final graduation, and spans seamlessly from the academic classroom to the industrial workshop. This structural continuity ensures that Ideological and Political Education remains neither interrupted nor attenuated at any critical transitional inflection point inherent to the Work-Study Alternation paradigm.

Third, it meets the requisite demand for facilitating deep content integration. Collaborative Governance Theory provides the essential methodological scaffolding required to dismantle the entrenched barriers isolating Ideological and Political Education from professional academic instruction. Through the establishment of a normalized, ongoing collaborative mechanism uniting Ideological and Political Education faculty, subject-specific faculty, and enterprise mentors, ideological and political elements can be organically infused into both professional pedagogy and authentic engineering practice. This synergistic integration ultimately culminates in a holistic educational landscape characterized by the ubiquitous presence of Ideological and Political Education tenets across all curricula, ensuring that every course concurrently imparts robust value guidance while maintaining its distinctive academic characteristics.

4. An Ideological and Political Education Framework: Value Paradigm and Three-Dimensional Synergy

4.1. The "One Root and Three Veins" Spiritual Lineage: Constructing the Core of the Value Paradigm

Value guidance constitutes the very soul of Ideological and Political Education. In response to the fluid nature of student identities and the susceptibility of their value systems to diverse ideological impacts under the Work-Study Alternation model, constructing a spiritual lineage centered upon the "one root and three veins" provides a profound axiological foundation for the cultivation of excellent engineers. The "one root" entails steadfastly employing Xi Jinping Thought on Socialism with Chinese Characteristics for a New Era to forge the soul and educate students, serving as the immutable political core and value coordinate that permeates the entire educational endeavor. The "three veins" denote the red bloodline, the cultural roots, and the craftsmanship roots. Specifically, the red bloodline embodies the political conviction of patriotism and devotion to the Party,

guiding students to seamlessly integrate their personal growth into the broader trajectory of national development; the cultural roots deeply cultivate patriotic sentiment and cultural confidence, ensuring that excellent engineers not only master cutting-edge technologies but also possess profound cultural depth and a resolute sense of national responsibility; and the craftsmanship roots nurture a professional ethos of continuous refinement alongside a robust awareness of engineering ethics, empowering students to strictly adhere to ethical boundaries while relentlessly pursuing technical mastery. Ultimately, this spiritual lineage exerts a critical value-guiding function throughout the entirety of the Work-Study Alternation process, ensuring that students—whilst acquiring foundational theory at the university and technical proficiency at the enterprise—consistently maintain an unerring value orientation.

4.2. The Three-Dimensional Collaborative Structural Framework: All-Staff, All-Process, and All-Around Synergy

Building upon the value guidance of the "one root and three veins" spiritual lineage, an "all-staff, all-process, and all-around" three-dimensional collaborative structural framework is constructed to formulate a multidimensional system for Ideological and Political Education.

The dimension of all-staff synergy emphasizes the pluralistic integration and organic cooperation of educational entities. Drawing upon Collaborative Governance Theory, this dimension constructs an educational community of "pluralistic co-governance," led by the university party committee, synergized by both the university and the enterprise, united by Ideological and Political Education faculty and subject-specific faculty, and actively involving enterprise mentors and management personnel. Through the establishment of mechanisms such as joint university-enterprise conferences for Ideological and Political Education, unified Party and Youth League organizations, and co-constructed educational bases, enterprises are effectively transformed from passive cooperative partners into proactive educational entities. The dimension of all-process synergy dictates that Ideological and Political Education must permeate the entire life cycle of talent cultivation under the Work-Study Alternation model. Spanning from initial enrollment education to the final graduation design, and from on-campus theoretical instruction to enterprise-based engineering practice, it forms a continuous, cohesive educational chain. Specifically, differentiated educational themes can be designated according to distinct developmental stages: the freshman year focuses on professional orientation and value identification; the sophomore year reinforces the cultivation of craftsmanship; the junior year deepens the cognitive understanding of professional ethics within authentic engineering practice; and the senior year integrates career guidance to instill an employ-

ment philosophy dedicated to serving national strategic imperatives.

The dimension of all-around synergy emphasizes the multidimensional expansion of educational spaces and the systematic integration of educational resources. By transcending the traditional spatial boundaries between the university and the enterprise, it constructs an integrated, four-dimensional educational sphere encompassing the classroom, the laboratory, the enterprise workshop, and the digital platform. By fully leveraging digital technologies, it establishes an information platform for Ideological and Political Education that seamlessly connects both the university and the enterprise, thereby enabling real-time tracking of and timely intervention in students' ideological dynamics. For instance, certain universities have already developed virtual reality experiential resources—featuring modules such as "red memories," "craftsmanship heritage," and "rural revitalization"—which effectively transfigure Ideological and Political Education from abstract didacticism into a profoundly immersive experience. The results section should provide an accurate and concise description of the experimental findings, and the resulting conclusions that can be inferred from the experiments. Meanwhile, the results should be presented in a transparent and truthful manner, avoiding any fabrication or improper manipulation of data. Where applicable, results of statistical analysis should be included in the text or as tables and figures.

5. A Five-Pronged Implementation Pathway

Grounded in the previously established systemic framework, this paper delineates the following five specific implementation pathways designed to facilitate the practical operationalization and tangible efficacy of Ideological and Political Education under the Work-Study Alternation model.

5.1. Party-Building Leadership: Fortifying Organizational Safeguards

Party-building initiatives are fundamental for Ideological and Political Education under the Work-Study Alternation model. We must fully leverage the core function of Party organizations in providing value guidance, coordinating resources, and forging ideological cohesion. Specific measures include propelling student Party branches into enterprises, establishing provisional Party branches or sub-groups on engineering frontlines, and organizing Party members to immerse themselves in production sites to conduct themed Party day activities, to profoundly apprehend craftsmanship and patriotic devotion within authentic engineering environments. Furthermore, it is essential to explore mechanisms for the joint establishment of university-enterprise Party organizations, seamlessly integrating Ideological and Political Education

throughout the entirety of university-enterprise synergy via initiatives such as conducting joint organizational life activities and co-constructing educational bases for Party members. Ultimately, the crux of Party-building leadership lies in translating the political advantages of Party organizations into organizational advantages for collaborative education, thereby achieving the profound integration of Party-building with core operational activities and ensuring that Ideological and Political Education does not inadvertently succumb to a "vacuum zone" as a consequence of Work-Study Alternation.

5.2. Competency Empowerment: Fortifying the Value Foundation

The core of literacy empowerment lies in translating the "one root and three veins" spiritual lineage into perceptible and internalizable Ideological and Political Education content. First, it involves systematically developing Ideological and Political Education resources that integrate industry characteristics, engineering ethics, and craftsmanship, establishing a three-tier mapping system of "industry cases—professional knowledge points—ideological and political elements" to achieve comprehensive coverage of Ideological and Political Education across professional courses. Second, it requires innovating the modalities of Ideological and Political Education by transforming enterprise environments—such as model worker studios, precision assembly lines, and factory history cultural corridors—into multidimensional educational domains. This facilitates the creation of a workshop-based "macro-ideological and political education course" jointly delivered by subject-specific faculty, Ideological and Political Education faculty, and enterprise experts, enabling students to profoundly apprehend craftsmanship and deeply cultivate patriotic sentiment within authentic engineering cases.

5.3. Mentorship Innovation: Optimizing Mentor-Student Interaction

Under the Work-Study Alternation model, the mentor–student relationship shifts from a traditional binary structure to a multipolar interaction involving university mentors, enterprise mentors, and students. Mentorship innovation therefore requires building a new relationship in which Ideological and Political Education is naturally embedded in daily guidance and interaction. This can be achieved by establishing a dual university–enterprise mentorship system, clarifying the responsibilities of enterprise mentors, and encouraging them to integrate value guidance with technical instruction. Meanwhile, activities such as engineering ethics case discussions and seminars on industry development trends can help incorporate Ideological and Political Education into academic exchange and technical problem-solving. The "innovative mentor–student Ideological and Political Education system" proposed by the Tsinghua University Academy of Engineering offers a representative example of this approach.

5.4. Career Guidance: Aligning with National Strategies

Career guidance is an important mechanism for transforming value shaping into conscious action. It should be deeply integrated with Ideological and Political Education to guide students in aligning personal career choices with national strategic needs. This can be achieved by inviting experts and alumni to share experiences in major national engineering projects, organizing students to visit and practice at key project sites, and embedding the value orientation of serving national strategies into curricula and engineering practice. In this process, students can gradually internalize the mission consciousness of contributing to national development as their professional pursuit.

5.5. Safeguard Incentives: Perfecting Long-Term Mechanisms

The safeguard and incentive mechanism serves as the found-

ational pillar ensuring the sustainable operation of the Ideological and Political Education framework. Regarding institutional safeguards, we must establish a joint conference system spearheaded by the college party committee, involving academic and student affairs offices, to regularly deliberate upon Ideological and Political Education issues within the Work-Study Alternation model. As illustrated in Figure 1., the system secures the consistency and efficacy of ideological and political education throughout work-study transitions by employing a five-pronged strategy anchored in Party-building leadership. In terms of resource safeguards, investments must be augmented to support the co-construction of university-enterprise Ideological and Political Education bases, alongside the development of virtual simulation teaching platforms and online resource repositories for Ideological and Political Education. Concerning evaluative incentives, the efficacy of Ideological and Political Education should be incorporated into the assessment metrics for university-enterprise cooperation; furthermore, formal recognition and rewards must be confand Political Education within the Work-Study Alternation paradigm, thereby generating a virtuous cycle of positive reinforcement.

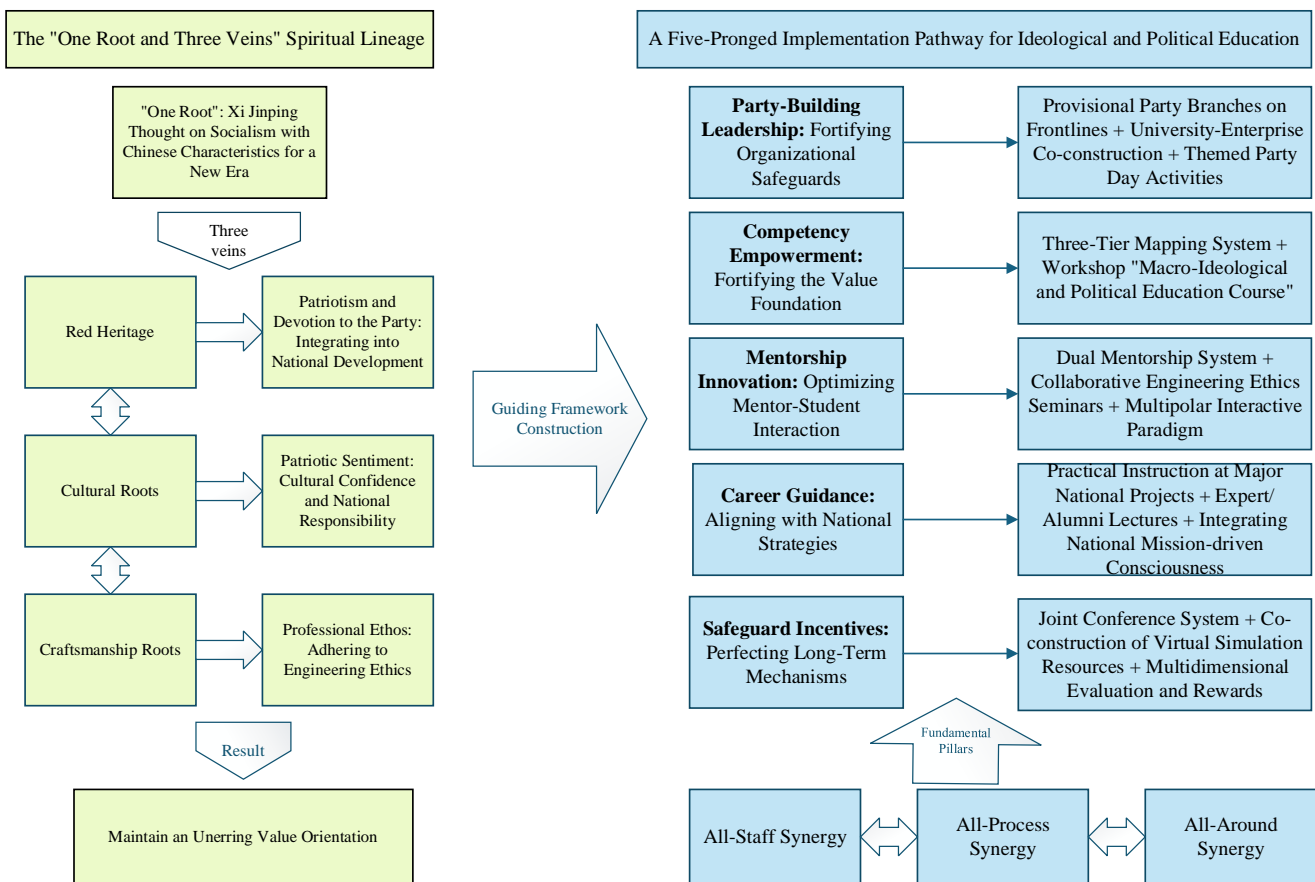


Figure 1. The Synergistic Ideological and Political Education Framework for Excellent Engineers.

6. The Construction of a Multidimensional Evaluation Mechanism

A scientific evaluation mechanism serves as the crucial linchpin for verifying the practical efficacy of Ideological and Political Education and facilitating its continuous improvement. Under the Work-Study Alternation model, the evaluation of Ideological and Political Education must transcend the traditional singular paradigm—which relies predominantly on examination scores and classroom performance—and definitively pivot toward a multidimensional, process-oriented comprehensive assessment.

The diversification of evaluation entities is paramount. This necessitates the construction of a four-dimensional evaluation system that seamlessly integrates university assessment, enterprise assessment, student self-assessment, and peer assessment. Specifically, the university focuses on evaluating students' Ideological and Political Education literacy alongside their theoretical cognitive levels; the enterprise concentrates on assessing students' professional ethical conduct and teamwork spirit during authentic engineering practice; student self-assessment fosters introspective reflection and value internalization; and peer assessment fortifies collective supervision and mutual learning.

The multidimensionalization of evaluation content must also be achieved. The overall efficacy of Ideological and Political Education should be systematically deconstructed into several observable dimensions—such as the degree of value identification, professional literacy performance, engineering ethics awareness, and the assumption of social responsibility—thereby facilitating the design of rigorous, scientific evaluation indicators. For instance, the degree of value identification can be assessed through metrics such as students' applications for Party membership and their articulated willingness to participate in projects aligned with national strategic imperatives. Performance in professional literacy can be explicitly quantified via the enterprise mentor's comprehensive scoring of the student's work attitude, quality consciousness, and collaborative teamwork. Furthermore, engineering ethics awareness can be rigorously tested through the student's demonstrated capacity for ethical judgment during the analytical dissection of authentic engineering cases.

Finally, the whole-process implementation of evaluation is essential. It is imperative to establish a dynamic evaluation portfolio that spans the entire life cycle of the Work-Study Alternation paradigm, meticulously documenting the nuanced fluctuations in students' ideological dynamics and their value growth trajectories across disparate developmental stages. By leveraging big data technologies to conduct dynamic monitoring and trend analysis of students' ideological conditions, institutions can secure robust data support for the delivery of highly personalized Ideological and Political Education. Concurrently, the evaluation outcomes must be systematically fed

back into the continuous optimization of training schemes and pedagogical refinements, thereby forging a self-sustaining, closed-loop mechanism of evaluation, feedback, and improvement.

7. Conclusion and Outlook

Grounded in Collaborative Governance Theory, this paper has systematically analyzed the practical predicaments and underlying determinants of Ideological and Political Education under the Work-Study Alternation cultivation model.

It has constructed a novel Ideological and Political Education framework, anchored by the "one root and three veins" spiritual lineage as its value paradigm and structured upon an "all-staff, all-process, and all-around" three-dimensional collaborative framework. Furthermore, it has proposed a five-pronged implementation pathway encompassing Party-building leadership, literacy empowerment, mentorship innovation, career guidance, and safeguard incentives, alongside the design of a multidimensional evaluation mechanism.

The research demonstrates that the predicaments confronting Ideological and Political Education under the Work-Study Alternation model are by no means insurmountable.

The crux lies in applying the systemic thinking inherent to Collaborative Governance Theory to transcend the traditional boundaries of entities, spaces, and content within Ideological and Political Education. This strategic approach facilitates the organic synergy between university and enterprise educational actors, the deep integration of theoretical instruction and practical cultivation, and the synchronous advancement of value guidance and capacity building. Ultimately, the construction of this systemic framework provides an actionable practical paradigm for local universities seeking to advance the educational reform of excellent engineers.

Future research should consider delving deeper into the following trajectories. First, conducting empirical research to rigorously verify the actual educational efficacy of the framework constructed in this study through quantitative analysis and comparative case studies. Second, focusing on the application potential of digital technologies within Ideological and Political Education under the Work-Study Alternation model, thereby exploring personalized educational modalities driven by artificial intelligence. Third, expanding the research perspective to enrich the theoretical connotations of Ideological and Political Education within Work-Study Alternation from complementary dimensions such as engineering ethics education and professional literacy cultivation. As the Work-Study Alternation paradigm serves as the pivotal pathway for cultivating excellent engineers, the perfection of its Ideological and Political Education system directly pertains to addressing the fundamental ontological questions of "whom to cultivate, how to cultivate, and for whom to cultivate"—an imperative endeavor that unequivocally merits sustained, intensive exploration by educational researchers and practitioners alike.

Abbreviations

WSA	Work-Study Alternation
IPE	Ideological and Political Education
ABET	Accreditation Board for Engineering and Technology
CGT	Collaborative Governance Theory

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Shifeng Ou: Conceptualization, Writing – review & editing

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Data Availability Statement

The data supporting the outcome of this research work has been reported in this manuscript.

Conflicts of Interest

The authors declare no conflicts of interest.

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