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Exploration on the Reform of Curriculum-Based Ideological and Political Education Teaching Resources in Digital Transformation

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Abstract: The digital transformation of education presents unprecedented opportunities for advancing the ideological and political construction of curricula across higher education institutions in the western regions of China. However, current pedagogical practice continues to encounter several substantive difficulties, including the fragmentation of ideological and political teaching resources, the superficial integration of professional content with ideological and political elements, and the absence of objective, data-driven mechanisms for evaluating the internalization of values among learners. To address these critical challenges, this study introduces knowledge graph technology and ontology construction methodology, proposing a dual-drive ontology model that integrates disciplinary knowledge with ideological and political dimensions. This model aims to achieve semantic representation and deep structural association of implicit ideological and political elements embedded within course materials. The research establishes systematic labeling norms for ideological and political elements through the Delphi method, constructs a domain knowledge graph encompassing core legal concepts and value dimensions, and designs a semantic association mechanism for integrating multi-source educational resources. On this foundation, a sixteen-week quasi-experimental study was conducted to evaluate the effectiveness of the proposed model. The results demonstrate that the model significantly reduces students' cognitive load during learning. Furthermore, the experimental group outperformed the control group in both knowledge transfer ability and value recognition, confirming the model's efficacy in enhancing the quality of ideological and political education through digital transformation.

Keywords: digital transformation; ideological education; knowledge graph; ontology construction; education evaluation

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1. Introduction

Today's society is undergoing profound transformation propelled by a new generation of information technologies, including big data analytics, artificial intelligence, and cloud computing infrastructure. This technological evolution has catalyzed comprehensive digital transformation across the social and economic domains, establishing it as an irreversible developmental trajectory. Within this context, higher education—serving as the primary institutional locus for cultivating high-caliber talent—faces consequential shifts in pedagogical approaches, instructional resource formats, and overarching educational paradigms. National strategic guidance emphasizes the imperative to accelerate the integration of digital capabilities into educational systems, supporting the renewal of pedagogical philosophies, the adaptation of instructional models, and the reconfiguration of institutional frameworks. Crucially, digital transformation in education extends beyond technological adoption; it entails the systematic reengineering of the educational ecosystem through digital tools and methodologies, enabling the simultaneous realization of scalable instruction and individually responsive learning pathways [1]. For ideological and political education in

institutions of higher learning, this transformation necessitates moving beyond conventional, transmission-oriented pedagogy toward integrative frameworks that cohesively unify value formation, disciplinary knowledge delivery, and competency development. It further requires transitioning ideological and political education from a functionally isolated component to a structurally embedded dimension within professional curricula—achieving seamless alignment between subject-specific content and ethical, civic, and cultural orientation throughout the entire teaching–learning continuum.

In this evolving landscape, Curriculum-based Ideological and Political Education has emerged as a pivotal strategic initiative for fulfilling the fundamental mission of talent cultivation [2, 3]. Nevertheless, practical implementation reveals persistent challenges in aligning ideological and political content with highly specialized disciplinary courses. First, conceptual and structural integration remains incomplete: ideological and political elements are often introduced in an ad hoc, episodic manner rather than being organically interwoven with core disciplinary concepts, resulting in superficial or mechanical insertion rather than coherent conceptual synergy. Second, assessment practices encounter significant methodological constraints when measuring internalized values and attitudinal outcomes; current evaluation mechanisms lack validated, scalable instruments capable of capturing nuanced cognitive-affective development. In parallel, knowledge graph applications in education have expanded considerably, yet prevailing implementations predominantly encode explicit, declarative domain knowledge while underutilizing semantic modeling techniques to represent implicit value-laden constructs such as ethical reasoning, civic responsibility, and cultural awareness. Consequently, many initiatives remain at the level of resource aggregation—merely assembling disparate materials without achieving functional interoperability or pedagogical coherence. To address these gaps, this study advances a conceptually grounded approach: constructing formal ontologies that explicitly define semantic relationships between disciplinary knowledge units and corresponding ideological and political constructs, thereby enabling principled integration at both the curriculum design stage and the learner’s cognitive processing level.

This paper aims to advance methodological innovation in the computational representation and pedagogical deployment of ideological and political content within professional education. Situated within the broader framework of digital transformation in higher education, the study selects the course 'E-commerce Legal Frameworks' as a representative case to investigate how interdisciplinary competencies can be cultivated through integrated curriculum design. The term 'E-commerce Legal Frameworks' refers strictly to the technical, procedural, and regulatory dimensions governing digital commercial transactions—including topics such as electronic contracts, data governance standards, platform accountability mechanisms, and consumer protection protocols—without implying any normative political stance. The investigation centers on developing a structured methodology for classifying, tagging, and dynamically linking digital learning resources with ideologically aligned learning objectives [4]. By applying intelligent mapping techniques grounded in domain ontology, the study constructs a multi-layered, adaptive curriculum resource architecture. This architecture supports the cultivation of e-commerce professionals equipped with robust digital literacy, sound technical ethics, and a well-developed sense of societal contribution—emphasizing responsible innovation, collaborative problem-solving, and adherence to professional integrity standards within digitally mediated economic environments.

The evolution of Curriculum-based Ideological and Political Education resources must respond systematically to the accelerating pace of digital advancement in the economy and society. Professional courses constitute foundational pillars for developing interdisciplinary expertise, making their digital enhancement both timely and essential. As digital transformation reshapes industry expectations and occupational profiles, the pedagogical infrastructure supporting ideological and political education must undergo coordinated recalibration across conceptual foundations, technological implementation,

and operational governance [5, 6]. Four interrelated challenges currently impede effective integration: (1) conceptual fragmentation, wherein ideological and political themes are treated as supplementary rather than constitutive elements of disciplinary epistemology; (2) technological immaturity, reflected in limited interoperability among digital platforms and insufficient support for context-aware, adaptive content delivery; (3) pedagogical misalignment, where instructional strategies fail to scaffold learners' progression from factual understanding to value-based judgment and ethical application; and (4) evaluative inadequacy, manifested in assessment tools that prioritize measurable outputs over developmental growth in character, judgment, and civic disposition. Addressing these challenges requires a holistic strategy that harmonizes theoretical clarity, technical feasibility, and institutional sustainability—ensuring that ideological and political education functions not as external imposition but as intrinsic, intelligible, and experientially grounded dimension of professional formation.

1.1. Fragmentation Dilemma and Structural Reconstruction Path of Ideological and Political Elements

In-depth analysis reveals that the integration of ideological and political education into professional courses frequently remains at a superficial level, relying primarily on surface-level semantic associations rather than achieving substantive alignment with the internal logic and epistemological structure of disciplinary knowledge. This shallow integration manifests in pedagogical practice as an inconsistent articulation of how core professional concepts inherently reflect broader ethical frameworks, societal responsibilities, and value orientations. For instance, when delivering foundational principles in specialized disciplines, instructors often omit systematic exposition of how those principles embody normative commitments—such as fairness, integrity, public interest, or collective well-being—and fail to explicitly trace their resonance with widely shared social values. Consequently, ideological and political content appears as externally appended commentary rather than organically embedded meaning, resulting in cognitive fragmentation for learners. Students struggle to synthesize discrete thematic inputs into coherent value frameworks, weakening the cumulative impact of curriculum-based ideological formation and diminishing long-term retention and application of normative reasoning within professional contexts.

To address this challenge, instructional design for curriculum-integrated ideological and political education must evolve from ad hoc, experience-based approaches toward rigorously structured, evidence-informed frameworks grounded in educational theory, domain-specific epistemology, and cognitive science. A robust implementation strategy involves constructing a three-dimensional integrative model organized around legal norms, value dimensions, and pedagogical contexts—each dimension calibrated to ensure conceptual coherence, functional relevance, and experiential authenticity. Within this architecture, natural language processing techniques are applied to systematically annotate core disciplinary knowledge points—not only for lexical presence but also for implicit normative valence, contextual applicability, and relational significance [7, 8]. Complementing algorithmic analysis, expert-led heuristic evaluation ensures interpretive fidelity and pedagogical appropriateness across diverse academic domains. Subsequently, high-fidelity teaching scenarios—whether real-world case studies, simulated decision-making environments, or scaffolded reflective exercises—are developed to instantiate these annotated elements in authentic learning settings. Such deliberate design facilitates transparent representation of value-laden content, enables coherent reorganization of previously isolated resources, and establishes a methodologically sound foundation for future knowledge graph development—including ontology definition, relational mapping, and inferential reasoning capabilities within the domain.

1.2. Lack of Semantic Association of Multimodal Resources

In-depth analysis: The types of teaching resources available in higher education institutions are diverse and abundant, encompassing textual documents, multimedia materials, and interactive digital assets. However, these resources are frequently

distributed across heterogeneous platforms—such as learning management systems, institutional repositories, video hosting services, and cloud storage—and stored in isolated formats including PDFs, PowerPoint presentations, hyperlinked web pages, and unstructured video files. This fragmentation results in a persistent 'data silos' phenomenon, where content remains semantically disconnected despite thematic or pedagogical relevance. For instance, within the instructional treatment of the judicial case commonly referred to as 'algorithmic price discrimination', there is no systematic linkage between foundational legal reasoning, underlying ideological and political dimensions, applicable statutory provisions, and supplementary news-based commentary videos. Consequently, educators face significant inefficiencies during lesson preparation, requiring extensive manual effort to locate, verify, and interrelate disparate materials. Similarly, learners lack computational support for discovering latent conceptual connections through self-directed inquiry, thereby impeding the development of integrated understanding and limiting opportunities for value-aligned, context-sensitive knowledge construction in collaborative educational settings.

Strategic advancement: A core objective is to achieve semantic interoperability among heterogeneous educational resources through structured knowledge representation. This entails constructing a unified resource description framework grounded in a lightweight ontology that explicitly models domain-specific concepts—including legal constructs, pedagogical contexts, and value-oriented attributes—while remaining scalable and maintainable. Natural language processing techniques are applied to perform automated entity recognition, contextual keyword extraction, and fine-grained annotation of ideological and political dimensions, ensuring consistent metadata enrichment across modalities. Semantic association rules are then established to formally encode relationships—such as 'illustrates', 'supports', 'contrasts with', or 'extends'—between legal principles, value-based educational objectives, and real-world case scenarios. As a result, previously isolated resources become nodes in a dynamic, machine-interpretable knowledge graph, enabling intelligent, context-aware retrieval mechanisms and precision-driven content delivery aligned with thematic clusters, value frameworks, and case typologies.

1.3. Subjective Teaching Effect Evaluation

In-depth analysis: Current evaluation practices for CIPE (Character and Integrity-oriented Pedagogy in Education) predominantly rely on summative artifacts such as final course papers, anecdotal teacher observations, or basic self-report questionnaires. These approaches are inherently limited by their dependence on individual instructor interpretation and lack of empirical grounding, rendering them insufficient for capturing the nuanced developmental trajectory of students' value internalization and behavioral disposition shifts. Specifically, while students may articulate normative statements—such as affirming the importance of integrity—in written assignments, such verbal endorsement does not reliably correlate with authentic ethical decision-making in real-world contexts [5, 9]. For instance, a student's theoretical agreement with integrity principles cannot be equated with consistent resistance to ethically ambiguous practices like fabricated e-commerce reviews or artificial credit inflation during entrepreneurial activities or professional practice. Consequently, this prevailing paradigm—characterized by an overemphasis on declarative knowledge acquisition while underemphasizing cognitive-affective integration, and prioritizing terminal outcomes over longitudinal developmental processes—fails to generate timely, granular, and actionable feedback. As a result, pedagogical refinement lacks empirical anchoring, impeding evidence-informed optimization of CIPE curricula, instructional strategies, and assessment frameworks.

Strategic advancement requires the development of a data-informed, multi-layered evaluation framework grounded in learning science principles. Drawing upon internationally validated methodologies—including longitudinal pre-intervention and post-intervention comparative assessments of value orientation shifts, as well as domestically piloted portfolio-based approaches in ideological and political education—

this framework should integrate three interdependent dimensions: conceptual understanding, affective value alignment, and observable behavioral inclination. Leveraging knowledge graph architecture and educational data mining techniques, a dynamic three-dimensional model can be implemented wherein students' navigation patterns—such as node dwell time, pathway sequencing, interaction frequency, and semantic annotation depth—are systematically captured and analyzed. These behavioral traces serve as proxy indicators for the maturation of value cognition, enabling inference about the degree to which ethical constructs are progressively assimilated into students' interpretive schemas and action repertoires. Crucially, this approach facilitates a methodological transition from impressionistic, instructor-centered judgments toward empirically traceable, learner-centered metrics—thereby enhancing both the validity and utility of formative assessment in CIPE implementation and continuous improvement cycles.

1.4. Case Dynamic Update Lag

In-depth analysis: Innovation in the field of e-commerce is highly dynamic, with novel operational models and application contexts—such as live-streamed commerce, immersive digital social platforms, and transnational data exchange—continuously evolving. Corresponding normative frameworks and administrative guidance are undergoing frequent refinement to maintain alignment with technological advancement and market practice. However, the case repository used for instructional purposes frequently exhibits temporal inertia relative to both industry evolution and the pace of normative updates. For instance, illustrative materials concerning the delineation of legal accountability in social commerce still predominantly reflect legacy micro-business paradigms from several years prior, while omitting timely integration of emergent scenarios such as liability attribution in live-streamed sales involving product misrepresentation or performance deviation. This temporal misalignment results in a pedagogical gap wherein learners acquire conceptual knowledge that lacks immediate applicability to contemporary professional challenges. Consequently, the instructional efficacy diminishes, as students struggle to bridge theoretical understanding with real-world implementation, thereby weakening both the credibility and functional utility of the curriculum. Moreover, persistent reliance on outdated exemplars may inadvertently reinforce obsolete assumptions about stakeholder roles, contractual expectations, and evidentiary standards within digital commercial ecosystems.

Strategic enhancement approach: Implement an industry-integrated, continuously refreshed case curation framework. The objective is to cultivate a responsive, adaptive, and empirically grounded case repository that evolves organically alongside sectoral developments. Drawing methodological inspiration from globally recognized academic-practice integration models, collaboration can be established with leading e-commerce enterprises, specialized legal service providers, and competent administrative bodies to co-develop, validate, and periodically refresh case materials. Concurrently, automated monitoring systems—leveraging web-based information harvesting techniques—can systematically collect newly published judicial decisions, administrative rulings, and authoritative policy interpretations disseminated through official judicial portals, government websites, and peer-reviewed professional publications. These inputs undergo structured processing via a semi-automated pipeline encompassing data cleansing, semantic annotation, contextual classification, and metadata enrichment [10]. Integration with a knowledge graph architecture enables version-controlled storage, lineage tracking, and traceable historical evolution of each case entry, supporting longitudinal pedagogical analysis and ensuring sustained fidelity between teaching resources and the rapidly shifting landscape of digital commerce governance and practice.

2. Research on the Construction of CIPE Teaching Resources Ontology in Digital Transformation

The construction of a domain-specific ontology for CIPE (Curriculum Integration of Ideological and Political Education) teaching resources represents a critical step in advancing pedagogical digital transformation. By adopting standardized semantic modeling approaches—particularly the Web Ontology Language (OWL) aligned with international interoperability frameworks—it becomes feasible to formalize conceptual relationships, hierarchies, and logical constraints among educational entities. This structured representation supports intelligent resource retrieval, adaptive learning pathways, and cross-platform integration. Ontology development is carried out systematically using Protégé as the primary authoring environment, enabling iterative refinement through expert validation and empirical testing. Within the context of professional courses such as E-commerce Laws and Regulations, the ontology design must reflect both disciplinary knowledge structures and pedagogical objectives related to value-oriented education. To ensure comprehensive coverage, four interrelated construction dimensions are proposed: (1) institutional mechanism alignment, ensuring coherence between curriculum policies and ideological education goals; (2) pedagogical innovation pathways, integrating interactive, case-based, and scenario-driven instructional strategies; (3) information resource architecture, emphasizing modular, reusable, and metadata-enriched digital assets; and (4) technical infrastructure support, focusing on scalable, secure, and interoperable platform deployment. Each dimension is accompanied by concrete implementation guidelines grounded in educational theory and practical classroom experience.

2.1. To Realize the Systematic Integration and Structured Expression of the Ideological and Political Elements of the Curriculum

The systematic integration of curriculum-based ideological and political education (CIPE) elements constitutes a foundational step in constructing a pedagogically grounded knowledge graph. This integration draws upon well-established principles from cognitive science, particularly cognitive load theory and meaning construction theory, which emphasize the importance of reducing extraneous cognitive demands when learners engage with abstract normative concepts. By representing value-laden content through a visual semantic network, instructional design can more effectively scaffold students' conceptual understanding and internalization of ethical, legal, and social responsibilities. Central to this approach is the epistemological shift from implicit, diffuse value references to explicit, logically organized knowledge structures that support coherent curriculum delivery. To ensure methodological rigor and intersubjective validity in identifying CIPE elements, this study employs a structured expert consensus process—specifically, a modified Delphi methodology—complemented by comprehensive literature synthesis. Over three iterative rounds, subject-matter experts—including senior law faculty and curriculum specialists in ideological education—refined definitions, scope boundaries, and annotation criteria, culminating in an objective, replicable semantic annotation specification for ideological and political elements. Based on this framework, thirty-two core legal conceptual entities—such as 'e-commerce operators', 'e-contracts', 'consumer rights protection', and 'platform accountability'—were systematically identified and categorized. Using the Protégé ontology editing environment, a domain-specific knowledge base was developed, comprising 87 classes, 45 object properties, and 28 data properties. A key innovation lies in the introduction of the 'hasIdeologicalDimension' object property, which formally links legal concepts to their corresponding ideological and political dimensions, thereby enabling precise, traceable, and computationally actionable representation. This structured expression not only mitigates fragmentation across curricular materials but also establishes a robust, interoperable data infrastructure essential for advanced knowledge reasoning, adaptive assessment, and intelligent pedagogical support systems.

2.2. Construct the Semantic Integration Mechanism of Multi-Source Heterogeneous Teaching Resources

The semantic integration of multi-source heterogeneous teaching resources constitutes a foundational capability for overcoming fragmented information architectures and enabling coherent pedagogical knowledge organization [11–13]. A comprehensive framework has been systematically developed, encompassing standardized semantic annotation protocols, domain-specific association logic, and scalable technical infrastructure. Central to this framework is the design of context-aware semantic association rules grounded in conditional trigger mechanisms: when linguistically co-occurring terms—such as 'platform responsibility' and 'consumer protection'—appear within a defined textual window and collectively exceed empirically calibrated frequency thresholds, the system initiates automated linkage to higher-order conceptual nodes, such as 'social responsibility', thereby embedding normative educational values within the semantic structure without prescriptive ideological framing. For unstructured textual materials—including lecture transcripts, policy documents, and open educational resources—natural language processing pipelines leverage robust entity recognition and dependency parsing techniques to identify salient concepts and infer relational semantics; validation against manually annotated gold-standard corpora confirms an overall precision-recall balance yielding an entity and relation extraction accuracy of 86.7%. At the implementation layer, Neo4j serves as the persistent graph database engine, supporting efficient storage and traversal of complex ontological relationships. The semantic network generation process follows a two-phase logic: first, domain-specific professional concept nodes (e.g., 'contract formation', 'digital evidence admissibility') are instantiated from curriculum standards and disciplinary taxonomies; second, graph traversal algorithms dynamically map these nodes to corresponding value-oriented educational constructs through weighted path analysis, producing directed semantic edges annotated with confidence scores, contextual relevance weights, and modality indicators (e.g., text, audio, video). This integrated architecture has successfully unified 1265 diverse instructional assets—including statutory provisions, judicial rulings, peer-reviewed scholarly articles, and interactive multimedia modules—into a cohesive, queryable semantic knowledge graph, thereby facilitating cross-modal retrieval, contextual recommendation, and pedagogically grounded associative reasoning.

2.3. Establish a Data-Driven Ideological and Political Teaching Effect Evaluation System

A comprehensive, multi-dimensional evaluation system has been developed to assess ideological and political education outcomes, integrating both quantitative metrics and qualitative interpretive frameworks. This system leverages structured data derived from a domain-specific knowledge graph to support precise, evidence-based assessment [14–16]. To empirically validate its efficacy, a quasi-experimental design was implemented across two parallel undergraduate classes over a 16-week instructional period, involving a total of 86 students. The experimental group received instruction supported by the data-driven evaluation framework, while the control group followed conventional pedagogical practices. As presented in Table 1, comparative analysis reveals statistically significant improvements in key competency domains. Specifically, for cognitive domain assessment, individualized learning profiles are generated by mapping student navigation patterns against the conceptual structure of the knowledge atlas, enabling granular insight into content engagement breadth and coherence. Regarding value-oriented development, a semantic similarity algorithm computes the alignment between students' written reflections during case-based discussions and normative expressions of socialist core values—measured as normalized semantic distance within a pre-trained contextual embedding space. Statistical analysis confirms that the experimental group demonstrates significantly higher performance in value-oriented reasoning ($p < 0.01$) and applied knowledge integration capabilities. Process-oriented evaluation incorporates longitudinal behavioral traces captured within the interactive knowledge atlas platform, including dwell time distribution and interaction frequency at interdisciplinary nodes bridging ideological-political concepts with professional disciplinary knowledge. The convergent validity between this multi-dimensional system

and established instructor-led assessments is confirmed by a Pearson correlation coefficient of 0.83, indicating strong alignment while simultaneously delivering richer diagnostic granularity—thereby facilitating a methodological shift from impressionistic judgment toward empirically grounded, actionable feedback.

Table 1. Post-test Differences in CIPE Learning Effectiveness between the Experimental and Control Groups (N=86)

Measure Dimension	Group	N	Mean	SD	t	p
Knowledge Mastery	Control	43	76.42	8.35	2.14	0.035*
	Experimental	43	81.15	7.12		
Knowledge Transfer Ability	Control	43	72.30	9.10	3.86	<0.01**
	Experimental	43	82.56	8.45		
Value Recognition	Control	43	74.15	7.88	4.52	<0.01**
	Experimental	43	85.32	6.90		

Note: * means $p < 0.05$, ** means $p < 0.01$. Data were derived from the final comprehensive assessment and the Value Recognition Scale (Cronbach's $\alpha=0.87$).

2.4. Implementation Guarantee—Teacher Training and Resource Labeling Tool Design

To ensure the practical transformation and sustained deployment of the knowledge graph system within educational contexts, a dual-track implementation mechanism has been systematically designed—integrating teacher capacity building with purpose-built technological support. At the pedagogical level, a structured 'three-stage and seven-module' training framework was developed to foster progressive competency development: the foundational stage focuses on theoretical understanding of knowledge representation and semantic modeling; the intermediate stage emphasizes hands-on technical operation—including ontology construction, triple extraction, and API integration; and the advanced stage centers on authentic classroom application, such as lesson design leveraging semantic relationships and adaptive resource retrieval. At the technological level, a Web-based visual resource indexing platform was engineered to lower adoption barriers for non-technical educators [4]. This platform incorporates automated feature extraction from multimodal educational assets (text, images, video transcripts) and employs lightweight semantic recommendation algorithms grounded in domain-specific ontologies. Its interface adopts low-threshold interaction principles—drag-and-drop annotation, one-click metadata generation, and real-time visualization of concept linkages—thereby decoupling complex backend logic from frontline usage. Empirical evaluation across ten pilot schools demonstrated a 65% improvement in average resource indexing speed, significantly reduced cognitive load during content curation, strengthened alignment between AI-driven modeling outputs and pedagogical intent, and established a scalable infrastructure for continuous refinement of both instructional practices and system functionality.

3. Conclusion

This study advances a systematic approach to reconfiguring teaching resources for ideological and political education (IPE) in higher education, grounded in the digital transformation of pedagogical infrastructure. By addressing the structural challenges of content fragmentation and conceptual siloing among disciplinary knowledge and value-oriented elements, the research develops and validates a knowledge graph-based architecture. Central to this architecture is a domain-specific ontology that formally models interrelationships between subject-matter concepts and value-laden constructs, alongside a semantic association mechanism that enables context-aware, bidirectional linking across curricular units. Empirical implementation demonstrates measurable improvements in instructional coherence, learner engagement with integrative tasks, and alignment between learning objectives and assessment outcomes. The resulting data-driven framework supports iterative refinement of teaching design, real-time monitoring of pedagogical effectiveness, and standardized evaluation of educational impact—

thereby enhancing process transparency and outcome reproducibility. Importantly, the closed-loop system facilitates scalable adaptation across diverse academic disciplines and institutional contexts without requiring bespoke technical development. Future work will explore longitudinal fidelity of knowledge graph representations, cross-institutional interoperability standards, and automated validation protocols for semantic consistency. This contribution provides a robust, transferable foundation for advancing intelligent, evidence-informed practices in IPE delivery.

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