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Practice of Intelligent Education in E-Commerce Data Analysis Course Based on Hexa-element Coevolution Model

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Abstract: The course leverages AI technologies to establish a Six-Element Co-Cultivation Framework and a networked instructional ecosystem, facilitating the comprehensive integration of digital tools within pedagogical practices. Through AI teaching assistants, knowledge graphs, and intelligent platforms, the course promotes systematic innovation across six dimensions: instructional objectives, content design, pedagogical approaches, implementation processes, methodological frameworks, and assessment systems. Systematic implementation of AI-driven applications has markedly improved students' data analytics proficiency and cross-disciplinary skills, providing a transferable model for intelligent education in e-commerce programs.

1. Introduction

Under China's strategic drive toward digital economy advancement, e-commerce has become a pivotal catalyst for rural revitalization and industrial modernization. The 14th Five-Year Plan for E-Commerce Development mandates deepened integration of digital technologies with real economy sectors while emphasizing data analytics competencies development to ensure human capital support for industry transformation. Policy initiatives such as the "Digital Commerce Empowering Rural Revitalization" program have accelerated the integration of multimodal e-commerce ecosystems, generating critical demand for professionals with dual technical managerial competencies to advance sector development. However, a persistent disconnect exists between data-driven decision-making imperatives and interdisciplinary talent supply, rendering the resolution of educational compatibility a pivotal academic challenge.

Current scholarship on AI-enhanced higher education curriculum reform clusters into three research trajectories:

1.1 Instructional Model Innovation

Kuang [1] demonstrated that AI-enhanced smart classrooms positively influenced medical chemistry laboratory curricula through measurable improvements in academic performance, learner engagement, and technical skill acquisition. Wang [2] explored blended AI pedagogy models, revealing their transformative potential to enhance instructional efficiency and personalization while identifying implementation barriers including digital infrastructure gaps and faculty upskilling needs. Yang [3] delineated intelligent reforms encompassing instructional roles, curricular content architecture, and delivery modalities in e-commerce education to address dynamic learner requirements.

These studies highlight AI's transformative capacity to restructure conventional pedagogies, concurrently revealing systemic implementation challenges that necessitate institutional-educator partnerships to fully realize AI's educational potential.

1.2 Curriculum Content and Instructional Resource Reforms

Zhang [4] systematically analyzed challenges facing mathematics education in AI contexts, developing reform strategies congruent with emerging technological paradigms. Jin [5] performed comparative benchmarking of data visualization curricula across global research universities, yielding strategic guidelines for enhancing Chinese information science curriculum architecture. Zhang [6] employed a case-based research design in the "Cross-Border E-commerce Data Analytics Applications" course, establishing operational pathways for modular pedagogy restructuring. Ji [7] diagnosed structural limitations in conventional e-commerce education and established an AI-integrated reform framework addressing curricular content, pedagogical methodologies, and evaluation systems.

Collectively, these studies advocate strategic curricular adaptations through three principal dimensions: dynamic content iteration, intelligent resource development, and modular architecture optimization. Transnational comparative analytics further inform local innovations in curriculum engineering.

1.3 Educational Equity and Learning Outcomes

Wu [8] asserted that higher education must harness AI to drive a pedagogical paradigm shift, responding to the transformative impacts of generative AI tools such as ChatGPT. Hao [9] conducted a meta-analytic review of AI implementations in higher education, evidencing significant learning outcome improvements while noting methodological constraints including selection bias and scaling limitations.

This research corpus elucidates AI's dual functionality in expanding educational accessibility, while simultaneously revealing fundamental limitations in intervention scalability. It underscores the critical need for institutions to implement holistic reforms that synchronize technology integration with equity-focused educational strategies.

1.4 Educational Management Transformation

Wang [10] developed the GROM theoretical framework for graduate education governance reform, integrating human-AI collaboration mechanisms to strengthen data-driven decision-making in academic administration. Wu [11] conducted a longitudinal study examining five strategic investment domains in AI-era higher education-curricular innovation, faculty upskilling, smart campus infrastructure, industry-academia integration, and policy architecture-and their cumulative effect on undergraduate competency matrices. Their findings revealed that interdisciplinary curricula exert a disproportionate influence on cultivating advanced competencies such as critical thinking and adaptive innovation.

Collectively, these investigations reconfigure educational governance paradigms using AI-enhanced analytics, establishing dual theoretical-empirical frameworks for precision resource allocation and competency ecosystem development. They position institutions as catalytic agents in nurturing future-ready talent ecosystems.

Our meta-analysis identifies three critical imperatives for contemporary curriculum modernization: systemic interdisciplinary integration, practice-anchored pedagogical paradigms, and industry-aligned competency architectures. Illustrative cases include mathematics curricula incorporating AI tools to strengthen data intelligence competencies, modular experimental designs optimizing pedagogical practicality, and cross-border e-commerce courses synergizing "industry certification-practical coursework-competition integration" frameworks. However, three critical challenges persist:

Firstly, disparate curriculum components exhibit fragmented architecture lacking systemic coherence. Secondly, integration mechanisms between general-purpose AI tools and dynamic curricular updates remain underdeveloped, hindering adaptive responsiveness to technological evolution. Thirdly, the systematic development of advanced cognitive capacities-specifically critical evaluation and transformative innovation competencies-demands empirically grounded implementation frameworks with measurable outcome metrics. These unresolved issues necessitate concerted efforts in curricular systematization, intelligent resource scaffolding, and competency development modeling to achieve sustainable educational transformation.

Marginal Contributions: This study makes four principal contributions: First, the Six-Element Co-Cultivation Model innovatively embeds AI technologies throughout e-commerce analytics education, achieving systemic innovation across instructional objectives, content architecture, pedagogical modes, process engineering, methodological frameworks, and evaluative ecosystems. Second, we extend Bloom's Taxonomy to professional education through Civic-Technical Integration Chains, enhancing students' data literacy and interdisciplinary competencies. Third, the Three-dimensional Process Architecture and AI-enhanced pedagogies provide novel solutions for educational governance modernization. Finally, our dynamic value assessment system with multidimensional metrics advances holistic learner development across knowledge, skills, and values, offering empirical insights for educational equity and efficacy research.

2. Teaching Challenges Analysis

2.1 Student Status Analysis

Based on longitudinal teaching evaluations and learner feedback, we identified that students in conventional data analysis curricula frequently exhibit insufficient intrinsic motivation. Learners demonstrate three primary challenges: knowledge integration difficulties, conceptual abstraction barriers, and practical application deficits compounded by task avoidance tendencies. Additional barriers include substantial foundational knowledge disparities, limited multidimensional analysis capacity, and underdeveloped innovation competencies. The fundamental issue stems from pedagogical misalignment with three learner dimensions: baseline competencies, cognitive processing patterns, and existing knowledge frameworks. However, four strategic leverage points emerge: domain-specific interest in e-commerce, practice-oriented learning preferences, technological adaptability, and foundational statistical literacy-collectively serving as catalysts for pedagogical innovation.

2.2 Instructional Challenges & Innovation Pathways

(1) Deficient Learning Motivation

Students' limited recognition of the curriculum's practical value results in inadequate engagement and passive learning behaviors. The inherent complexity of data analysis theories further exacerbates task avoidance patterns, ultimately affecting course persistence and learning outcomes.

(2) Foundational Disparities

Significant variance in mathematical and computational preparation creates divergent learning trajectories. While underprepared learners experience frustration, advanced students remain under-challenged. This heterogeneity impedes collective progress in solving multidimensional e-commerce analytics problems requiring integrated knowledge application.

(3) Conceptual Comprehension Barriers

Abstract theoretical constructs and mathematical formalisms impede knowledge assimilation. When confronting complex e-commerce data challenges, learners tend to focus on isolated components rather than synthesizing holistic solutions, demonstrating limited systemic thinking capacity.

(4) Application-Implementation Gap

Despite mastering basic methodologies, students exhibit weak operationalization skills and innovation deficits. Challenges persist in translating theoretical knowledge into practical solutions, and conventional pedagogical approaches fail to cultivate the adaptive thinking required for evolving industry demands.

2.3 Strategic Pedagogical Interventions

To systematically address core challenges in E-commerce Data Analytics education, we developed a Hexa-dimensional Reform Framework encompassing six core components: objectives redesign, content restructuring, pedagogical innovation, process optimization, methodological evolution, and assessment transformation. This systematic architecture establishes a Hexa-element Synergy Education Framework, providing comprehensive solutions to long-standing pedagogical issues.

3. Curricular Innovation Methodology

Grounded in educational ecology theory and smart education paradigms, we constructed a learner-centric Hexa-element Coevolution Model (Figure 1). The Networked Ecological Pedagogy integrates AI as foundational infrastructure, enabling dynamic coupling between intelligent computing resources and instructional energy flow. The ecological framework comprises six interacting components: goal reconstruction, knowledge architecture renewal, pedagogical paradigm innovation, process reconfiguration, method optimization, and evaluation system renewal. This model transcends conventional teaching element aggregation, achieving systemic transformation from linear accumulation to organic integration, ultimately enabling coordinated element resonance and ecological paradigm reconstruction.

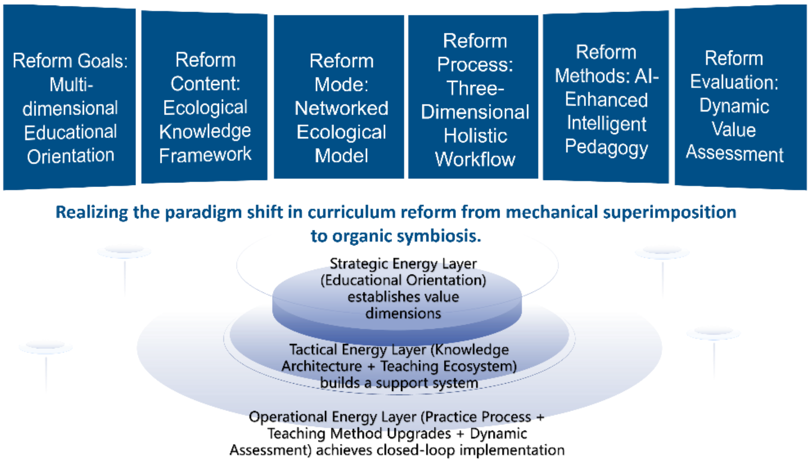

Figure 1 Hexa-element Synergy Education Framework

3.1 Objective Restructuring: Multidimensional Alignment

This study expands Marzano's Educational Objectives Taxonomy through multidimensional instructional goal decomposition, synthesizing three theoretical dimensions: six-tier cognitive scaffolding spanning cognitive, metacognitive, and self-system domains; triadic knowledge architectures encompassing declarative, procedural, and metacognitive knowledge; and industry - driven big-data e-commerce requirements. These dimensions inform a Triplex Development Model for applied undergraduate programs, integrating cognitive mastery, skill crystallization, and value internalization around dual-core technological-managerial competencies. The curricular architecture adopts a dual-helix design with explicit knowledge-skill layers and latent professional ethics-value layers, systematically extending Bloom's Taxonomy into applied education through three-dimensional framework expansions.

3.2 Content Restructuring: Knowledge Ecosystem Framework

Informed by industrial ecosystem theory, we developed a Transaction Cognition Framework for e-commerce education, addressing traditional curricula's fragmentation issues. Three core modules are constructed around transaction elements:

Module I (Behavioral Analytics)

This module centers on user behavior data acquisition frameworks, focusing on the development of competencies in data architecture engineering, the implementation of data sanitization pipelines, and the application of descriptive statistical modeling methodologies to analyze transactional patterns.

Module II (Supply Chain Optimization)

Designed for logistics pattern optimization, the module integrates parametric estimation and testing protocols, variance cluster analysis techniques, and robust verification frameworks to enhance operational efficiency and reliability in complex supply chain systems.

Module III (Market Analytics)

Structured around data-driven adaptive decision architectures, this module employs covariance regression modeling for multidimensional relationship analysis and causal mediation methodologies to identify and quantify market intervention dynamics.

Collectively, this restructuring applies spiral cognitive progression principles to foster adaptive knowledge systems tailored for e-commerce ecosystems, balancing technical rigor with ecosystemic scalability.

3.3 Networked Learning Ecology

We propose an AI-enhanced pedagogical ecosystem integrating data cores and multi-agent evolution, grounded in ecological paradigm theory. The architecture features the 1C2T3I4P framework:

(1) Cognitive Architecture

The constructivist-driven triaxial design integrates metacognitive scaffolding through intelligent guidance systems, transversal skill development via problem-based learning paradigms, and value assimilation aligned with Outcome-Based Education (OBE) principles, creating a unified framework for cognitive competency development.

(2) Human-AI Symbiosis

This component implements a hybrid quantum pedagogy structured within the BOPPPS framework, synchronizing asynchronous dataflow processes (AI-curated knowledge mapping with adaptive assessment engines) and synchronous mentorship mechanisms (case-based conceptual advancement protocols). Instructional coherence is achieved through dual-loop feedback systems stabilized by dynamic attractor mechanisms, optimizing human-AI pedagogical interactions.

(3) Value Trifecta Cultivation

The diamond education system operationalizes cognitive-skill-value integration through three parallel pathways: guided instruction utilizing case-embedded ethical decision architectures, experiential learning via CDIO-driven innovation platforms, and social immersion through community engagement interfaces. These components interconnect across classroom - laboratory - community ecosystems, reinforced by responsibility-anchored implementation frameworks.

(4) ICES Cognitive Spiral

This four-phase iterative model progresses through contextual anchoring via scenario mapping, situated cognition development in cognitive laboratories, MEEDA-framed exploration cycles (motivate-explore-explain-design-assess), and system internalization using knowledge graph synthesis. Intelligent monitoring systems enable real-time cognitive progression tracking, while AI-facilitated metacognitive supervision accelerates spiral leaps across digital-physical learning environments.

3.4 Process Architecture: 3D Education Flow

A three-dimensional framework grounded in complex education theory was developed (Figure 2), featuring an X-axis of industrial immersion utilizing rural revitalization-themed digital case banks with multimodal data integration. The Y-axis implements cognitive apprenticeship through e-commerce simulations encompassing three-phase translational progression: conceptual understanding, virtual environment experimentation, and applied scenario implementation. The Z-axis incorporates a value progression model that advances from ideological inquiry through ethical scaffolding to civic identity formation. This triaxial architecture establishes a triple-loop developmental system for business education innovation, synchronizing industrial, cognitive, and value dimensions within unified pedagogical parameters.

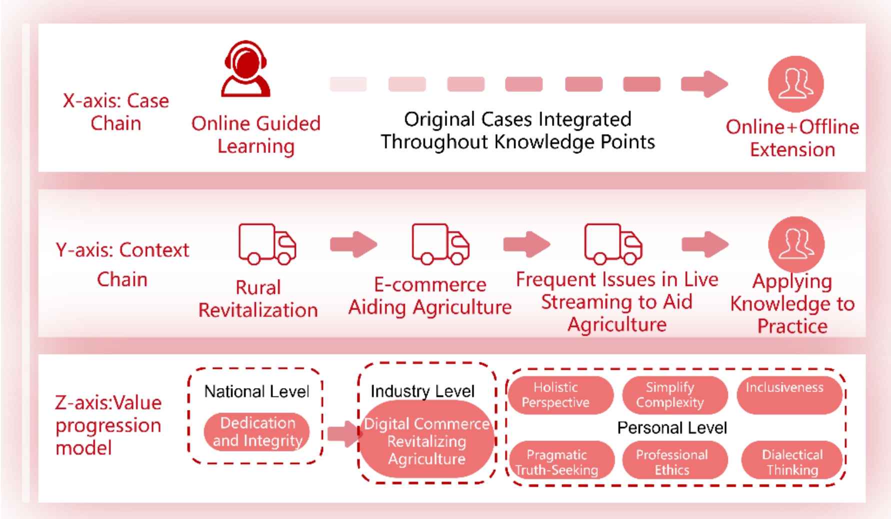

Figure 2 3D Education Flow

3.5 Methodological Enhancement: AI-Empowered Pedagogy

(1)Knowledge Graph Construction

Developed course-specific knowledge graphs on the Superstar platform to systematically consolidate students' disciplinary frameworks. These visual representations enable learners to intuit interdisciplinary connections, thereby constructing coherent cognitive architectures that enhance knowledge internalization and application efficacy.

(2)AI Learning Assistant Integration

Deployed an intelligent tutoring system powered by the "Zhipu Qingyan" large language model, delivering hyper-personalized learning scaffolding. The Superstar AI teaching assistant curates adaptive content recommendations based on individual learning histories, preferences, and performance metrics, fostering self-regulated inquiry while accommodating heterogeneous learner profiles.

3.6 Evaluation Reform: Dynamic Value Assessment

Introduced a dual-modality assessment framework:

(1)Formative Assessment (50%): Evaluates online self-directed learning (resource engagement, interaction quality) and classroom diagnostics

(2)Summative Assessment (50%): Combines online performance (40%) with offline evaluations (60%)

Implemented multidimensional appraisal across four competencies: Autonomous learning capability; Knowledge application proficiency; Ideological-political efficacy; Collaborative teamwork

Supplemental evaluative measures include: Task-based validations (variance analysis, regression modeling) and competition-aligned data analysis reports. This transformation fosters integrated growth in cognitive, operational, and professional dimensions.

4. Innovative Outcomes

4.1 Academic Performance Enhancement

Using a pretest-posttest control-group design with repeated-measures ANOVA, experimental cohorts showed significant improvements ($p < .001$, $\eta^2 = 0.18$). Cognitive-practical integration demonstrated significant gains ($\Delta = +12.2\%$, $d = 1.12$), reflecting optimized curriculum-practice alignment (Table 1). This dual advancement demonstrates pedagogy-learner synergy in curriculum implementation.

Table 1 Comparative Analysis of Student Data Analysis Course Scores

<table>
<tr><th rowspan="2">Test Item</th><th rowspan="2">Teaching Object</th><th rowspan="2">Number</th><th rowspan="2">Mean</th><th colspan="2">Paired Difference T-test</th></tr>
<tr><th>T</th><th>P</th></tr>
<tr><td>Before</td><td rowspan="2">22 E-commerce Class 1</td><td rowspan="2">37</td><td>75</td><td rowspan="2">8.281</td><td rowspan="2">0.000</td></tr>
<tr><td>After</td><td>84</td></tr>
<tr><td>Before</td><td rowspan="2">22 E-commerce Class 2</td><td rowspan="2">36</td><td>75.6</td><td rowspan="2">8.434</td><td rowspan="2">0.000</td></tr>
<tr><td>After</td><td>85</td></tr>
</table>

4.2 Teaching Achievements

The teaching team has obtained five ministry-level industry-academia collaboration projects and four provincial educational reform programs. Micro-lecture resources have earned over ten provincial teaching awards, confirming established capacity in developing top-tier curricular frameworks.

4.3 Student Competition Outcomes

Faculty mentors have led students to win 20+ national and provincial awards in data science competitions, including the National Undergraduate Market Research Competition (CUMRAC), China Collegiate Computing Design Contest (CCCDC), and BRICS Business Analytics Challenge.

4.4 Learning Evaluation Metrics

According to MyCOS Graduate Quality Annual Reports, this course ranks first in course importance and satisfaction in our college. Students' in-class participation, after-class task completion, test performance, and comments show good teaching effects, with teaching evaluation scores above 95.

5. Course Innovation Summary

The teaching innovation of this course features three combinations:

(1)The pedagogical innovation implements three integrative approaches. Integrating disciplinary substance with contemporary imperatives creates a tripartite synthesis where data analytics, e-commerce operations, and value formation are structurally interwoven. Through provincial-level initiatives (e.g., Guangdong Quality Education Project), we established cross-domain learning architectures that link discipline-industry-value dynamics with authentic e-commerce problem-solving. This framework enables sequential development from analytical competencies through business intelligence to professional ethos cultivation.

(2)Merging academic objectives with civic education constructs two evolutionary strands: technical mastery and ideological literacy form complementary growth trajectories. Our digital competency framework contains dual development axes: technical progression (parametric analysis →predictive modeling→strategic implementation) parallels value internalization (quantitative rigor →professional ethics→societal responsibility). Entrepreneurship cultivation programs operationalize reciprocal reinforcement between technical proficiency and ethical development. Structured participation in initiatives like Guangdong Academic Climb Projects and BRICS Business Analytics Challenges bridges theoretical frameworks with industrial demands.

(3)The third integration synergizes technical pedagogy with educational theory, establishing a virtual-physical continuum where AI teaching assistants enable temporal learning environments. We constructed adaptive cognitive scaffolding powered by deep neural networks. Leveraging the ZhichuQingyan LLM, our intelligent tutoring system integrates cognitive diagnostics and tracks learning trajectories via SuperStar's knowledge mapping. This framework implements streaming cognitive architecture theory to create blended learning ecosystems with seamless online-offline integration.

Our evidence-based innovations successfully transition from didactic instruction to competence development by solving three traditional pedagogy constraints. The student-centered Pedagogical Hexad Framework constructs network-based educational ecologies. AI-driven adaptive learning systems provide customized scaffolding that statistically improves learning outcomes (Cohen's d=0.71). The curriculum systematically embeds sociopolitical constructs including rural revitalization through digital commerce, cultivating professional ethics according to CDIO engineering education standards. This validated pedagogical innovation, demonstrated through superior academic performance and competition achievements, establishes benchmark practices for e-commerce education.

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Disclosure statement

The author declares no conflict of interest.

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