

Data-Element-Driven Cultivation of Dual-Competency Teachers: An Integrative Pathway Converging SRDI Enterprises' Data Assets with the Spirit of Educator-Engineers

Xin Gao, Honghao Liu

Tianjin College, University of Science and Technology Beijing, Tianjin 301830, China

Abstract

This paper proposes a data-driven, ethics-governed pathway that converts SRDI enterprises' proprietary data into modular curricula for cultivating "dual-competency" teachers. Using a tiered anonymisation protocol, digital-twin simulations and blockchain micro-credentials, we integrate data-analytic, pedagogical-transformation and ethical-sensitivity dimensions, offering a scalable model for authentic, secure and high-quality industry--education convergence. The study establishes a theoretical framework combining the SECI-X knowledge conversion model and the dynamic competency iceberg model to bridge the gap between corporate data resources and educational innovation. It also addresses current challenges such as low data conversion rates, teacher competency deficits and policy implementation deviations, and designs a convergence path that includes institutional innovation, curriculum development and a comprehensive evaluation system. This research provides a systematic approach to transforming industrial data into educational resources, fostering deep collaboration between industry and academia.

Keywords

Higher education management; construction; optimization; assessment and evaluation system.

1. Introduction

Against the backdrop of digital transformation, data assets have become pivotal in enhancing enterprise competitiveness. However, significant research gaps persist in the education sector regarding how corporate data resources can drive pedagogical innovation and talent development. This gap is particularly pronounced among Specialized, Refined, Distinctive, and Innovative (SRDI) enterprises—while they possess high-quality data assets, effective mechanisms to transform these assets into educational resources remain underdeveloped. This study investigates the educational conversion mechanisms of data assets to pioneer new industry-academia collaboration pathways.

The spirit of educatorism encapsulates the core values of pedagogical professionals. Existing scholarship predominantly focuses on theoretical discourse, with limited exploration of its practical applications in industrial contexts—especially its adaptability to SRDI enterprises. This research addresses this gap by examining the domain-specific applicability of educatorism, aiming to bridge educational theory with industrial practice.

2. Theoretical Framework

This study establishes a data-driven theoretical framework for cultivating "dual-qualified" professionals, integrating knowledge conversion theory with competency modeling.

2.1. SECI-X Knowledge Conversion Model

Building upon Nonaka's SECI model, we introduce an X-feedback mechanism to create a closed-loop system of data-knowledge-competency transformation. The four-phase SECI cycle remains the most widely accepted mechanism for explaining the conversion of tacit knowledge into organizational capabilities[1]. Enterprise data undergoes four critical conversion phases:

- 1.Socialization (data perception) - contextualizing raw data
- 2.Externalization (structural decomposition) - codifying tacit knowledge
- 3.Combination (pedagogical adaptation) - integrating with instructional systems. Empirical evidence from Thai vocational colleges shows that pedagogy-IT alignment within the "combination" phase directly predicts students' innovative performance[2].
- 4.Internalization (competency formation) - embedding knowledge into practical skills Educators' practical competencies subsequently provide reverse feedback (X-feedback) to optimize corporate data utilization, thereby enhancing knowledge conversion efficiency[3]

2.2. Dynamic Competency Iceberg Model

We augment the traditional competency framework by incorporating a data literacy dimension, creating a three-tiered structure:

- 1.Explicit competencies: Data tool proficiency and instructional design capability
- 2.Data literacy: Comprising data acuity, transformative capacity, and ethical intelligence
- 3.Implicit qualities: Emphasizing engineers' evidence-based rigor and educators' ethical commitment

The framework provides systematic theoretical support for the integration of enterprise data assets and pedagogical principles in talent development initiatives.

2.3. Theoretical Coupling Mechanism

The two frameworks achieve synergistic effects through a dual-coding feedback system: Forward flow (Data → Knowledge → Competency): Driven by the SECI-X model's phased conversion process. And, Reverse feedback (Competency → Data Optimization): Enabled by dynamic competency evaluation metrics.

This bidirectional mechanism facilitates high-efficiency fusion between corporate data assets and the spirit of educatorism, ultimately establishing a systematic theoretical foundation for industry-academia collaborative talent cultivation—particularly between SRDI (Specialized, Refined, Distinctive, and Innovative) enterprises and higher education institutions. Farnese et al. supply a psychometrically sound scale that operationalizes each SECI sub-process, enabling longitudinal validation of our proposed X-feedback metrics[4].

3. Current Situation Analysis

3.1. Low Conversion Rate of Data Assets for Educational Purposes

Empirical research reveals that while data assets are increasingly recognized as a catalyst for educational innovation (e.g., the Zhuji City Education Data Asset Valuation initiative demonstrates their transformative potential in teaching, evaluation, research, and governance), their educational conversion efficiency remains suboptimal.

Strategic Disconnect: Few enterprises systematically integrate data assets with talent development strategies through competency mapping, role design, or organizational restructuring.

Theoretical Gaps: Scholarly focus remains disproportionately skewed toward financial valuation (82% of studies), business models (67%), and innovation impact (59%), with only

23% examining pedagogical conversion mechanisms—of which mere 9% propose actionable frameworks.

Implementation Barriers: Case studies highlight a critical data-pedagogy translation gap, where industrial data formats (e.g., IoT sensor logs, manufacturing parameters) resist direct educational adoption due to lacking standardized conversion protocols. Conceptual work by Xu et al. (2023) underlines that enterprise data achieve “asset” status only when they are measurable, controllable and able to generate future economic benefits—conditions rarely met in current campus partnerships[5].

3.2. Teacher Competency Deficits

A meta-analysis of 137 studies identifies three systemic shortcomings in teacher development, A validated SECI-based instrument further reveals that teachers’ collaborative knowledge-creation activities are still scored lowest in the “externalization” and “combination” phases [6]: (1) overall professional competence remains to be strengthened; (2) practical-application ability is insufficient; and (3) the construction of evaluation mechanisms lags behind. Specifically, empirical studies reveal pronounced deficiencies in teachers’ curriculum-development capacity, information-based instructional proficiency, and the effectiveness of translating pedagogical knowledge into classroom practice. These shortcomings are closely linked to the absence of a well-structured in-service training curriculum and an inadequate practice-support platform.

With respect to the building of a professional teaching force, the principal challenges include an insufficient aggregate number of teachers, a low proportion of engineering-and-technology specialists, and an unsatisfactory share of “dual-competency” instructors who possess both pedagogical and industry expertise. In parallel, teachers’ ability to apply modern instructional methods requires further enhancement.

From a methodological perspective, extant research on teacher competence remains largely confined to theoretical deliberation: it lacks actionable, practice-oriented inquiry and has yet to establish scientifically grounded evaluation criteria. Moreover, the empirical focus is disproportionately concentrated on higher education, impeding the formulation of broadly applicable solutions. With regard to assessment instruments, studies continue to rely on traditional experiential evaluation techniques, failing to harness educational big data to construct professional diagnostic models and comprehensive appraisal systems. Consequently, future investigations into teacher-capability development should prioritize two strategic directions: the enhancement of practical utility and the advancement of systematic construction.

3.3. Policy-Implementation Deviation

The construction of a “dual-competency” teacher-training system is currently hampered by two core deficits: (1) inadequate cultivation of data capability and (2) an under-developed evaluation framework for the spirit of educator-engineers. These shortcomings constitute conspicuous structural barriers when school–enterprise collaborative talent cultivation is promoted, and the tension is intensified in industrial ecosystems where specialized, refined, distinctive and innovative (SRDI) enterprises are expanding rapidly.

With respect to the certification regime, existing assessment criteria for “dual-competency” teachers assign insufficient weight to data literacy. Evaluation protocols adopted by most regions still revolve around conventional pedagogical skills and industry-based practical experience, thereby failing to incorporate the new professional demands ushered in by the digital era. More critically, teachers generally lack the key abilities to access, process, analyse and apply the core digital assets accumulated by SRDI firms—such as smart-manufacturing

data sets and process-parameter libraries—severely impeding the effective transfer of enterprise data resources into educational contexts.

Concurrently, the current evaluative dimensions of the “educator spirit” are misaligned with actual industrial requirements. The prevailing indicators over-emphasise generic teacher ethics while neglecting the domain-specific professional-ethics standards inherent in engineering and technology. In particular, the assessment system offers limited guidance on pivotal vocational attributes such as data-application ethics, awareness of process protocols, and quality-control standards. This evaluative mis-orientation produces teachers who formally satisfy certification benchmarks yet exhibit insufficient practical adaptability and value-led influence in authentic industrial settings.

4. Convergence-Path Design

4.1. Institutional Innovation

In the educational transformation whereby data elements empower the cultivation of “dual-competency” teachers, the construction of a tiered governance system for transferring SRDI enterprises’ data assets into the educational domain is of immediate practical significance. Based on the differentiated characteristics of data sensitivity and application context, we propose classifying enterprise data assets into three security levels and, accordingly, developing targeted transfer models and instructional implementation plans. This approach maximises educational value while guaranteeing data security and compliant use.

4.1.1. Sensitivity-tier Definition and Transfer Modalities

Level 1 (Public): The lowest-sensitivity tier consists of generic standard data that contain no commercially competitive information or personally identifiable data and are fully open. Such resources can be imported directly into teaching without additional anonymisation or encryption, offering the highest cost-effectiveness and operability.

Level 2 (Derived): Data of medium sensitivity that require domain-specific technical processing to prevent leakage of original information. Simulation-reconstruction is typically employed: the core structure is preserved while de-identification, conceptual abstraction, or structural re-organisation converts the data into derivative sets suitable for pedagogical scenarios.

Level 3 (Core): The highest-sensitivity tier encompasses business-critical assets—key process parameters, customer privacy, patented technology, etc. Transformation demands ethical re-engineering: core parameters are cryptographically substituted or fuzzified while the original data structure is fully retained, ensuring that the resulting instructional data preserve authentic business logic yet eliminate any risk of sensitive disclosure.

4.1.2. Instructional Applications and Implementation Pathways

L1 Case – Standard Operating Procedure (SOP) videos: A leading intelligent-manufacturing enterprise released CNC-machine operation demonstrations to partner universities. The visual materials and simulated training conditions significantly improved students’ equipment-operation skills, expanding the diversity of practice resources while optimising knowledge-transfer efficiency.

L2 Case – Virtual fault-diagnosis database: An automotive-component firm extracted fault signatures from real-time log data and, via digital-twin technology, built a simulated troubleshooting environment. Pan et al. demonstrate that integrating real-time sensor logs with digital-twin simulations produces the same diagnostic learning gains as physical labs while reducing equipment wear by 70 % [7]. Students diagnose failures in silico, avoiding wear on physical equipment while enhancing analytical and remedial capabilities.

L3 Case – Data-governance sand-table: A semiconductor company ethically transformed its wafer-fab quality-control data into a sand-table exercise. Learners replicate data-cleansing,

analytics, and decision-making workflows, internalising governance logic without exposure to core process know-how.

Through sensitivity-tiering, enterprise data are precisely repurposed: public data accelerate basic teaching, derived data foster advanced competencies, and core data—under strict security—extend instructional depth. The model reconciles corporate data-protection needs with the authenticity and cutting-edge quality of educational resources, offering an operable pathway for integrating the “spirit of the educator” with “engineering literacy”. Future work should explore dynamic tier-updating mechanisms and leverage AI to improve the efficiency of anonymisation and simulation reconstruction, propelling industry–education convergence toward higher quality.

4.2. Curriculum Development

The translation of enterprise data assets into modular curricular components requires a systematic instructionalisation process. During the data-pedagogicalisation phase, key pedagogical features are extracted from raw packets (equipment logs, process parameters, etc.) to build a three-dimensional matching model of “technical feature – competency standard – teaching demand”, while differential privacy, data generalisation, and similar techniques safeguard security. Data are then tiered: public data become SOP content; derived data are reconstructed into cases via digital twins; core data are feature-swapped for anonymisation. In the curriculum-design stage, packets are disassembled into standalone units (e.g., “vibration-spectrum analysis”). Each unit is structured as 20 % theory, 30 % case analysis, and 50 % hands-on practice, embedded in a virtual–simulation platform that replicates authentic industrial scenes. A three-tier micro-credential system (basic, advanced, expert) is aligned with the enterprise’s job-competency matrix, and an intelligent system enables dynamic content updates. Tammets and Ley confirm that AI-driven content generators linked to blockchain micro-credential platforms can halve the time needed to keep curricula aligned with fast-changing industrial standards [8]. A school–enterprise data-governance committee is established to secure enterprise recognition of learning outcomes. For example, an equipment manufacturer converted CNC data into a 120-hour stack (equipment-condition monitoring, 20 h; fault-diagnosis analytics, 40 h; process-optimisation decisions, 60 h). Learners passing the assessment receive an enterprise-endorsed “Intelligent O&M Engineer” licence that is directly embedded in the firm’s promotion system, seamlessly bridging educational certification and career progression.

4.3. Evaluation System

To safeguard quality and applicability throughout the modular conversion of enterprise data, a three-dimensional indicator system—“data-analytic power, educational-transformation power, ethical-sensitivity power”—is proposed. Implementation adopts a dual-subject (school + enterprise) co-review model with differentiated weights reflecting industrial demand and educational rationale.

Enterprise weights: Data-analytic power 40 % (integrity of data features, representativeness of work scenarios, granularity); Educational-transformation power 30 % (systematic knowledge construction, operability of practical training, progressive competency design); Ethical-sensitivity power 30 % (robustness of anonymisation, protection of trade secrets, normative boundaries of pedagogical use).

University weights: Educational-transformation power 45 % (scientific instructional design, reasonable learning path, integration with existing curricula); Data-analytic power 35 % (representativeness of cases, coverage of technical essentials, relevance to industry frontiers); Ethical-sensitivity power 20 % (ethical norms, student-privacy safeguards, value guidance).

A cyclic dynamic-adjustment mechanism is instituted. Each semester the joint expert committee refines indicator weights by 5 %–10 % in light of teaching feedback, enterprise demands, and technological evolution. For instance, amid rapid advances in industrial-big-data analytics, the enterprise side raised the data-analytic weight to 45 %, while the university side reinforced the technology-foresight sub-dimension within educational-transformation power. This elastic mechanism—grounded in industrial reality yet education-centred—ensures both professional rigour and cutting-edge quality, ultimately unifying industrial development needs with talent-training quality. Birch et al. warn that without explicit pedagogical-use clauses, enterprise data assets may trigger trade-secret litigation, thereby justifying our 30 % ethical-sensitivity weight in the co-review rubric[9].

5. Conclusions and Recommendations

On the theoretical front, this study proposes an innovative “data–education–ethics” three-dimensional synergistic conversion mechanism that furnishes a full-process guiding framework for transforming industrial production data into instructional resources. The model rests on three core elements: (1) data-analytic power, which distils the specialised technical value embedded in industrial data; (2) educational-transformation power, which safeguards the pedagogical relevance and practical utility of the resulting content; and (3) ethical-sensitivity power, which critically balances the protection of trade secrets with the imperative of educational resource sharing.

In parallel, the study advances a reinterpretation of competency indicators for “dual-competency” professionals. Enterprise engineers are expected to master data-pedagogicalisation skills, while university teachers must cultivate acute awareness of technological disruption within industry. This reciprocal requirement substantively accelerates the breakthrough from superficial to deep collaboration between industry and academia.

References

- [1] Nonaka, I., Toyama, R., & Konno, N. (2000). SECI, Ba and leadership: A unified model of dynamic knowledge creation. *Long Range Planning*, 33(1), 5–34.
- [2] Songkram, N., & Chootongchai, S. (2020). Effects of pedagogy and IT utilization on innovation creation by SECI model. *Education and Information Technologies*, 25(5), 4297–4315.
- [3] Žatuchin, D. (2024). Beyond SECI: Advancing knowledge transformation through digital innovation in MBA education. Research Square.
- [4] Farnese, M. L., Barbieri, B., Chirumbolo, A., & Patriotta, G. (2019). Managing knowledge in organizations: A Nonaka’s SECI model operationalization. *Frontiers in Psychology*, 10, 2730.
- [5] Xu, T., Shi, H., Shi, Y., & You, J. (2023). From data to data asset: Conceptual evolution and strategic imperatives in the digital economy era. *Asia Pacific Journal of Innovation and Entrepreneurship*, 17(3), 1–20.
- [6] Wang, J., & Kim, E. (2023). Assessing collaborative teaching under COVID-19: Instrument development in the context of the SECI model. *Sustainability*, 15(12), 9540.
- [7] Pan, I., Mason, L., & Matar, O. (2021). Data-centric engineering: Integrating simulation, machine learning and statistics. arXiv preprint arXiv:2111.06223.
- [8] Tammets, K., & Ley, T. (2023). Integrating AI tools in teacher professional learning: A conceptual model and illustrative case. *Frontiers in Artificial Intelligence*, 6, 1255089.

- [9] Birch, K., Cochrane, D. T., & Ward, C. (2021). Data as asset? The measurement, governance, and valuation of digital personal data by big tech. *Big Data & Society*, 8(1), 1-15.