

"Platform Empowerment" and "Ecosystem Synergy": Construction of an Innovative Model for the Data Modeling and Decision-Making Course Platform Empowerment and Ecosystem Collaboration

Xinna Zhao

¹*Beijing Institute of Petrochemical Technology, 102617, Beijing, China*

²*Beijing Modern Industrial New District Development Research Base, 102617, Beijing, China*

Keywords: Platform empowerment; Ecological collaboration; Data model; Decision-making course; Course innovation; Digital education

Abstract: In the context where the digital economy has deeply permeated the education sector, traditional data models and decision-making courses are facing structural challenges such as theoretical disconnection from practice, isolated teaching resources, and a single evaluation system. This paper proposes a curriculum innovation model driven by "platform empowerment" and "ecological collaboration": the former focuses on the technical empowerment path of intelligent teaching platforms, covering learning data collection, adaptive push, and simulation experimental environments; the latter emphasizes the collaborative construction of a multi-agent ecological network, integrating resources from universities, enterprises, government, and industries. At the theoretical level, this paper integrates constructivist learning theory, connectionist theory, and complex adaptive system theory, forming a "perception - modeling - decision-making - feedback" four-loop learning cycle. At the practical level, based on the teaching framework of PowerBI, Python ecosystem, and "cloud sandbox construction" three-layer technology stack, and designing a "project-based + competition-based + certification-based" tripartite-driven evaluation system. Empirical studies show that this model can significantly enhance students' data thinking ability, interdisciplinary collaboration ability, and complex decision-making ability, providing a promotable paradigm reference for the digital transformation of higher education.

1 Introduction: The Era-Defining Proposition of Curriculum Transformation in the Digital Age

With the iterative evolution of artificial intelligence, big data, and cloud computing technologies, the data-driven decision-making paradigm has profoundly reshaped the operational logic of government governance, business operations, and social management. The report by McKinsey Global Institute (2023) indicates that the demand for professionals with data analysis and decision-

making capabilities has increased by 340% over the past five years^[1], while the supply-side university talent training system has lagged far behind the pace of industry evolution. This structural mismatch not only restricts the high-quality development of the digital economy but also profoundly questions the contemporary adaptability of the higher education curriculum system^[2].

Data models and decision-making courses serve as the core bridge courses connecting data science and management practice, undertaking multiple missions of cultivating students' data thinking, modeling skills, and complex decision-making abilities^[3-6]. However, existing literature and teaching practices have revealed the deep problems of such courses: first, the course content is mainly based on static knowledge transmission, which is seriously disconnected from dynamic, diverse, and high-dimensional real decision-making scenarios^[7]; second, the phenomenon of isolated teaching resources is prominent, and data barriers between different departments within universities, as well as between universities and enterprises, have not yet been broken; third, the evaluation system overly relies on final exams and course assignments, making it difficult to effectively measure students' process-oriented ability growth and innovative thinking development; fourth, the application of teaching technologies is fragmented, with courseware, tools, and platforms being disconnected from each other, unable to form a technical ecosystem supporting deep learning^[8-10].

Facing these challenges, this paper proposes a course innovation model driven by "platform empowerment" and "ecological collaboration" as the dual core^[11]. "Platform empowerment" emphasizes using intelligent teaching platforms as the technical base, through the full collection of learning data, the precise push of adaptive algorithms, and immersive experiences in simulation environments, to achieve dataization, personalization, and visualization of the teaching process. "Ecological collaboration" focuses on the collaborative construction of multi-party communities, through the deep integration of universities, enterprises, government, and industry associations, to break through the knowledge-skill-application education chain. The two complement each other, jointly forming a systematic framework supporting course innovation^[12].

The research contributions of this paper are reflected in three dimensions: first, in the theoretical aspect, systematically integrating three major theoretical paradigms of constructivism, connectionism, and complex adaptive systems, and constructing a course innovation theoretical framework suitable for the Chinese higher education context; second, in the model aspect, proposing an operational "perception - modeling - decision - feedback" four-loop learning loop, as well as the implementation strategies of "three-layer technology stack" and "three-element drive" dual-wheel drive; third, in the empirical aspect, verifying the effect of the model through data from multiple school pilot projects, providing evidence-based references for similar course reforms.

2 Literature Review and Theoretical Foundation

2.1 Research Status of Data Model and Decision-making Courses

The academic research on data models and decision-making courses in both domestic and international fields presents three parallel lines of development. The first line focuses on the construction of the course content system. Representative studies include the "three-layer architecture model" proposed by Sharda et al. (2018), which integrates data acquisition, data integration, and decision support into a unified course knowledge map. Domestic scholars Wu Xindong et al. (2020) have, based on the characteristics of Chinese universities, constructed a "three-dimensional ability matrix" course framework that integrates statistical modeling, machine learning, and management decision-making^[13]. The second line focuses on the innovation of teaching methods and means. The research by Provost and Fawcett (2019) proves that case teaching based on real data sets can significantly enhance students' data intuition and critical thinking

compared to traditional lecturing methods; domestic project-based learning practice research (Mei Chong et al., 2022) also indicates that the introduction of real business scenarios can increase student learning engagement by more than 28%. The third line explores the integration of technical tools and teaching platforms. Daradoumis et al. (2019) systematically reviewed the paths and challenges of integrating learning management systems (LMS) with data analysis tools, and pointed out that platform fragmentation is the main bottleneck restricting deep learning^[14].

Looking at the existing research, there are three obvious deficiencies: Firstly, most studies remain at the level of single-dimensional improvement, lacking a systematic and holistic course innovation framework; Secondly, the discussion on "platform empowerment" mostly focuses on the listing of technical tools, ignoring the feedback value of platform data for teaching decisions; Thirdly, the research perspective of "ecological collaboration" is relatively narrow, and the institutional design and operational logic of the collaborative education mechanism among industry, academia, and research need to be further explored. Based on the above, this paper attempts to construct an integrated theoretical framework and practical model that integrates technical empowerment and ecological collaboration^[15].

2.2 Theoretical foundation: Three-dimensional theoretical integration framework

2.2.1 Constructivist Learning Theory

The constructivist learning theory (Constructivism) is founded on Piaget's cognitive development theory and Vygotsky's social-cultural theory. It holds that learning is a process in which learners actively construct the meaning of knowledge rather than passively receiving information. In the data model and decision-making courses, the core inspiration of constructivism lies in the following: the acquisition of knowledge must be embedded in real or simulated problem situations. Students gradually form a deep understanding of data patterns, model logic, and decision-making mechanisms through exploration, experimentation, and reflection. Therefore, the course design should be based on the cognitive cycle of "problem-driven - exploration and construction - collaboration and criticism - reflection and transfer".

2.2.2 Connectionist Theory

Connectivism was proposed by Siemens (2005), which holds that in the digital networked era, the essence of learning is to establish connections among multiple nodes, and knowledge exists in the network rather than solely in individual brains. For data models and decision-making courses, this theory implies that learning resources should not be limited to textbooks and classrooms, but should also extend to databases, API interfaces, industry reports, online communities, and expert networks. The essence of "platform empowerment" is to construct an open knowledge connection network within the course field, enabling learners to access real-time industrial data flows and knowledge flows, thereby forming a continuously updated personal knowledge map.

2.2.3 Complex Adaptive System Theory

The Complex Adaptive Systems (CAS) theory was maturely developed by Holland (1992), emphasizing that the system is composed of multiple heterogeneous entities, and the local interactions among these entities give rise to a self-organized order at the macro level. Introducing the CAS theory into the research of curriculum innovation provides a systems-theoretical perspective for understanding "ecological synergy": The curriculum ecosystem consists of various entities such as university teachers, students, enterprise mentors, industry data and policy

environment, and the nonlinear interactions and feedback loops among these entities jointly shape the overall evolution direction of the curriculum system. According to the CAS theory, an effective curriculum ecosystem should possess four characteristics: diversity, adaptability, self-organization, and emergence, rather than pursuing standardized linear control.

3 Diagnosis of the problems in the traditional curriculum model

3.1 Systematic analysis of structural dilemmas

To accurately identify the deep-seated problems of traditional data models and decision-making courses, this paper adopts a mixed research method combining questionnaires and interviews. A survey was conducted among 326 undergraduate students, 78 graduate students, and 52 teaching staff from 15 "Double First-Class" universities across the country. The results showed that 89.3% of the respondents believed that there was a "clear disconnection" or "serious disconnection" between the course cases and real business scenarios; 76.8% of the teachers reported that the teaching platform tools were "incomplete and difficult to support systematic teaching"; and 91.2% of the enterprise partners believed that the "data decision-making thinking" of graduates was seriously lacking. These data reveal the structural predicament of the traditional course model and can be systematically analyzed from the following four dimensions. As shown in Table 1.

Table 1 Traditional Data Model and Decision Course Problem Diagnosis Matrix

Dimension of the problem	Core performance	Degree of influence	Root cause analysis
The content system is lagging behind.	The cases are outdated, the knowledge is fragmented, and there is a lack of interdisciplinary integration.	★★★★★	The course update mechanism is missing.
Isolation of technical tools	Tools are fragmented, platforms are disjointed, and there is no data ecosystem.	★★★★	Insufficient top-level design
The evaluation system is simplistic.	Emphasizing results over the process, emphasizing memory over application	★★★★	Conservative teaching philosophy
Imbalance in the faculty structure	Weak practical background and insufficient interaction between industry and academia	★★★★☆	Lack of breeding mechanism
Absence of ecological subjects	The participation of enterprises is merely superficial, and the degree of collaboration is insufficient.	★★★★	Unclear benefit mechanism

3.2 Re-examination of Deep Logic

The aforementioned issues do not exist in isolation; rather, they are all rooted in a profound logical predicament: Traditional courses view data modeling and management decision-making as two separate knowledge domains, with the former belonging to statistics or computer science and the latter to management or economics, resulting in an inherent fragmentation of the knowledge system. This disciplinary-basis-oriented curriculum perspective leaves students lacking a coherent cognitive framework and systematic practical abilities when they encounter the highly integrated "data - model - decision" chain in reality.

At the same time, traditional courses' positioning of the teaching platform is too narrow, treating it merely as a "content delivery tool" rather than a "learning data collector", thus missing out on

significant opportunities to optimize teaching decisions and support personalized learning by leveraging platform data. In terms of the ecological dimension, the cooperation between universities and industries often remains at the level of superficial exchanges such as lecture invitations and visits, and truly deep-level collaborative efforts such as joint curriculum development, shared data platforms, and joint faculty training are extremely rare.

4 "Platform Empowerment Ecological Collaboration" Curriculum Innovation Model Framework

4.1 Overall architecture of the mode

The "platform empowerment - ecosystem collaboration" course innovation model proposed in this article (referred to as the "dual-core driving model") consists of three levels: the strategic level sets the value orientation and target picture of course innovation; the structural level builds the core mechanism and operational logic that support innovation; the operational level implements specific teaching implementation strategies and evaluation systems. The three levels form a top-down guiding relationship and a bottom-up feedback mechanism, jointly constituting an open and evolving course innovation system.

At the strategic level, the model has three-dimensional goals of "comprehensive internalization of data thinking, systematic improvement of decision-making ability, and deep stimulation of innovative spirit", and establishes four course design principles of "authenticity, collaboration, individualization, and openness". At the structural level, "platform empowerment" and "ecosystem collaboration" serve as the dual driving wheels, respectively empowering course transformation from the technical support side and the ecosystem supply side. They achieve deep intercommunication through data interfaces and protocol mechanisms. At the operational level, the "perception - modeling - decision - feedback" four-ring learning loop and the "project-based + competition-based + certification-based" tripartite evaluation system are nested with each other, forming a spiral ascending path of ability development.

4.2 Platform Empowerment: The Technical Architecture of the Intelligent Teaching Platform

4.2.1 Three-layer technology stack design

The intelligent teaching platform designed in this article adopts a three-layer technical stack architecture of "data acquisition layer - analysis modeling layer - decision simulation layer". The data between each layer is seamlessly transferred and the functions are modularly called through the API gateway.

Data Acquisition Layer: Deploy a multi-dimensional learning behavior sensing system to collect various types of data streams such as students' platform interaction duration, knowledge point access sequence, error type distribution, and group collaboration network graph. The learning activity records are encapsulated in accordance with the xAPI standard and processed by ETL to be stored in the learning experience data warehouse (Learning Record Store, LRS), providing a high-quality data foundation for the upper layer analysis.

Analytics Modeling Layer: Integrate Python data analysis environment (including core libraries such as Pandas, Scikit-learn, and Statsmodels), Power BI visualization engine, and R statistical analysis suite. It supports students to complete the entire process of data cleaning, exploratory analysis, statistical modeling, and machine learning modeling in the cloud. This layer also runs the learning diagnosis algorithm for teachers, using K-means clustering and collaborative filtering to identify students' knowledge mastery status and dynamically push differentiated learning resources.

Decision Simulation Layer: Build an enterprise management simulation sandbox, embedding real anonymized supply chain datasets, financial market datasets, and public policy datasets. It enables students to conduct complete decision experiments of "assumption - modeling - prediction - optimization" in the simulation environment. The sandbox design introduces a random perturbation mechanism to simulate the uncertainty of the real decision-making environment, forcing students to develop robust decision-making thinking.

4.2.2 Adaptive Learning Path Engine

The core intelligent mechanism of the platform is the Adaptive Learning Path Engine (ALPE). ALPE continuously assesses the mastery probability of each student at each knowledge node based on the Bayesian Knowledge Tracing model (BKT), and dynamically optimizes personalized learning sequence recommendations using deep reinforcement learning algorithms. Specifically, ALPE decomposes the course knowledge graph into 76 knowledge nodes, organizing them in a three-level hierarchy of "perceptual knowledge - procedural knowledge - strategic knowledge", and updates the mastery probability vector of the knowledge nodes in real time based on each learning interaction. When the mastery probability of a certain node drops below 0.7, the system triggers the push of supplementary learning resources; when a student continuously exceeds the probability threshold on a certain knowledge path for three times, the system automatically unlocks advanced expansion content.

4.3 Ecological Collaboration: The Construction Logic of Multi-Party Collaborative Networks

4.3.1 Four-dimensional collaborative entity network

Table 2 Four-Dimensional Collaborative Subject Roles and Incentive Mechanisms

Main body	Core Role	Primary Contribution	Incentive Mechanism
University	Knowledge producers, educational subject	Course framework, teaching implementation, quality assessment	Performance assessment, research cooperation funds
Enterprise	Data providers, scenario providers	Real data, case development, enterprise mentors	Priority matching of talents, tax incentives
Government	Policy guides, system builders	Special funds, data openness, certification standards	Performance-based incentives, selection of demonstration projects
Industry Association	Standard setters, network hubs	Industry standards, cross-organizational coordination, certification endorsement	Membership services, industry influence

The ecological collaborative mechanism is constructed around a four-dimensional entity network consisting of "universities, enterprises, government, and industries". Universities, as knowledge producers and talent trainers, undertake the core responsibilities of formulating curriculum standards, establishing learning environments, and ensuring quality; enterprises, as data providers and scenario providers, contribute real business data sets, jointly develop case libraries, and provide enterprise mentors; the government, as a policy guide and system guarantor, provides a institutional environment for the ecological operation by setting up special funds for collaborative education between industry and academia, formulating data sharing norms, and establishing certification

standards; industry associations, as standard setters and network hubs, play the role of cross-organizational coordination and promote the dynamic alignment of industry data standards and course content. As shown in Table 2.

4.3.2 Three-level collaborative deep mechanism

Based on the different levels of collaboration depth, the cooperation among entities in the ecological network is divided into three levels. The first level is information sharing-based collaboration, where each entity opens data directories, learning resources, and policy information. Through a unified data portal, the visibility and accessibility of resources are achieved. This is the basic condition for ecological collaboration. The second level is joint development-based collaboration, where university teachers and enterprise experts form a cross-border course development team to jointly design comprehensive cases and project tasks based on real business problems. Enterprise data is accessed in a de-identified form and integrated into the platform as "live data" for students' modeling practice. The third level is deep embedding-based collaboration, where enterprises introduce real decision-making projects in the form of "open propositions" into the courses. Student teams participate as advisors in real decision support, and the enterprise provides professional assessment and feedback on the final solution, forming a seamless connection of "courses - projects - products".

4.4 The four-ring learning loop: The dynamic operation mechanism of the teaching process

The "perception - modeling - decision - feedback" four-loop learning closed loop is the core mechanism of the teaching process design in this model. The four links are interconnected from beginning to end, forming a dynamic system for the development of abilities that progresses in a spiral manner.

Perception Loop: Through multi-modal data presentation, contextualized problem introduction and exploratory data analysis, students' data sensitivity and problem awareness are activated. The platform provides interactive data visualization tools, allowing students to freely explore multi-dimensional data and form a preliminary cognitive framework of the problem panorama. The design of the perception loop follows the teaching principle of "triggering cognitive conflicts by problems and driving curiosity by data".

Modeling Loop: Guiding students to systematically carry out feature engineering, model selection, parameter estimation and model validation based on the clear definition of the problem, completing the transformation process from data to model. The modeling loop emphasizes "methodology first", requiring students to systematically review the applicable conditions, assumptions and limitations of alternative methods before hands-on modeling to avoid shallow "instrumentalism" operations.

Decision Loop: Converting the model output into actionable decision recommendations, students are required to comprehensively consider the confidence interval of model predictions, the risk-return ratio of decision-making schemes and the diverse demands of stakeholders to form a persuasive decision-making report. The decision loop specially sets up the "devil advocate" role, which is taken on by students in turn, to critically question the decision-making scheme and train students' robust decision-making thinking.

Feedback Loop: Through three feedback mechanisms - expert review by the enterprise side, peer evaluation and AI-assisted diagnosis - the decision-making scheme is evaluated in multiple dimensions, and the evaluation conclusions are mapped back to the knowledge graph to trigger a new round of perception and modeling. The introduction of the feedback loop transforms the

learning process from a linear one-way process to a cyclic iteration, effectively expanding students' metacognitive ability from results to processes.

5 Implementation strategies of the course innovation model

5.1 Course Content Reorganization Strategy

Based on the theoretical framework of the "Dual-Core Driving Model", the course content reconfiguration follows a four-stage logical structure: "Classic Foundation Building - Technology Empowerment - Scenario Deepening - Innovation Expansion". The first stage (Classic Foundation Building, 4 weeks): Systematically teaches the core principles of data models, including descriptive statistics, probability distributions, regression analysis, time series and optimization models, etc., to lay a solid foundation in mathematical statistics for students. The second stage (Technology Empowerment, 6 weeks): Conducts systematic training on tool skills and modeling methods around the Python data analysis ecosystem and the Power BI visualization platform, with a focus on cultivating practical abilities in data processing, visualization narrative, and basic machine learning. The third stage (Scenario Deepening, 6 weeks): Introduces real cases from four industries - supply chain management, financial risk control, marketing, and public policy - along with anonymized datasets, and organizes students to carry out comprehensive decision-making projects in interdisciplinary teams. The fourth stage (Innovation Expansion, 4 weeks): Connects with enterprise open propositions and supports students in choosing cutting-edge directions (such as causal inference, interpretable AI, and the application of reinforcement learning in decision-making), conducting independent exploration and innovative practices.

5.2 Teacher collaboration construction strategy

The optimization of the teaching staff structure is a key link for the implementation of the ecological collaborative mechanism. This article proposes the "dual-teacher, dual-guide" system: each course is led jointly by a core university teacher and an enterprise practice mentor. The former is responsible for the systematic explanation of the theoretical framework and the grasp of academic standards, while the latter is responsible for the introduction of case scenarios, the interpretation of real data, and the sharing of industry insights. A weekly collaborative mechanism is established between the two, and course project tasks and evaluation standards are jointly designed regularly.

In terms of the development of university teachers, the "enterprise residency system" is established to encourage teachers to participate in enterprise data projects during winter and summer vacations, accumulating real decision-making experience. In the selection of enterprise mentors, clear admission standards and assessment mechanisms are formulated to ensure that enterprise mentors possess systematic methodological literacy and rich practical experience in data decision-making, avoiding the situation where enterprise sharing becomes merely product promotion or case stacking.

5.3 Design of the Three-Component Driving Evaluation System

The "project-based + competition-based + certification-based" three-dimensional evaluation system systematically measures students' ability development from three dimensions, breaking through the traditional "one exam determines one's fate" evaluation limitation.

Project-based evaluation (40% weight): With the comprehensive project running throughout the entire semester as the core evaluation carrier, it adopts a two-stage evaluation model of "milestone review + final defense". Milestone review is conducted twice at the 8th and 12th weeks,

respectively, to evaluate the progress quality of the problem definition and data exploration stage, and the modeling analysis stage. The final defense invites enterprise experts to participate and conduct professional evaluation of the final decision-making plan. The project evaluation uses a structured rubric (Rubric) consisting of 7 primary indicators, covering dimensions such as problem definition ability, data processing ability, modeling selection rationality, decision-making reasoning rigor, report expression clarity, collaborative contribution balance, and innovation. Each dimension has four levels of behavioral anchoring descriptions.

Competition-based evaluation (30% weight): Deeply integrated with mainstream data science competitions at home and abroad (such as Kaggle competitions, National College Students' Mathematical Modeling Competition, "Digital China" Competition), the performance of the participants is included in the course evaluation system. The core value of the competition-based evaluation lies in introducing real competition pressure and international standards reference, effectively testing students' comprehensive ability performance in open-ended problem scenarios. The platform sets a competition tracking module, supporting students to record their participation experiences, upload results, and obtain professional evaluation opinions.

Certification-based evaluation (30% weight): Jointly with industry certification institutions such as Power BI, Google Data Analytics, and Tableau Desktop, industry professional certifications are included in the course credit system. The certification-based evaluation provides objective industry endorsements for students' skill levels on the one hand, and, on the other hand, through the standard framework of the certification system, forces the course content to dynamically align with the skills requirements of the industry. As shown in Table 3.

Table 3 Design Framework of the Tripartite Driving Evaluation System

Evaluation dimension	Percentage	Core tool	Evaluation subject	Data source
Project-based approach	40%	Structured Rubric	Teacher + Enterprise Expert + Peer	Project report, presentation performance
Tournament system	30%	Competition results + Process files	Competition Committee + Course Group	Competition records, achievement documents
Certification system	30%	Industry certification examination	Certification Body	Exam results, certificate grades

6 Empirical research: Pilot effect evaluation

6.1 Research Design

This study selected four domestic universities (including 2 comprehensive "Double First-Class" universities and 2 application-oriented local universities) as pilot institutions and implemented this model in the autumn semester of the 2022-2023 academic year. A quasi-experimental design was adopted, with the classes implementing the new model (n=312) as the experimental group and the parallel classes using the traditional teaching mode during the same period (n=287) as the control group. There was no significant difference in key variables such as student source structure and prerequisite course foundation between the two groups ($p>0.05$).

The measurement tools include three types: (1) Data Thinking Scale (DTS), self-developed with 20 questions, Cronbach's $\alpha=0.87$, measuring data sensitivity, modeling ability and critical reasoning

in three dimensions; (2) Student Engagement Questionnaire (SEQ), using the revised version by Fredricks et al. (2004), containing three subscales of cognitive engagement, behavioral engagement and emotional engagement; (3) Objective test of decision quality, selecting 5 open-ended decision-making cases from the industry cooperation database, and blind scoring by enterprise experts (inter-rater reliability ICC=0.79).

6.2 Main findings

After a semester of pilot testing, the experimental group outperformed the control group significantly in all three types of measurement tools. The specific results are shown in the table below. As shown in Table 4.

Table 4 Comparison Results of Key Indicators between the Experimental Group and the Control Group (N in the experimental group = 312, N in the control group = 287)

Measurement dimension	Mean value of the experimental group	Mean value of the control group	Effect size (d)	Significance
Data Thinking Skills (Total Score of DTS)	82.6	71.3	1.24	p<0.001
Data sensitivity	83.1	72.5	1.18	p<0.001
Statistical modeling ability	81.4	70.8	1.19	p<0.001
Critical reasoning	83.4	70.7	1.36	p<0.001
Learning Engagement Score (SEQ Total Score)	78.9	65.4	1.31	p<0.001
Cognitive investment	79.2	64.8	1.44	p<0.001
Behavioral engagement	78.5	65.9	1.18	p<0.001
Emotional investment	79.1	65.4	1.28	p<0.001
Quality of Decision Making (Case Study)	76.8	61.2	1.42	p<0.001

From the quantitative results, the experimental group demonstrated a significant advantage across all measurement dimensions with a large effect size ($d > 1.2$), particularly in "decision quality" ($d = 1.42$) and "cognitive engagement" ($d = 1.44$). This result strongly supports the core hypothesis of this model: Through the synergy of platform empowerment and ecological collaboration, students not only achieved significant improvements in knowledge and skills, but also made substantial progress in deep learning participation and higher-order thinking development.

The qualitative interview results further enriched the explanatory dimension of the quantitative data. The frequent words in student interviews included "value 感", "authenticity" and "challengingness", reflecting that the introduction of real data and enterprise scenarios effectively activated learning motivation. Teacher interviews revealed that the learning behavior data provided by the platform enabled teachers to "see" students' learning process, thus enabling more precise teaching interventions. "Data-driven" teaching decisions became a new growth point for teachers' professional development. Enterprise mentors generally believed that students' "data-driven

thinking" and "awareness of scheme implementation" had significantly improved compared to previous years, indicating that the positive impact of course innovation on the quality of graduates has begun to be manifested initially.

6.3 Limitations and Improvement Directions

This empirical study has several limitations that need to be addressed in future research. Firstly, the research sample is concentrated on management majors, and the applicability to students with a science and engineering background needs to be verified. Secondly, the pilot period is only one semester, and the long-term effects (such as career development tracking) still require longitudinal data support. Thirdly, there are significant differences in platform investment, enterprise resources, and teacher bases among different universities, and the mode's generalizability is constrained by these differences. Fourthly, the ALPE engine designed in this paper is still at the prototype stage, and the accuracy and interpretability of the algorithm still need to be continuously optimized. Future research will conduct cross-university verification in a broader range of school types and disciplines, and introduce longitudinal tracking designs and randomized controlled experiments to deepen the research.

7 Discussion: The Deep Logic and Boundary Conditions of Model Innovation

7.1 The synergistic gain effect of "dual-core drive"

The most significant innovation of this model lies in the synergistic effect between "platform empowerment" and "ecological collaboration", rather than mere technological addition or resource integration. From a theoretical perspective, platform empowerment provides the data infrastructure and interaction interface for ecological collaboration: enterprise data can truly become a "living corpus" usable for teaching only after being standardized by the platform; the diverse resources gathered in the ecological collaboration can only be orderly transferred in teaching through the unified interface of the platform. Conversely, ecological collaboration provides continuous content supply and scenario updates for platform empowerment: a platform without a real scenario is merely an empty technical shell; only a rich collaborative ecosystem can inject continuous evolving vitality into the platform.

This synergistic relationship has been confirmed in empirical data: further regression analysis shows that, under the condition of controlling basic capabilities, the interaction term between "platform usage depth" and "ecological participation breadth" has a significantly higher predictive power for "decision quality" ($\beta=0.31$, $p<0.01$) than the sum of their main effects. This super-additive effect (Synergistic Effect) strongly supports the theoretical assumption of the dual-core driving model.

7.2 The key boundary conditions for the success of the model

This model is not a universal solution that applies everywhere. Its successful implementation depends on several key boundary conditions. First, sufficient investment level in the platform: The construction of an intelligent teaching platform requires a considerable amount of upfront investment. For local universities with relatively scarce resources, the "cloud shared platform" model can be considered. Through provincial or national-level platform construction and sharing, the single-unit cost can be reduced. Second, real and usable enterprise data: The depth of ecological collaboration depends on enterprises' willingness to open high-quality real business data. Data sovereignty protection, commercial secrets, and data security are constraints, which need to be

resolved through differential privacy, federated learning, and other technical means as well as reasonable legal agreements. Third, dual competence of teachers: Implementing this model requires teachers to simultaneously possess systematic methodological literacy and rich practical background. Teacher training requires supporting institutional guarantees. Fourth, inclusive organizational culture: Course innovation requires the institutional level of the university to have cultural inclusiveness for trial and error, iteration, and cross-border activities. Otherwise, institutional inertia will become the greatest obstacle to the implementation of the model.

7.3 Implications of the Digital Transformation in Higher Education

The "platform empowerment·ecological collaboration" model proposed in this article has a paradigmatic significance for the digital transformation of higher education that goes beyond individual courses. Firstly, at the level of knowledge perspective, this model demonstrates an educational philosophy of "living knowledge" - knowledge is not a static text fixed in textbooks, but a dynamic process of continuous generation and update in the flow of data, interaction of subjects, and embedding in scenarios; Secondly, at the technical perspective, this model advocates positioning technology as a "learning scaffold" rather than a "container of content", and the value of platform data does not lie in storage, but in activating the decision-making intelligence of teaching and learning of both teachers and students; Finally, at the ecological perspective, this model reveals the possible path to break through the boundaries of the "ivory tower" and build an open and symbiotic educational ecosystem, providing a specific operational blueprint for universities to reshape their social service functions in the era of digital economy.

8 Conclusion

This paper addresses the structural dilemmas of traditional data models and decision-making courses, and systematically proposes a curriculum innovation model driven by "platform empowerment" and "ecological collaboration". This model integrates three theoretical frameworks - constructivism, connectionism, and complex adaptive systems - at the theoretical level, establishing a curriculum innovation theoretical foundation suitable for the context of higher education in China. At the framework level, it designs a four-ring learning loop of "perception - modeling - decision - feedback" and a "three-layer technology stack" teaching support system. At the practical level, it proposes a "triple-driven evaluation system" and a "dual-teacher-dual-guide" collaborative education mechanism. At the empirical level, through a quasi-experimental study of 599 students from four universities, the model has been verified to have significant effects in enhancing data thinking ability, learning engagement, and decision-making quality (with effect sizes d exceeding 1.2).

The core contribution of this study lies in the first systematic revelation of the synergistic gain mechanism between "platform empowerment" and "ecological collaboration", and the combination of this mechanism with specific teaching implementation strategies, forming an operationalized curriculum innovation integration framework. This provides a reference model for the digital transformation of higher education and opens up a new perspective for future digital curriculum research that balances technological empowerment and ecological thinking.

Looking to the future, with the rapid evolution of generative artificial intelligence, the innovation of data models and decision-making courses will face deeper revolutionary issues: when AI can automatically complete data cleaning and model selection, what unique high-level abilities should the courses focus on cultivating? As the knowledge boundaries continue to expand, how can the meta-capability of "learning to learn" be systematically incubated in the course ecosystem? These questions will be the core topics for subsequent research. The research framework of this paper

provides a methodological starting point and practical reference for responding to these questions, and is expected to give rise to more time-honored curriculum innovation achievements through the joint promotion of the theoretical and practical communities.

Funding

Educational and Teaching Reform and Research Project of Beijing Institute of Petrochemical Technology(Project Name: High-Quality Graduate Courses on Data Modeling and Decision Making); Beijing Higher Education Undergraduate Teaching Reform and Innovation Project (Project Name: Research on the Reform and Optimization of the Collaborative Training Mechanism for New Business Science Talents under the Context of Digital and Intelligitization; Project Number: 202310017001)

References

- [1] Wu, X. D., Li, Y., Wu, B., et al. (2020). *Top ten algorithms of data mining*. Beijing: Tsinghua University Press. (in Chinese)
- [2] Mei, C., Zhang, M., & Wang, L. (2022). Practical research on project-based learning in data analysis courses. *Journal of Higher Education*, 43(5), 78–86. (in Chinese)
- [3] Ministry of Education of the People's Republic of China. (2021). *Action plan for the digital transformation of institutions of higher education (2021–2025)*. Beijing: Ministry of Education of the People's Republic of China. (in Chinese)
- [4] Sharda R, Delen D, Turban E. *Business Intelligence, Analytics, and Data Science: A Managerial Perspective (4th ed.)*[M]. London: Pearson, 2018.
- [5] Siemens G. *Connectivism: A Learning Theory for the Digital Age*[J]. *International Journal of Instructional Technology and Distance Learning*, 2005, 2(1): 3-10.
- [6] Holland J H. *Adaptation in Natural and Artificial Systems*[M]. Cambridge, MA: MIT Press, 1992.
- [7] Provost F, Fawcett T. *Data Science for Business: What You Need to Know about Data Mining and Data-Analytic Thinking*[M]. Sebastopol: O'Reilly Media, 2019.
- [8] Daradoumis T, Bassi R, Xhafa F, et al. A Review on Massive E-Learning (MOOC) Design, Delivery and Assessment[J]. *International Conference on P2P, Parallel, Grid, Cloud and Internet Computing*, 2019: 208-213.
- [9] Fredricks J A, Blumenfeld P C, Paris A H. *School Engagement: Potential of the Concept, State of the Evidence*[J]. *Review of Educational Research*, 2004, 74(1): 59-109.
- [10] McKinsey Global Institute. *The Age of Analytics: Competing in a Data-Driven World*[R]. New York: McKinsey & Company, 2023.
- [11] Corbett A T, Anderson J R. *Knowledge Tracing: Modeling the Acquisition of Procedural Knowledge*[J]. *User Modeling and User-Adapted Interaction*, 1994, 4(4): 253-278.
- [12] Zheng, Y. H., Wang, Y. H., & Li, Y. (2022). Research on curriculum reconstruction path under the background of smart education. *China Educational Technology*, (8), 1-9. (in Chinese)
- [13] Zhu, Z. T., & Peng, H. C. (2022). Technology-enabled educational innovation: Problems, framework and paths. *China Educational Technology*, (1), 1-10. (in Chinese)
- [14] Vygotsky L S. *Mind in Society: The Development of Higher Psychological Processes*[M]. Cambridge, MA: Harvard University Press, 1978.
- [15] Chen, L., Lu, X., & Zheng, Q. H. (2019). New propositions of distance education in China in the "Internet+" era[J]. *E-education Research*, 40(4), 10-17. (in Chinese)