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From Digital Apprentice to Data-Driven Strategist: A Situated Learning Approach to E-Commerce Education

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Abstract

In response to the growing demand for data-driven competencies in the digital economy, this study develops and implements the "E-commerce Operations and Statistical Analysis Virtual Simulation Experiment" under the framework of China's "New Business Disciplines" initiative. Built on a B2B2C high-fidelity architecture, the platform integrates business operations with statistical modeling through a closed-loop "operate generate analyze decide" data sandbox. Grounded in situated learning and Legitimate Peripheral Participation (LPP), it establishes a digital apprenticeship pathway that guides students from peripheral operational tasks toward central roles as data-driven strategists. A dual-phase design combining case-based and project-based learning provides scaffolding for this progression. Mixed-methods evaluation demonstrates significant improvements in students' data literacy, model application, and strategic interpretation skills, with both process and outcome assessments showing strong results. The study contributes a replicable simulation analysis integration paradigm that effectively bridges the gap between academic theory and practical industry requirements. It offers a scalable pedagogical model for digital curriculum reform and industry university collaboration, providing robust evidence for cultivating data-fluent business professionals in the era of digital transformation.

Keywords Business Simulation Games; Situated Learning; Legitimate Peripheral Participation; Technology-Enhanced Learning; E-commerce Education; Data-Driven Decision Making

1 Introduction: The Digital Imperative for a New Business Pedagogy

1.1 The Global Challenge: Realigning Business Education for the Digital Economy

The ascendancy of the digital economy, characterized by the pervasive influence of big data, artificial intelligence (AI), and ubiquitous connectivity, has fundamentally reshaped the global business landscape. This transformation has created an urgent and widely recognized demand for a new archetype of business professional: one who combines traditional business acumen with sophisticated data literacy and the capacity for data-driven decision-making. Enterprises no longer seek graduates who are merely familiar with

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business theory; they require individuals who can navigate complex digital ecosystems, extract actionable insights from vast datasets, and translate those insights into competitive strategy.

Despite this clear industry demand, higher education in business has struggled to keep pace. A persistent "learning-doing gap" continues to define the transition from university to the workplace, where traditional pedagogical models often fall short. Curricula heavily reliant on static case studies and theoretical lectures frequently fail to provide students with the dynamic, hands-on experience necessary to develop practical skills in a rapidly evolving technological environment. This disconnect results in a significant talent deficit, a concern echoed by international organizations. The Organisation for Economic Co-operation and Development (OECD), for instance, has highlighted that a substantial portion of the workforce lacks the requisite digital skills to operate effectively, even with standard office productivity software, let alone advanced analytical tools. This global challenge necessitates a profound rethinking of how business education is conceptualized and delivered, moving beyond knowledge transmission toward the cultivation of applied, adaptive competencies.

1.2 A National Response: China's 'New Business Disciplines' Initiative

In response to this global imperative, the Chinese Ministry of Education has launched a comprehensive and strategic reform known as the "New Business Disciplines" (新商科) initiative. This initiative represents far more than a simple curriculum update; it is a systemic reimagining of business education designed to align academic training with the concrete demands of the nation's burgeoning digital economy. The core tenets of this reform address the shortcomings of traditional models by mandating a shift towards interdisciplinary integration, particularly the fusion of business with technology and data science ("Business + Tech"). Furthermore, the initiative places a strong emphasis on deepening industry-university collaboration to ensure that pedagogical content and practice remain relevant and forward-looking. The ultimate goal is to cultivate a new generation of "composite" and innovative talent—graduates who possess not only foundational business knowledge but also robust data literacy, critical thinking abilities, and the practical skills to thrive in digitally-native enterprises. The "New Business Disciplines" initiative, therefore, is not an isolated policy but a clear and deliberate national strategy to address the same talent gap identified by global observers. It provides the specific problem context and institutional impetus for the development of innovative pedagogical tools and models capable of realizing its ambitious vision.

1.3 The Proposed Solution: A Virtual Simulation as a Situated Learning Environment

To address the challenges outlined by both global trends and the national "New Business Disciplines" mandate, this paper introduces the "E-commerce Operations & Statistical Analysis Virtual Simulation Experiment". This intervention was developed at Ningxia University as a direct, practical response to the need for a more integrated and experiential approach to business education. The core argument of this paper is that by creating a high-fidelity, risk-free digital environment where students are required to both manage an e-commerce business and analyze the data generated by their own actions, the simulation functions as a modern form of "digital apprenticeship".

This paper aims to provide a comprehensive account of this educational intervention. It will detail the simulation's design and architecture, grounding its innovative pedagogical model in the robust theoretical framework of Situated Learning. It will then present rigorous mixed-methods evidence of the simulation's effectiveness in cultivating the data-driven decision-making competencies that are central to the "New Business Disciplines" paradigm. By doing so, this study offers a replicable and theoretically-informed model for bridging the gap between academic learning and the practical demands of the contemporary digital economy, presenting a case study with relevance for educators and policymakers worldwide who are grappling with the same fundamental challenge.

2 Theoretical Framework: From Experiential Learning to Situated Digital Apprenticeship

2.1 The Efficacy of Business Simulation Games (BSGs) in Higher Education

The use of Business Simulation Games (BSGs) as pedagogical tools in higher education is a well-established and empirically validated practice. A substantial body of research demonstrates that BSGs offer a powerful alternative to traditional teaching methods by providing students with interactive, risk-free environments in which to apply theoretical knowledge.[5] Platforms such as Marketplace Simulations, Capsim, and MonsoonSIM have become mainstays in business schools globally, enabling students to manage virtual companies, make strategic decisions across various functional areas (e.g., marketing, finance, operations), and experience the consequences of their choices in a dynamic, competitive setting.[6] Systematic reviews of the literature consistently affirm the benefits of BSGs. They have been shown to significantly enhance a wide range of learning outcomes, including knowledge acquisition, the development of cognitive and interactive skills, and, most critically, the improvement of strategic decision-making capabilities.[4] By immersing students in realistic business scenarios, BSGs effectively bridge the gap between abstract theory and concrete practice, fostering critical thinking and a holistic understanding of how different business functions are interconnected. However, while the efficacy of BSGs in producing positive learning outcomes is clear, the literature often lacks a deep theoretical exploration of the underlying process of learning that occurs within these complex digital environments. Many studies focus on outcomes rather than the nuanced mechanisms through which students develop expertise.

2.2 From Experiential Learning to Situated Practice: Building a Foundational Layer

The design of the simulation presented in this paper is fundamentally aligned with established learning theories, addressing the need for a robust theoretical underpinning. It is rooted in constructivist principles, which posit that learners actively construct their own knowledge by engaging with and solving authentic problems. The pedagogical flow also mirrors Kolb's (1984) Experiential Learning Cycle, guiding students through a recursive process that includes four stages.[10] First, through **Concrete Experience**, students operate the virtual store, making decisions about pricing, marketing, and inventory. Second, via **Reflective Observation**, they analyze the data generated by their actions, observing sales trends and customer behavior patterns. Third, during **Abstract Conceptualization**, based on their analysis, they form new hypotheses and strategies, such as identifying a new target market or a more effective promotional tactic. Finally, through **Active Experimentation**, they implement these new strategies in the next round of the simulation, testing their hypotheses in a live environment. These theories provide a solid foundation, confirming that the simulation is built upon sound pedagogical ground. To achieve a more profound and explanatory theoretical framing, however, this study adopts the lens of Jean Lave and Etienne Wenger's (1991) theory of Situated Learning.[2] This perspective reframes learning not as the individual acquisition of decontextualized knowledge, but as a fundamentally social process of becoming a member of a Community of Practice (CoP).[14] A CoP is a group of individuals who share a common practice and learn from each other through regular interaction.

2.3 A Framework for Digital Apprenticeship: Legitimate Peripheral Participation (LPP)

Within the Situated Learning framework, the central mechanism of learning is Legitimate Peripheral Participation (LPP).[2] LPP describes the trajectory of a newcomer (a novice) who begins on the periphery of a community, engaging in simpler, observable, and low-risk tasks. Through this legitimate, sanctioned participation, the novice gradually masters the skills, language, and norms of the community, moving towards its core and eventually becoming a full participant or expert. According to this theory, learning is synonymous with this transformative journey of participation and identity formation.

By synthesizing the concepts of BSGs and Situated Learning, this paper proposes a novel theoretical argument: the "E-commerce Operations & Statistical Analysis" simulation is designed to function as a digital apprenticeship, providing a structured and scaffolded environment for students to progress through the stages of LPP. This framework facilitates an analysis that moves beyond simply measuring skill acquisition to understanding how the simulation facilitates a change in students' participation and identity. The transition from the simulation's first phase to its second is not merely a change in task complexity; it represents a structured shift in the student's identity. The simulation's two-phase pedagogical design explicitly maps onto the LPP trajectory. **Phase 1 (Case-Based Learning)** represents the periphery of the e-commerce community of practice. In this stage, students are newcomers learning the fundamental tools (the platform interface), language (e-commerce terminology), and basic procedures (how to list a product, process an order). Their participation is legitimate and guided, and their identity is that of a "student-operator" following a script to gain confidence and foundational knowledge in a low-stakes context. Conversely, **Phase 2 (Project-Based Learning)** facilitates the movement from the periphery toward the core. Here, students engage in the authentic and complex practice of a data analyst and business strategist. They are no longer just following instructions but are tasked with framing a business problem (e.g., customer churn), analyzing complex, self-generated data, and formulating strategic recommendations. This represents a deeper, more central form of participation, where their identity transforms into that of a "novice strategist" exercising autonomy and critical judgment. This LPP framework provides a powerful lens for both designing and analyzing technology-enhanced learning environments. It shifts the focus from the technology itself to the social and participatory learning processes it enables, offering a robust explanation for how a well-designed simulation can cultivate the deep, practical expertise required in the modern business world.

3 Design of the Situated Learning Environment: The 'Data Sandbox' Model

3.1 Architectural Philosophy: High-Fidelity Simulation

The foundational design philosophy of the simulation was to construct a high-fidelity, closed-loop learning environment that authentically replicates the operational and analytical complexities of modern e-commerce. To achieve this, the system was built on a B2B2C (Business-to-Business-to-Consumer) multi-store platform architecture. This model was chosen because it closely simulates the ecosystems of mainstream e-commerce giants like JD.com and Tmall, ensuring that students engage with business logic and user interfaces that mirror real-world industry standards. This commitment to realism provides an authentic context for learning, moving beyond simplified models to a genuine practice field. The technical architecture, built on a robust stack including Python, Flask, Pandas, and Matplotlib, ensures platform stability, accessibility, and scalability for future development.

3.2 Integrated Modules: Collapsing the Operate-Analyze Divide

A signal innovation of the platform is the seamless integration of two core functional modules within a single, unified environment, a design choice that directly counters the fragmented nature of many existing educational tools. This integration is critical to facilitating the core pedagogical loop of the simulation. The first module is the **E-commerce Operations Module**, which provides a comprehensive suite of tools covering the entire lifecycle of managing an online store. It includes functionalities for initial store setup, product and inventory management, order processing, logistics and payment configuration, and the design and execution of various marketing campaigns, such as promotions and coupons. The second module is the

Statistical Analysis Module, which is embedded directly within the platform as a powerful suite of data science tools. This module allows students to perform data preparation and preprocessing, apply various statistical models (including Decision Tree, Logistic Regression, and Random Forest algorithms), conduct model evaluation using standard metrics (e.g., accuracy, recall), and generate interactive data visualizations and reports. By housing these two distinct but deeply interconnected functions within one platform, the design forces students to confront and understand the intrinsic link between operational actions and data-driven insights.

3.3 The "Data Sandbox" Loop: From Action to Insight

The pedagogical centerpiece of the simulation is a self-reinforcing, dynamic learning cycle termed the "Data Sandbox". This loop guides students through the iterative process that defines modern data-driven management: Operate → Generate Data → Analyze → Decide. The process begins with **Step 1 (Operate)**, where students make concrete operational decisions within the E-commerce Operations Module. Actions such as setting product prices, launching a targeted promotional campaign, or adjusting inventory levels are not merely abstract exercises; they are the primary mechanism for creating unique, proprietary datasets. Next, in **Step 2 (Generate Data)**, the simulation platform captures every student action and its market consequences, generating authentic datasets that reflect sales figures, customer behavior patterns, and marketing campaign performance. Each student team thus produces a dataset that is a direct and unique consequence of their own strategic choices. Following this, **Step 3 (Analyze)** has students pivot to the Statistical Analysis Module to mine the very data they just created. They are tasked with identifying trends, modeling relationships, and uncovering the underlying drivers of their business's performance. Finally, in **Step 4 (Decide)**, the insights derived from their analysis—for example, discovering that a specific type of coupon is highly effective at converting a particular customer segment—directly inform their next round of strategic decisions, which they then implement back in the Operations Module. This closed loop transforms students from passive consumers of pre-packaged, static case data into active producers and analysts of dynamic, personalized data. The "Data Sandbox" provides a micro-world where they can safely experiment with strategies and immediately observe and analyze the data-driven consequences, fostering a deep and intuitive understanding of the causal chain connecting business action to business outcomes.

3.4 Scaffolding the LPP Journey: A Dual-Drive Pedagogical Model

To effectively guide students through the complexities of the "Data Sandbox" and facilitate their journey of Legitimate Peripheral Participation, the intervention employs a "dual-drive" pedagogical model that combines Case-Based Learning with Project-Based Learning. The first stage, **Phase 1: Case-Based Learning (Peripheral Participation)**, dedicates the initial four hours of the experiment to structured, case-based learning. Students work in small teams (5-6 members) and assume specific roles (e.g., CEO, Operations Manager, Customer Service) to complete a guided task, such as "Launch and Operate a New Amazon Store". This phase focuses on mastering the procedural knowledge and fundamental skills required to navigate the platform's operational functions. It represents the "peripheral" stage of LPP, where newcomers learn the community's tools and basic practices under clear guidance. The second stage, **Phase 2: Project-Based Learning (Moving to the Core)**, shifts the focus of the latter four hours to open-ended, data-centric projects. A typical project might be "Analyze Customer Data to Identify and Reduce Churn". In this phase, teams are given autonomy to define their research questions, select appropriate analytical models from the platform's toolkit, interpret their findings, and present a formal report with strategic recommendations. This phase emphasizes higher-order cognitive skills such as problem-solving, critical thinking, and strategic interpretation, representing the students' movement toward the "core" practices of the community. This two-phase model provides essential scaffolding, ensuring that students first build a solid foundation of operational competence before progressing to more complex and autonomous analytical tasks, thereby mirroring a natural apprenticeship trajectory. To ensure the instructional design was comprehensive and targeted, each platform function was meticulously mapped to a specific knowledge domain and learning objective. This systematic design process demonstrates that every feature was built with a clear educational purpose, strengthening the claim that this is a rigorously designed learning environment (Table 1).

Table 1: Core Modules and Knowledge Domain Matrix

No.	Knowledge Domain	Corresponding System Module/Function	Core Learning Objective
1	Store Planning & Basic Setup	Store setup wizard, product management interface	Master the process and basic configuration elements of opening an e-commerce store.
2	Store Logistics & Payment Setup	Logistics template configuration, simulated payment interfaces	Understand the construction and management of e-commerce backend support systems.
3	Transaction Simulation & Order Processing	Simulated buyer/seller interaction, order management system	Familiarize with the full order lifecycle management and customer service processes.
4	Store Data Preparation & Preprocessing	Data export and cleaning tools	Learn basic skills for cleaning, organizing, and transforming business data.
5	Store Data Model Identification & Building	Data modeling workbench (with built-in Decision Tree, Logistic Regression, etc.)	Master the use of classification and prediction models to solve business problems (e.g., user churn prediction).
6	Store Data Model Evaluation	Model evaluator (providing accuracy, recall, etc.)	Learn the scientific standards and techniques for evaluating the performance of different data models.
7	Interactive Visualization Generation & Export	Chart generator (bar charts, line charts, etc.)	Cultivate the ability to present and interpret complex data in intuitive graphical formats.
8	Association Rules & Statistical Conclusions	Association rule mining component, report generator	Develop the ability to extract business insights from data analysis results and write formal analytical reports.

3.5 A Holistic Assessment Framework

To ensure that evaluation was aligned with the multifaceted learning goals of the simulation, a comprehensive, multi-dimensional assessment framework was developed. This framework moves beyond traditional, summative examinations to capture a more holistic view of student competency, blending process-oriented evaluation with outcome-based assessment. This approach recognizes and rewards not only the final product of a student's work but also the skills and collaborative behaviors demonstrated throughout the learning process. The alignment of the assessment with the pedagogical philosophy is crucial; by placing a heavy emphasis (60%) on process-based metrics, the framework provides evidence that the intervention values the *how* of learning—the LPP journey—as much as the *what* of learning, reinforcing the paper's theoretical claims (2).

This integrated assessment strategy ensures a comprehensive evaluation of student learning, placing particular emphasis on crucial soft skills such as teamwork and problem-solving. By providing multiple avenues for students to demonstrate their capabilities, it motivates a wider range of learners and fosters a more positive and engaging educational experience.

Table 2: Multi-Dimensional Process and Outcome Assessment Framework

Assessment Category	Weight	Assessment Metrics	Assessment Method
Process Evaluation	60%	Learning Attitude	Classroom participation, timely task completion
		Operational Skills	Platform operation proficiency, procedural correctness
		Method Application	Rationality of data analysis model selection and application
		Collaborative Spirit	Division of labor, communication efficiency within the team
Outcome Assessment	40%	Lab Report	Depth of data analysis, soundness of conclusions, report formatting
		Group Presentation	Quality of presentation slides, clarity of oral delivery, demonstration of teamwork
		Reflections	Depth and originality of learning reflections
		Online Test	Mastery of core knowledge points and skills

4 A Mixed-Methods Evaluation of Learning Outcomes

4.1 Research Design

To empirically validate the pedagogical effectiveness of the virtual simulation, a mixed-methods evaluation was conducted. The quantitative component employed a one-group, pre-test/post-test quasi-experimental design, implemented over the course of a single academic semester. The study was structured around several key elements. The **participants** in the study cohort consisted of 56 undergraduate students enrolled in a business course at the School of Business, Ningxia University; this group participated in the full simulation experiment as part of their curriculum. The **instrument** was a comprehensive assessment developed to measure students' core competencies in data analysis, structured around four key dimensions critical to data-driven decision-making: (1) data cleaning and preparation, (2) statistical modeling, (3) model evaluation, and (4) business interpretation of analytical results. This same instrument was administered at the beginning of the semester (pre-test) and upon completion of the simulation experiment (post-test) to measure changes in competency. For the **Data Analysis**, the quantitative data from the pre-test and post-test were analyzed using a paired-samples t-test to determine if the observed changes in scores were statistically significant. In addition, a separate satisfaction survey was administered to a larger group of students who had used the platform (N=111), with its internal consistency and reliability assessed using Cronbach's alpha. The qualitative component involved the analysis of peer endorsements from other academic institutions and a detailed examination of student-generated artifacts.

4.2 Quantitative Findings: Significant Gains in Data Competency

The quantitative analysis revealed substantial and statistically significant improvements in students' data analysis capabilities following their engagement with the virtual simulation. A comparison of the pre-test and post-test scores showed a marked increase in student performance. The cohort's mean score rose from M=61.5 (SD=9.2) on the pre-test to M=85.2 (SD=7.8) on the post-test. The paired-samples t-test confirmed that this improvement was not due to chance. The result, $t(55)=12.3$, $p<.001$, indicates a highly significant statistical effect, providing strong evidence that the simulation intervention was effective in enhancing the students' data-driven decision-making skills. To quantify the practical significance of this result, the effect size was calculated. For a paired-samples t-test, Cohen's d_z is computed as $d_z = t/\sqrt{n}$.[16] With $t = 12.3$ and $n = 56$, the effect size is $d_z = 12.3/\sqrt{56} \approx 1.64$. According to established conventions, an effect size of 0.8 is considered large; a value of 1.64 is therefore exceptionally large, indicating that the intervention had a profound practical impact on student learning.[17] Furthermore, the analysis of the student satisfaction survey, completed by 111 participants, yielded a Cronbach's alpha of 0.88. This high value indicates excellent internal consistency, suggesting that the survey instrument is reliable and that the overwhelmingly positive feedback from students is a dependable measure of their experience. These quantitative findings robustly support the conclusion that the simulation successfully achieved its primary pedagogical objective of cultivating core data competencies.

4.3 Qualitative Findings: Evidence of Authentic Practice

To provide a deeper understanding of the learning process and the nature of the skills developed, qualitative data were collected from two primary sources. The first source was **Peer Endorsements**, as the simulation platform was trialed and evaluated by several partner institutions, which provided strong qualitative validation of its educational value. The School of Economics at Southwest University of Political Science and Law reported that the platform successfully made abstract theory "intuitive and concrete," significantly enhancing students' data modeling and analysis skills. Their evaluation concluded with a "strong recommendation" for its adoption by universities nationwide. Similarly, the School of Economics and Management at North China University of Technology highlighted the platform's potential as a catalyst for academic output, noting that their faculty had already utilized it to generate four new experimental teaching cases and mentor two undergraduate innovation projects. This external feedback underscores the platform's practical utility and its potential to serve as a generative tool for both teaching and research. The second source was an **Artifact Analysis**, specifically focusing on a customer churn decision tree. The most compelling evidence of authentic learning comes from the analysis of these student-generated artifacts. During the project-based phase, one student team developed a decision tree model to analyze and predict customer churn based on the operational data they had created.

```
[Root: Purchase Frequency < X?]
|
|-- Yes --> [Node: Used Coupon?]
| |
| |-- Yes --> [Predicted: Low Churn Risk]
| |
| |-- No --> [Predicted: HIGH CHURN RISK] <-- Key Insight
|
|-- No --> [Predicted: Low Churn Risk]
```

(Note: This is a descriptive representation of the visual artifact discussed in the source material.)

Figure 1: Example of Student-Generated Decision Tree Model for Customer Churn Prediction

This artifact provides a window into the students' cognitive processes. The decision tree visually and clearly identified the key drivers of customer churn within their simulated business. The model revealed that the highest-risk segment consisted of customers with "low purchase frequency who had not used a coupon". This demonstrates a level of learning that transcends simple model execution. The students were able to, first, frame a relevant business problem (customer retention); second, apply an appropriate analytical technique (decision tree classification); third, interpret the complex, visual output of the model to extract a key insight; and fourth, translate that insight into an actionable business strategy (e.g., "We should target this high-risk group with a high-value coupon to incentivize re-engagement"). This process perfectly mirrors the authentic work of a professional data analyst. The artifact serves as powerful qualitative evidence that the simulation environment facilitated not just the acquisition of technical skills but the development of higher-order strategic thinking. The combination of strong quantitative gains and rich qualitative evidence provides a synergistic and highly persuasive validation of the intervention's success. The quantitative data answers *if* learning occurred, while the qualitative data reveals *what* was learned and *how*, showcasing the depth and authenticity of the competencies students developed.

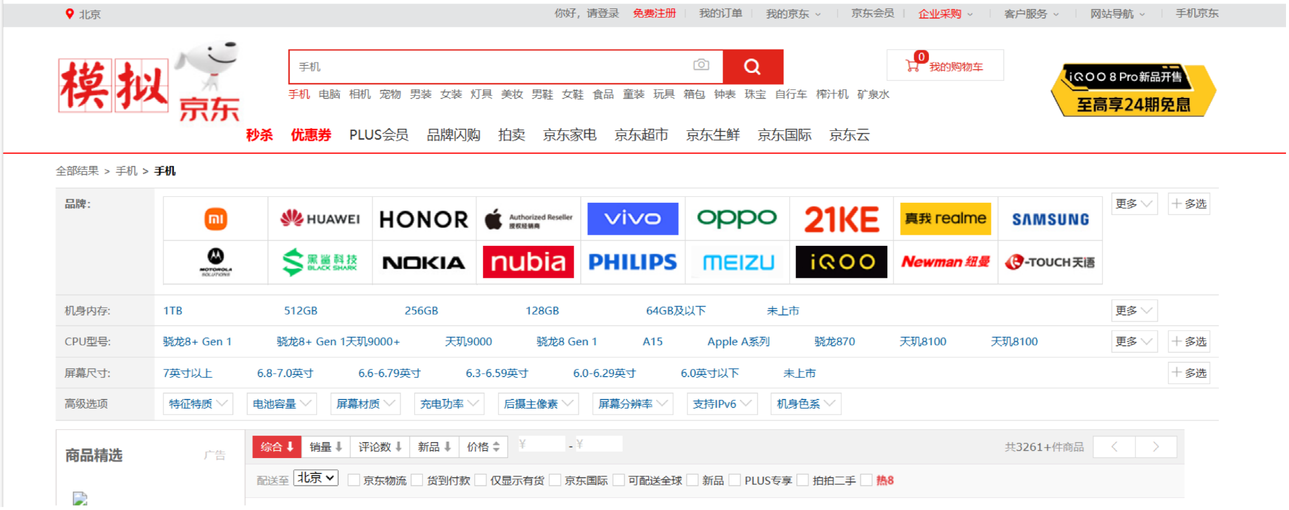

Figure 2: Ningxia University "E-commerce Operation and Statistical Analysis Virtual Simulation Experiment"

5 Discussion: From a Digital Tool to a Data-Driven Pedagogy

5.1 The Simulation as a Digital LPP Environment

The empirical findings of this study, when interpreted through the theoretical lens of Legitimate Peripheral Participation (LPP), provide a compelling explanation for the intervention's success. The statistically significant learning gains and the sophisticated nature of the student-generated artifacts are not merely outcomes of using a new technology; they are the result of a carefully designed digital apprenticeship that guided students along a structured learning trajectory. The simulation environment successfully operationalized the core principles of LPP by creating a temporary, task-focused community of practice for each student team. The progression from the initial case-based phase to the subsequent project-based phase directly mirrors the novice-to-expert journey from the periphery to the core of this community.[14] In the first phase, students acted as legitimate peripheral participants, learning the fundamental rules, language, and tools of e-commerce management in a structured, low-risk setting. In the second phase, they moved toward the core by engaging in the authentic, complex, and high-stakes practice of a data analyst. They were no longer just learning about e-commerce and data analysis; they were actively participating in the sociocultural practices of that domain.[15] This transformative process of participation is what underpins the deep, applied learning demonstrated in the results.

5.2 Contribution to Pedagogy: The "Data Sandbox" and the Data Ownership Gap

Beyond its theoretical implications, this work offers a significant pedagogical contribution in the form of the "Data Sandbox" model. This model represents a paradigm shift from traditional case-based teaching and many existing business simulations. While established BSGs are highly effective for teaching strategy and finance through competition and decision analysis, they often position students as consumers of performance data generated by the simulation's underlying model.[7] Even advanced platforms that allow for data export for external analysis still maintain a degree of separation between the operational environment and the analytical one.[8]

The "Data Sandbox" model addresses a crucial "data ownership" gap in BSG pedagogy. The "Operate → Generate Data → Analyze" loop positions students as active producers and analysts of dynamic, personalized data within a single, integrated platform. This approach fosters a profoundly deeper and more intuitive understanding of the causal relationships between strategic business actions and their data-driven consequences. When students see a spike in sales data, they know exactly which marketing promotion they designed caused it. When they model customer churn, they are analyzing the behavior of virtual customers whose entire history was shaped by their own decisions. This direct, unmediated, and experiential link between action, raw data creation, and subsequent analysis is a powerful learning mechanism. It shifts the student's role from a strategic decision-maker who consumes performance reports to a business operator who produces a unique dataset and then becomes a data analyst who mines it for strategic insight. This pedagogical model directly addresses the need for students to develop competencies in computational thinking and knowledge construction, key skills advocated by international educational frameworks for 21st-century learning.

5.3 Implications for the Future of Business Education

The success of this project provides a tangible and replicable model for other higher education institutions seeking to implement the reforms of the "New Business Disciplines" initiative or, more broadly, to modernize their business curricula for the digital age. It demonstrates that technology-enhanced learning can be far more than a supplemental tool; it can constitute the core learning environment for cultivating the hybrid, interdisciplinary skills demanded by the modern economy. This vision aligns with the strategic direction for digital transformation in higher education promoted by global bodies like the OECD and UNESCO, which advocate for leveraging technology to create more effective, equitable, and innovative learning experiences that prepare students for an increasingly digital world.

Furthermore, the strong positive feedback from partner institutions reveals the platform's potential to evolve from a standalone tool into a generative academic ecosystem. The report from North China University of Technology, detailing their creation of new teaching cases and research projects based on the simulation, is particularly telling. This indicates that the simulation is not a closed, static resource but a flexible, high-fidelity "world" that can serve as a foundation for other educators' creativity. The platform's value transcends its function as a direct teaching tool; it can catalyze further innovation, enabling a community of educators to build and share new pedagogical content derived from the core simulation. This significantly amplifies the project's impact and contribution to the wider academic community.

5.4 Limitations and Future Research

While the results of this study are highly encouraging, it is important to acknowledge its methodological limitations. The quasi-experimental design, which lacks a parallel control group, means that it is not possible to definitively attribute all of the observed learning gains solely to the simulation. Other factors, such as regular course instruction or maturation effects, could have contributed to the improvement. Additionally, the study was conducted with a single cohort of students at one university, which may limit the generalizability of the findings to other institutional or cultural contexts.

Future research should aim to address these limitations. A randomized controlled trial (RCT) that directly compares the learning outcomes of students using the simulation against a control group taught via traditional methods (e.g., lectures and static case studies) would provide more conclusive evidence of the intervention's specific impact. Longitudinal studies that track graduates into their careers would also be invaluable for assessing the long-term effects of this pedagogical approach on their professional performance

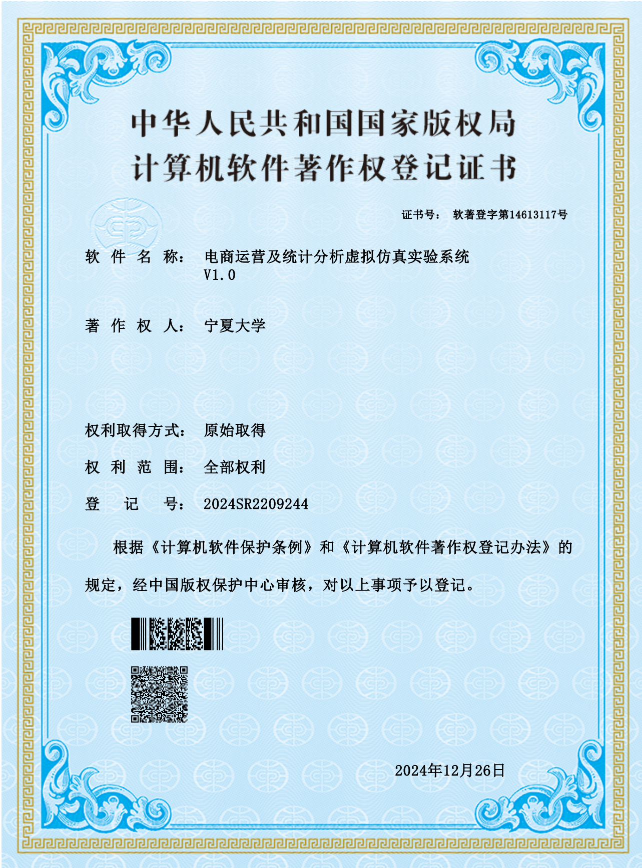

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Figure 3: Certificate of Computer Software Copyright Registration for the E-commerce Operations and Statistical Analysis Virtual Simulation Experiment

and career trajectories. In terms of platform development, future iterations will focus on integrating more advanced AI-driven features, such as personalized feedback, adaptive learning pathways, and more complex, AI-driven market competitors. This aligns with the technological frontiers in education and would further enhance the simulation's realism and pedagogical power.

6 Conclusion: Cultivating the Next Generation of Data-Fluent Business Leaders

The "E-commerce Operations & Statistical Analysis Virtual Simulation Experiment" represents a systematic, innovative, and successful response to the urgent need to modernize business education. By integrating advanced simulation technology with a robust pedagogical design grounded in the theory of Situated Learning, this project effectively addresses the core challenge of bridging the gap between academic theory and the practical demands of the digital economy. It provides a powerful, empirically-validated solution that successfully operationalizes the ambitious goals of China's "New Business Disciplines" initiative, offering a model with clear relevance to the global higher education community.

The project's key contribution lies in its unique "Data Sandbox" model, which transforms students from passive recipients of knowledge into active participants in a digital apprenticeship. This closed-loop cycle of operating a business, generating unique data, and analyzing those data to inform strategy cultivates not just technical skills but a deep, intuitive understanding of data-driven decision-making. The findings demonstrate that this approach leads to significant and measurable gains in students' analytical competencies. More importantly, it fosters the kind of authentic, higher-order thinking that is essential for leadership in the 21st century.

Ultimately, this project provides more than just a new software tool; it offers a blueprint for a future-oriented business education. It argues persuasively that to prepare students for the complexities of a data-rich world, pedagogy must evolve beyond knowledge transmission. It must focus on creating immersive, situated learning environments where students learn by doing—by participating in the authentic practices of their future professions. This simulation stands as a powerful and replicable example of how to build that future, cultivating the next generation of agile, analytical, and data-fluent business leaders.

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