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Digital Scenario-Driven Practical Teaching of Cross-Border E-Commerce Customs Clearance in Higher Vocational Education: A Case Study of a Digital Teaching Platform Prototype

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Abstract: The customs clearance business of cross-border e-commerce features long process chains, fast-updating rules, intensive post collaboration and diverse abnormal scenarios. It is difficult for traditional classrooms to fully present real work processes such as customs supervision, document circulation, tax and fee accounting and inspection disposal, which easily causes a disconnection between knowledge learning and post competency cultivation. Grounded in the concepts of situated cognition, experiential learning and competency-based education, this paper takes the prototype of digital teaching platform for cross-border e-commerce customs clearance as the carrier, and proposes a digital teaching scenario architecture characterized by five-layer interconnection of "post demand – scenario resources – business process – teaching interaction – data evaluation" and closed-loop optimization with data feedback. It further elaborates the platform functions and implementation paths from the aspects of pedagogical translation of business processes, task chain design, role-based interaction, abnormal decision-making training and multi-dimensional evaluation. The study holds that the key to digital scenario construction lies not in the simple 3D replication of the real environment, but in embedding business rules, operation behaviors, decision-making basis and evaluation evidence into the same learning process with typical work tasks as the main line, so as to realize the reconstruction of teaching content from knowledge items to work processes, the transformation of learning modes from viewing and memorization to situational action, and the extension of teaching evaluation from result scoring to process diagnosis. This research can provide references for the digital transformation of practical teaching of cross-border e-commerce majors in higher vocational education and the construction of virtual simulation training resources for finance, economics and business majors.

1. Problem Statement

Cross-border e-commerce has evolved from a single online transaction activity into a composite business system connecting commodity organization, platform operation, international logistics,

payment and settlement, customs supervision and after-sales service. Statistics released by the General Administration of Customs show that China's cross-border e-commerce imports and exports reached approximately 2.71 trillion yuan in 2024, a year-on-year increase of 14%, and the role of cross-border e-commerce in stabilizing foreign trade, expanding markets and cultivating new drivers of foreign trade has been further enhanced[1]. The expansion of industrial scale and continuous innovation of supervision modes have put forward higher requirements for enterprises for compound technical and skilled talents who can understand policy rules, be familiar with customs clearance chains, accurately handle documents and respond to abnormal businesses.

Vocational education emphasizes the alignment of major setting with industrial demand, curriculum content with vocational standards, and teaching process with production process. The Opinions on Deepening the Construction and Reform of the Modern Vocational Education System proposes to build practice centers integrating practical teaching, social training, real production and technical services against the forefront of industrial development[2]. The 2025 revised teaching standard for cross-border e-commerce major in higher vocational colleges further emphasizes project-based and situational teaching as well as the application of technologies such as artificial intelligence in the digital transformation of courses[3]. Accordingly, transforming the real work process of cross-border e-commerce enterprises into digital teaching scenarios that can be brought into classrooms, trained repeatedly and recorded for evaluation is a practical requirement to improve the adaptability of professional talent training.

However, cross-border e-commerce customs clearance business has obvious characteristics of "cannot be directly moved into the classroom": first, real environments such as customs supervision places and port yards are limited by safety, time and cost, making it difficult for students to access the whole process; second, processes such as customs declaration, risk deployment, tax and fee accounting, and inspection disposal are completed by multi-agent collaboration, while classroom cases can only present partial results; third, policy rules and supervision modes iterate rapidly, leading to a time lag between textbook content and enterprise business; fourth, real business data involves commercial sensitivity, so it is hard for enterprises to open complete data for students to practice repeatedly. As a result, students face the competency gap of "being able to retell the process but unable to handle tasks" and "being able to fill in documents but unable to judge abnormalities".

Digital scenarios provide possibilities to solve the above problems. In the construction of national virtual simulation experiment teaching projects, the Ministry of Education puts forward the principle of "student-centered, output-oriented and continuous improvement", emphasizing that information-based experimental teaching supports competency cultivation[4]; the national vocational education digital strategy action continues to promote digital resources, virtual simulation training and the application of learning data[5]. However, the introduction of digital technology into teaching does not necessarily lead to the improvement of teaching quality. Existing studies point out that virtual simulation projects are prone to problems such as prioritizing display over tasks, prioritizing technical realism over teaching design, and prioritizing system construction over process evaluation[6-9]. Therefore, the core concern of this study is not "whether to use 3D technology", but "how to translate the real business process into learnable, interactive and evaluable digital teaching scenarios".

2. Theoretical Basis and Research Ideas

2.1 Situated Cognition: Embedding Knowledge into Real or Simulated Vocational Activities

Situated cognition theory holds that knowledge does not exist independently of activities, situations and cultures, and learners need to understand the application conditions and action significance of knowledge in the process of participating in real community practice[10]. Cross-border e-commerce customs clearance knowledge is highly situation-dependent: the same commodity may

correspond to different document requirements and disposal paths under different trade modes, declaration modes, destination country rules and logistics status. Digital scenarios should organize learning around "who completes what tasks under what conditions and what judgments are made based on what rules", rather than merely transforming textbook text into 3D images.

2.2 Experiential Learning: Forming a Closed Loop of Competency through Action, Feedback and Reflection

Experiential learning emphasizes the cycle among concrete experience, reflective observation, abstract generalization and active experimentation[11]. The formation of customs clearance practice competency also requires students to go through task attempts, error feedback, rule retrospection and re-operation. The advantage of digital platforms is that they can generate a variety of business conditions at low cost, allow students to operate repeatedly in a safe environment, and record each step of choice and its consequences. Therefore, platform design should not stop at "completing a correct process", but should also support students to compare different paths, analyze the causes of errors and carry out corrective retraining.

2.3 Competency-Based Education: Integrating Knowledge, Skills and Literacy with Typical Work Tasks

Vocational education curricula cannot be simply arranged according to the subject knowledge catalogue, but should take the comprehensive action competency required by vocational posts as the goal, and embed knowledge, skills, normative awareness and collaborative literacy into complete tasks. Project-based curriculum research emphasizes that tasks should have clear outputs, real constraints and evaluable action processes[12]. Accordingly, this study adopts the research path of "post task analysis – business process modeling – teaching task translation – platform prototype development – evaluation evidence design", decomposes the cross-border e-commerce customs clearance business chain into interconnected task chains, and reconstructs teaching space, role relationship and feedback mechanism through digital technology.

3. Practical Dilemmas of Traditional Cross-Border E-Commerce Customs Clearance Teaching

3.1 Lack of Field: Business Environment Compressed into Text and Flowcharts

Traditional classrooms usually present customs clearance knowledge through policy provisions, document samples, business flowcharts and teacher explanations. This method is conducive to quickly establishing a conceptual framework, but it is difficult to restore the information flow, time constraints and behavioral consequences among various posts after commodities enter the supervision place. Students only see the linear process of "declaration – review – inspection – release", unable to perceive the role boundaries among enterprises, customs declaration agents, logistics enterprises and customs, and difficult to understand why business nodes occur and how previous errors affect subsequent links.

3.2 Fragmented Tasks: Single-Skill Training Hard to Form a Complete Work Process

Existing practical training often splits commodity code query, customs declaration form filling, tax calculation, etc. into several independent exercises. Single-skill training is easy to organize and score, but it is likely to cause knowledge fragmentation. For example, students can fill in declaration elements according to a given code, but do not understand the basis of commodity classification and

supervision conditions; they can calculate taxes and fees, but cannot link tax calculation results with enterprise costs and declaration mode selection. Real posts require students to comprehensively identify order, commodity, logistics and supervision information and make continuous decisions under constraints, while single-point training can hardly support the generation of such comprehensive competency.

3.3 Insufficient Abnormal Scenarios: More Standard Process Training and Less Complex Decision-Making Training

Textbooks and software usually focus on standard businesses, and students can get correct answers by following fixed steps. However, in the actual customs clearance process of enterprises, there are often situations such as inconsistent documents, missing declaration elements, disputes over commodity codes, tax differences, abnormal inspection and return. Abnormal scenarios involve rule understanding, evidence verification, communication and coordination and risk judgment, which are the key to distinguishing "being able to operate" from "being competent". Without abnormal task training, students tend to equate process memory with post competency.

3.4 Single Evaluation: Result Scores Hard to Explain Competency Problems

Traditional evaluation mostly gives scores based on final documents, task results or theoretical examinations, which cannot fully reflect students' operation paths and judgment basis. The same error result may stem from unfamiliar rules, missing information, wrong process sequence or insufficient time management, and different causes require different teaching interventions. Without process data, teachers can only rely on classroom observation and experience judgment, and it is also difficult for students to get targeted feedback. Digital teaching scenarios should transform "what was operated, why this choice was made, where the error occurred, and whether it can be transferred after correction" into traceable evaluation evidence.

4. Overall Architecture of Digital Teaching Scenarios for Cross-Border E-Commerce Customs Clearance

4.1 Construction Principles

First, post demand orientation. The system determines the scenario content based on the typical tasks and competency requirements of posts such as cross-border e-commerce operation, customs affairs, and international logistics, to avoid stacking scenarios for the sake of technology display. Second, unity of business authenticity and teaching suitability. The system retains key rules, role relationships, and work constraints, and appropriately simplifies complex details that do not affect competency objectives, to prevent invalid cognitive load caused by excessive simulation. Third, task chain interconnection. The system organizes commodity identification, document preparation, declaration review, tax calculation, inspection, release, and archiving into continuous tasks, so that students can understand the causal relationship between preceding and subsequent links. Fourth, interpretable feedback. The system should not only prompt "right or wrong", but also explain error nodes, rule basis, and possible consequences. Fifth, safe and controllable data. The system uses desensitized, fictional, or authorized data, clarifies the data access boundaries of different roles, and balances teaching openness and business compliance.

4.2 Structural Model of "Five-Layer Interconnection and One-Loop Feedback"

This study constructs a five-layer architecture consisting of post demand layer, scenario resource layer, business process layer, teaching interaction layer and data evaluation layer. The post demand layer answers "what competencies to cultivate", the scenario resource layer provides "where to learn and with whom to collaborate", the business process layer specifies "what work to complete", the teaching interaction layer organizes "how to learn and make decisions", and the data evaluation layer records "how is the learning performance". The five layers are not in a one-way transmission relationship; instead, they reversely adjust task difficulty, resource allocation and teaching strategies through learning data, forming a closed loop of continuous optimization.

4.3 Translation of Business Processes into Teaching Tasks

Real business processes cannot be directly equated with teaching processes. Pedagogical translation needs to complete three transformations: first, shift from enterprise result orientation to learning objective orientation, and refine "completing customs clearance" into competency objectives such as information identification, rule application, standardized operation and abnormal decision-making; second, shift from continuous business operation to hierarchical tasks, and decompose complex processes into basic, comprehensive and challenging tasks; third, shift from implicit experience to explicit evidence, and transform judgments made by enterprise personnel based on experience into rule basis that students can find, explain and verify. Table 1 shows the corresponding relationship among core processes, teaching tasks, competency objectives and evaluation evidence.

Table 1 Mapping of Customs Clearance Business Processes and Teaching Tasks

Business Stage	Digital Scenarios and Tasks	Key Student Actions	Main Competency Objectives	Evaluation Evidence
Order and Commodity Identification	Scenarios of enterprise order receiving and commodity data verification	Read order and commodity information, identify trade modes and supervision conditions	Business information identification, rule retrieval	Information extraction records, rule references
Declaration Preparation	Document center and declaration workbench	Classify commodities, fill in declaration elements, check document consistency	Commodity classification, document processing, standardized operation	Operation paths, field accuracy rate, checklists
Document Review and Tax Calculation	Scenarios of customs document review and tax and fee accounting	Explain the reasons for document return, calculate taxes and fees and revise the declaration	Policy understanding, data accounting, risk judgment	Number of revisions, basis explanation, completion time
Inspection and Abnormal Handling	Scenarios of inspection area and abnormal events	Select disposal plans, supplement evidence and complete collaborative communication	Problem diagnosis, decision-making and collaboration	Decision chains, communication records, disposal results
Release and Archiving	Scenarios of release, logistics handover and business review	Confirm release status, sort out documents and review key risks	Process coordination, quality control, reflective transfer	Archiving integrity, review reports, transfer task performance

5. Functional Design of the Platform Prototype

5.1 Scenario Resource Module: Establishing Combinable Vocational Situations

The scenario resource module consists of space environment, business objects, role identities and rule resources. The space environment includes cross-border e-commerce enterprise work areas, customs supervision operation places, yards and inspection areas; business objects include orders, commodities, contracts, invoices, packing lists, logistics documents and declaration data; role identities include operation personnel, customs personnel, logistics personnel, customs review personnel, etc.; rule resources link the basis of commodity classification, declaration specifications, supervision modes and tax calculation. Resources adopt modular design, which can be recombined according to curriculum chapters and task difficulty, avoiding repeated construction of complete 3D scenarios for each teaching task.

5.2 Process Task Module: Organizing Knowledge Learning with Continuous Tasks

The platform transforms the customs clearance process into "main tasks + subtasks + checkpoints". The main task takes real enterprise orders as the carrier, requiring students to complete the whole process from data verification to release and archiving; subtasks correspond to key operations such as commodity classification, declaration element filling and tax accounting; checkpoints are used to confirm whether students have completed necessary judgments. Tasks are divided into three levels: basic tasks provide clear steps and prompts for establishing process cognition; comprehensive tasks reduce prompts and increase cross-link information for forming independent operation competency; challenge tasks implant abnormal conditions and multi-scheme options for training complex decision-making and knowledge transfer.

5.3 Role Interaction Module: Reconstructing Multi-Agent Collaborative Relationship

Customs clearance is not a closed operation completed by a single person, but an information collaboration process jointly participated by enterprises, agents, logistics and regulatory authorities. Through the design of role permissions and information gaps, the platform enables different students to master different information and must complete tasks through standardized communication. For example, the operation role grasps order and customer needs, the customs role is responsible for rule verification and declaration, the logistics role provides transportation node information, and the review role feeds back problems according to rules. Role interaction can prevent students from only focusing on software operation, and urge them to understand post boundaries, information responsibilities and collaboration norms. Teachers can adopt organization methods such as single-person multi-role exercise, group role-based collaboration or role rotation according to the class size.

5.4 Abnormal Decision-Making Module: From "Process Reproduction" to "Problem Solving"

The abnormal decision-making module generates events around situations such as inconsistent documents, missing declaration elements, classification disputes, tax differences, inspection discrepancies and returns. Each event includes trigger conditions, available information, disposal options, rule basis and consequence feedback. The system should not set a unique fixed operation path, but allow students to compare among multiple schemes and require them to explain the judgment basis. Operations that obviously violate norms shall be blocked immediately; for schemes with trade-offs, feedback shall be delayed, and differences in cost, timeliness and risk shall be presented in task review. Through this design, students can realize that professional decision-making

is not mechanical clicking, but a reasonable choice among rules, evidence and business objectives.

5.5 Immediate Feedback and Learning Analysis Module: Forming Interpretable Evaluation Evidence

The platform records task start time, operation sequence, resource invocation, number of modifications, error types, collaborative information and final results. Feedback is divided into three categories: operational feedback prompts direct problems such as missing fields and sequence errors; explanatory feedback links specific rules to explain the causes of errors and business consequences; reflective feedback requires students to compare the original plan with the revised plan and form a review record. The teacher end presents class learning situation in the form of task completion rate, error clustering, process stay time and competency dimension radar, to identify common difficulties and individual weak links. It should be emphasized that learning analysis serves teaching diagnosis, rather than replacing professional judgment with data volume.

6. Teaching Implementation Path Supported by Digital Scenarios

6.1 Before Class: Activating Problem Awareness with Post Situations

In the pre-class stage, students should not passively watch the complete demonstration. Instead, task packages composed of enterprise orders, customer requirements and supervision conditions should be provided to guide students to identify "what to complete, what is known, and what is missing". Students understand the post division through scenario navigation, and complete rule pre-inspection and document preliminary review; the platform generates learning situation prompts according to the preview results. Teachers adjust the difficulty of classroom tasks accordingly, provide process support for students with weak foundation, and increase abnormal conditions for students with strong ability, to realize layered learning under the same scenario.

6.2 In Class: Promoting Collaborative Operation and Decision-Making with Role Tasks

Classroom implementation can adopt the five-step process of "task release – role collaboration – key decision-making – result feedback – collective review". Teachers first clarify task outputs, rule boundaries and evaluation criteria; students enter the scenario according to their roles, and complete data verification, declaration, document review feedback and abnormal disposal; the platform records operations at key nodes and provides appropriate prompts; teachers do not give answers directly, but raise questions around evidence, rules and consequences. After the task is completed, each group displays the decision chain and revision process, and compares the compliance, timeliness and cost impact of different schemes, so that implicit operation experience can be transformed into discussable professional judgment.

6.3 After Class: Organizing Targeted Retraining with Data Diagnosis

In the after-class stage, personal learning reports and class problem lists are formed based on platform data. Personal reports focus on error types, time consumption at key nodes, use of rule resources and revision effects; class lists are used to determine the focus of subsequent teaching. Students carry out variant task retraining targeting weak links, avoiding simply repeating the original questions. For example, students with wrong commodity classification need to re-judge under the conditions of different materials, uses and specifications of similar commodities; students with wrong process sequence need to complete comprehensive tasks without step prompts. The retraining results

are compared with the first performance to evaluate whether students truly understand and can transfer knowledge.

6.4 Evaluation: Constructing a Multi-Dimensional System of "Knowledge – Operation – Decision-Making – Literacy"

Evaluation should take into account results, processes and transfer. Result evaluation focuses on whether documents, taxes and fees and final disposal are correct; process evaluation focuses on operation sequence, standardization degree, information verification and collaboration quality; transfer evaluation examines whether students can apply rules under new conditions through variant tasks. Platform data, student achievements, oral explanations and peer mutual evaluation together form an evidence chain. Table 2 gives the evaluation dimensions and suggested weights available for courses, which can be adjusted according to curriculum objectives in practical application.

Table 2 Multi-Dimensional Evaluation Design of Digital Scenario Practical Training

Evaluation Dimension	Core Indicators	Main Evidence Sources	Suggested Weight
Rule Knowledge and Compliance Awareness	Rule identification, basis reference, risk awareness	Rule retrieval records, basis explanation, theoretical tests	20%
Process Operation and Quality Control	Operation sequence, document accuracy, task timeliness	Operation logs, achievement documents, system checkpoints	35%
Abnormal Decision-Making and Problem Solving	Information diagnosis, scheme comparison, revision transfer	Decision chains, abnormal disposal records, variant tasks	25%
Collaborative Communication and Professional Literacy	Role performance, communication norms, review reflection	Collaboration records, peer evaluation, review reports	20%

7. Value of Teaching Reform and Innovative Manifestations

7.1 Teaching Content Shifts from Knowledge Catalogue to Work Process

Digital scenarios connect commodity knowledge, policy rules, document skills and communication norms with complete business tasks, changing the organization mode of traditional courses that are taught and trained separately by chapters. What students learn is not several isolated knowledge points, but how knowledge is called, combined and verified under specific business conditions. The curriculum content shifts from "what is customs declaration and how to calculate taxes" to "how to organize information and complete compliant customs clearance facing a certain order", which is more in line with the law of vocational competency formation.

7.2 Learning Modes Shift from Viewing and Memorization to Situational Action

3D environment itself is not equal to deep learning. The real transformation comes from students taking on roles, processing information, making decisions and bearing consequences in the scenario. Immersive learning studies show that presence and action autonomy can enhance interest and engagement, but may also increase irrelevant cognitive load, which must be guided by clear objectives, appropriate tasks and feedback mechanisms[13]. This study controls the scenario realism within the scope of serving tasks, and avoids students staying in the shallow experience of "watching scenarios and clicking buttons" through task-driven design and evidence-based questioning.

7.3 Teaching Evaluation Shifts from Endpoint Scoring to Process Diagnosis

The platform transforms operation paths, error types, rule invocation and revision processes into evaluation evidence, enabling teachers to distinguish different problems such as knowledge understanding, operation norms, decision-making judgment and collaborative communication. Evaluation no longer only answers "how many points are obtained", but also answers "at which node what problem occurred, why it occurred, and how to train next". This interpretable data feedback helps to implement layered guidance and targeted retraining, and also provides a basis for continuous curriculum improvement.

7.4 Practical Training Resources Shift from Closed Systems to Iterative Scenarios

Cross-border e-commerce policies and supervision rules are updated rapidly, and fixed software is prone to content lag. Modular scenarios manage space, objects, rules and tasks separately, which can update policy parameters, replace business cases or add abnormal events without rebuilding the whole system. Schools can also cooperate with cross-border e-commerce enterprises, logistics enterprises and customs agencies to jointly maintain the case base, realizing the continuous transformation of enterprise business experience into teaching resources. The platform prototype can not only serve on-campus courses, but also be expanded to enterprise new employee training, post retraining and business drills.

8. Key Issues in Implementation and Improvement Directions

8.1 Establishing a Dynamic Update Mechanism for Rules and Cases

With the continuous changes of cross-border e-commerce supervision policies, declaration modes and enterprise businesses, scenario resources must establish version management and regular review mechanisms. A content maintenance team composed of professional teachers, industry experts and technical personnel can be formed to mark the source of rules, applicable time and case authenticity; adjust task parameters in time for major policy changes, and retain historical versions for comparative learning. Only by keeping the business content effective can the digital platform avoid becoming a display tool for outdated processes.

8.2 Balancing Authenticity, Learning Load and Development Cost

Teaching scenarios should not blindly pursue visual details and full-process replication. Environmental decorations, complex animations and non-key steps that have no direct contribution to competency objectives should be appropriately simplified, and development resources should be concentrated on information judgment, process logic and abnormal feedback. Different terminals can provide graded experiences: ordinary computers undertake main task operations, and immersive devices are used for spatial cognition and key link experience, to reduce equipment dependence and use threshold.

8.3 Strengthening the Standardized Use of Learning Data and Privacy Protection

The operation data collected by the platform should follow the principle of minimum necessity, and clarify the collection purpose, scope of use and storage period. Real enterprise data need to be authorized and desensitized, and student data should not be used for evaluations unrelated to the course. Competency portraits should be used as an auxiliary tool for teaching diagnosis, to avoid

solidifying single operation results into students' competency labels. The system should also retain teacher review and student appeal mechanisms to ensure transparent and interpretable data evaluation.

8.4 Improving Teachers' Digital Teaching Design Ability

Digital scenario teaching puts forward new requirements for teachers to integrate business, teaching and technology. Teachers should not only be familiar with platform operation, but also be able to extract typical tasks, design abnormal conditions, set feedback nodes and interpret learning data. Schools should carry out scenario script development and teaching trial in the form of curriculum teams, forming a collaboration mechanism among teachers, industry experts and technical personnel. Technical personnel are responsible for implementation but do not determine teaching design; teachers must master the educational logic and evaluation standards of scenario construction.

9. Conclusion

The construction of digital teaching scenarios for cross-border e-commerce customs clearance is a practical exploration under the intersection of industrial business digitalization and vocational education teaching digitalization. Aiming at the problems of lack of real field, fragmented task chains, insufficient abnormal training and single evaluation evidence in traditional customs clearance teaching, this paper constructs an overall architecture of five-layer interconnection of "post demand – scenario resources – business process – teaching interaction – data evaluation" with continuous optimization of data feedback, and proposes specific paths including pedagogical translation of business processes, modular platform design, role-based task implementation and multi-dimensional evaluation.

The study shows that the core value of digital scenarios is not simply restoring spaces such as ports, customs and yards, but organizing rules, tasks, roles, decisions and consequences in real work into a learnable action system through technology. Only by adhering to the orientation of post demand and teaching objectives, and coordinating scenario authenticity, task challenge, feedback interpretability and data compliance, can the transformation from "technology display" to "competency generation" be realized. Follow-up research can carry out multiple rounds of teaching application and controlled studies on the basis of completing the iteration of the platform prototype, focusing on testing the effects of different task difficulties, feedback types and collaboration methods on students' process understanding, abnormal decision-making and knowledge transfer, so as to further form a replicable digital practical training mode for cross-border e-commerce.

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