Research on Adaptive Reconstruction of Vocational Undergraduate Talent Cultivation Models under the Background of Enterprise Digitalization

Chen Zhao*

Hainan Vocational University of Science and Technology, Haikou, 571126, China
**Corresponding author: 18623772243@163.com*

Abstract: *The advancement of enterprise digitalization has triggered a profound reshaping of production organization forms and post competency structures, leading to a systematic imbalance in traditional vocational undergraduate talent cultivation models with respect to task ecological migration and dynamic capability generation. The study identifies a shift in training objectives from substantive knowledge to procedural knowledge on the knowledge dimension, and an expansion from task execution to situational adaptation on the competency dimension. On this basis, it constructs a modular integrated curriculum system and a virtual-real integrated teaching structure. Furthermore, the study proposes multi-agent collaborative calibration rules, digital twin-driven matching strategies, and a competency map-oriented progressive evaluation mechanism, thereby forming a closed-loop operation regulation system. This model is designed to enhance the response speed and adaptation precision of the cultivation system to the dynamic changes brought about by enterprise digitalization.*

Keywords: *Enterprise digitalization, Vocational undergraduate education, Talent cultivation model, Adaptive reconstruction, Competency map, Virtual-real integration.*

Introduction

During the process of enterprise digitalization, the large-scale application of technologies such as cloud computing, the Internet of Things, and edge computing has prompted production systems to shift from hierarchical structures to networked dynamic collaborative units, bringing significant changes to task allocation methods, information transmission paths, and the stability of technical activity units. Traditional discrete functions such as operation, debugging, and maintenance tend to converge under the support of intelligent equipment, while job requirements for system perception capability and abnormal response capability continue to rise. Against this backdrop, the current vocational undergraduate talent cultivation model exhibits a misalignment with digital job demands in both the skill structure dimension and the competency depth dimension. The traditional logic based on closed-loop deterministic tasks fails to meet the urgent demand for dynamic capability generation triggered by the shortened iteration cycles of enterprise technical systems. Therefore, it is clearly necessary to identify the imbalance manifestations of the vocational undergraduate talent cultivation model in the digital context, explore the adaptive reconstruction elements of training objectives, curriculum systems, and teaching structures, and construct corresponding operational regulation mechanisms. This study, starting from the dual shift in knowledge and competency, analyzes the flexible organizational logic of the modular integrated curriculum system and the restructuring plan for the virtual-real integrated teaching structure based on work-field iteration. Furthermore, it proposes regulation mechanisms involving multi-agent collaborative calibration, digital twin-driven matching, and competency map-oriented progressive evaluation, with the aim of providing theoretical support for the systematic optimization of the vocational undergraduate talent cultivation system.

1. Imbalance Manifestations of Vocational Undergraduate Talent Cultivation Models in the Context of Enterprise Digitalization

1.1 The Reshaping Effect of Digital Technology Embedding on Production Organization Forms

During the process of enterprise digital transformation, digital technologies have exerted a deep deconstruction and restructuring on traditional production organization forms. The large- scale application of technologies such as cloud computing, the Internet of Things, and edge computing has driven enterprise production systems to shift from hierarchical, linear structures to networked, decentralized dynamic collaborative units. Task allocation has transformed from fixed job responsibilities to temporary combinations of project- based and modular teams, while information transmission paths have evolved from vertical command chains to multi- source real- time sharing networks. This reshaping effect directly alters the time scale and spatial distribution of skill demands, and the technical activity units corresponding to vocational undergraduate talents are no longer stable[1].

The digital restructuring of production organization forms has given rise to new job function boundaries and role overlap phenomena. Traditional discrete functions such as operation, debugging, maintenance, and preliminary analysis tend to converge under the support of intelligent equipment and digital twin platforms, requiring a single position to simultaneously undertake composite tasks such as equipment monitoring, data interpretation, and local decision-making. The coupling relationships among technical units within enterprises shift from causal determinism to probabilistic correlations, imposing higher demands on practitioners' system perception capability and abnormal response capability. If the vocational undergraduate talent cultivation model continues to adopt a competency framework based on static job descriptions, it will find it difficult to map the task ecological migration brought about by the aforementioned organizational changes.

1.2 The Misalignment Dimensions between Vocational Undergraduate Talent Supply and Digital Job Demands

In terms of skill structure dimension, digital job demands exhibit a trend of concentration toward algorithm understanding, digital interface operation, and cross- system joint debugging capabilities. Among the digital technical positions posted by enterprises, the weight of requirements for underlying logic recognition, data feature extraction, and proficiency in human- computer interaction interfaces has increased significantly. Meanwhile, the current curriculum systems and competency evaluation indicators of vocational undergraduate programs still largely retain a traditional orientation toward mechatronic integration and single- equipment operation, resulting in observable competency gaps among graduates in digital job adaptability tests. This misalignment is particularly prominent in tasks involving medium- complexity fault diagnosis and multi- source information integration.

From the perspective of the competency depth dimension, the demand for tacit knowledge transfer capability in digital jobs grows faster than that for explicit operational skills. Enterprise digital scenarios require practitioners to mobilize rule sets from different knowledge domains when facing semi- structured problems, thereby forming cross- process and cross- equipment problem representations. The current vocational undergraduate cultivation models often take deterministic processes and standardized operations as the competency backbone, while the judgment capability required in non- deterministic environments for digital jobs has not been adequately structurally embedded in the training programs. This misalignment in knowledge organization between supply and demand manifests as graduates' response lag and monotonous strategies when facing unpreset abnormal operating conditions[2].

1.3 The Adaptation Lag of Traditional Cultivation Models in Dynamic Capability Generation

The traditional cultivation model takes the closed- loop of deterministic tasks as its basic logic, namely clear input, standardized processing, and standard output. This logic faces fundamental challenges in the dynamic environment of enterprise digitalization, because digital tasks frequently exhibit characteristics such as incomplete input conditions, unfixed processing rules, and multi- dimensional output evaluation. The skill structure formed under the traditional model tends toward repetitive operations on stable technical systems rather than adaptive generation for variable technical ecosystems. When the iteration cycle of enterprise technical systems shortens to one or two years, the update pace of course content and equipment platforms in the cultivation model struggles to keep pace, thereby resulting in a phenomenon of capability generation lag.

The generation of dynamic capabilities depends on the temporal consistency between learning scenarios and work scenarios. Under the traditional cultivation model, on- campus practical training sessions typically employ technical tasks that have been simplified and stripped of interference, with levels of complexity and uncertainty far lower than those of real digital production environments. The behavioral patterns and cognitive schemas that learners establish in simplified tasks lack transfer resilience when confronted with noisy data, intermittent equipment anomalies, and multi- constraint conflicts in real digital scenarios. The competency structure formed through training in low-complexity scenarios requires substantial compensatory adjustments upon entry into highly dynamic digital positions, significantly prolonging the effective adaptation period for posts. This reflects a systemic lag in the dynamic capability generation mechanism of the cultivation model.

2. Identification of Elements and Relationship Reconstruction for Adaptive Reconstruction of Vocational Undergraduate Talent Cultivation Models

2.1 The Dual Shift in Knowledge and Competency of Training Objectives Driven by Digitalization

Digital technology systems impose requirements on the knowledge structure of enterprise positions, calling for a shift from substantive knowledge to procedural knowledge. Traditional vocational undergraduate training objectives place greater emphasis on the mastery of substantive knowledge such as equipment principles, process parameters, and material characteristics, which are relatively stable and documentable. In digital production environments, procedural knowledge such as data flow logic, cyber- physical system interaction rules, and interpretation of algorithm outputs becomes a prerequisite for technical operations; the latter is more time- sensitive and context- dependent, requiring continuous updating in dynamic operations. The shift in the knowledge dimension of training objectives is manifested in incorporating data perception, information screening, and digital model invocation into the core knowledge domain, forming a structured ratio of substantive knowledge to procedural knowledge, wherein the proportion of procedural knowledge increases progressively with the degree of digitalization of the position[3].

In the competency dimension, training objectives expand from task execution capability to situational adaptation capability. Digital positions require practitioners to be capable of making judgments and interventions under the dynamic coupling of multiple variables such as equipment status, production planning, and quality feedback, rather than merely operating according to established procedures. The competency composition within training objectives needs to incorporate sub-competencies such as abnormal pattern recognition, decision- making under limited resources, and cross- equipment data correlation analysis. This coordinated shift in both the knowledge dimension and the competency dimension constitutes the logical starting point for adaptive reconstruction, providing objective constraints for the subsequent adjustment of curriculum systems and teaching structures.

2.2 The Flexible Organizational Logic of the Modular Integrated Curriculum System

The flexible organizational logic of the modular curriculum system is built upon the separability and recombination of knowledge units. Vocational undergraduate courses are segmented into relatively independent modules according to technical domains, with each module corresponding to a clearly definable competency unit in a digital position, such as sensor data reading, digital twin model verification, and edge computing device configuration. Modules achieve horizontal connections and vertical progression through preset interface rules, which contain three types of metadata: prerequisite knowledge tags, output competency signatures, and compatibility version numbers. Learners selectively combine modules based on the competency map of their target positions to form differentiated learning paths, and the combination plans are subject to automatic validation of interface compatibility. This organizational logic breaks the fixed curriculum sequence under the traditional academic year system, enabling the cultivation program to respond to localized capability update demands arising from enterprise digital technology iterations. Moreover, update operations are limited to replacing, adding, or deleting individual modules without triggering a global restructuring.

The integrated curriculum structure further achieves the interwoven integration of theoretical instruction and skill training along the temporal dimension. Unlike the linear arrangement of fundamentals before specialization, the integrated structure embeds the teaching of digital technology principles into corresponding equipment operation and system debugging sessions, enabling abstract concepts to obtain referential anchors within concrete technical actions. Explicit knowledge review nodes and competency verification checkpoints are set between curriculum modules to ensure that different module combinations can still form a coherent cognitive schema. The core of this flexible organizational logic lies in replacing disciplinary logic with capability generation paths as the basis for curriculum arrangement, thereby enhancing the vocational undergraduate curriculum system's ability to follow enterprise digital changes.

2.3 Restructuring of the Virtual- Real Integrated Teaching Structure Based on Work- Field Iteration

The restructuring of the virtual- real integrated teaching structure is technologically supported by the deep coupling of physical training equipment and digital simulation platforms. Equipment operations, sensor signal acquisition, and actuator responses in real work fields are synchronously mapped into digital space, forming a mirrored training environment. After completing operations such as wiring and calibration on the physical side, learners can observe the corresponding relationships between parameter changes and system responses on the digital side. Conversely, they can also conduct parameter adjustment rehearsals on the digital side before implementing them on the physical equipment. This bidirectional mapping mechanism reduces material consumption and safety risks during the training process, while also allowing multiple parametric reconfigurations of the same work scenario, thereby expanding the coverage domain of training.

The work- field iteration logic requires that the teaching structure be organized around typical digital task units rather than equipment types. Each task unit corresponds to a complete technical closed loop in enterprise production, such as the resetting of sensor thresholds under batch recipe switching, with the closed loop comprising four stages: perception, decision- making, execution, and verification. During the teaching process, learners successively experience three progressive fields: physical simulation, semi- physical simulation, and quasi- production environment, with the constraints and uncertainty levels of tasks increasing stepwise in each field, and the quasi- production environment adopting desensitized real enterprise working condition data. The transitions between fields are automatically recorded by the digital platform in terms of learners' operation sequences and decision-making trajectories, forming individualized capability evolution profiles, which contain error pattern clustering and correction time distribution under each field. The essence of this teaching structure restructuring is to replace the gradient of equipment complexity with the gradient of work- field complexity as the main thread of teaching arrangement, enabling vocational undergraduate talents to complete cognitive pre- adaptation to multi- level uncertain environments before entering real digital positions, and to develop cross- field strategy transfer capability[4].

3. Operational Regulation Mechanisms for Vocational Undergraduate Talent Cultivation under the Adaptive Reconstruction Model

3.1 Multi- Agent Collaborative Dynamic Calibration Rules for Cultivation Programs

The dynamic calibration rules for cultivation programs are established on the basis of quantitative collection and structured processing of input signals from multiple agents. Different agents, including enterprise technical units, vocational undergraduate teaching administration departments, and industry skill certification bodies, each provide differentiated constraint conditions and demand vectors. Enterprise technical units output the competency frequency distribution of digital positions and records of typical task changes; teaching administration departments provide the current resource allocation status of curriculum modules and credit- hour capacity constraints; skill certification bodies submit updated entries in professional competency level standards. The above signals are fed into the calibration hub through preset interface protocols, forming a quantitative description of the deviation between the current cultivation program and digital job demands.

The execution mechanism of dynamic calibration adopts a dual- channel mode that combines periodic triggering and event- driven triggering in parallel. Under periodic triggering, the module weights, class hour ratios, and prerequisite relationships within the cultivation program are reviewed and adjusted on a semester or academic- year basis, with the adjustment magnitude constrained by data on graduates' competency attainment and job retention rates from the previous cycle. Event-driven triggering, on the other hand, is initiated by key nodes in the iterative process of enterprise digital technology, such as the commissioning of new equipment or the overall replacement of old control systems, whereupon the system will launch local emergency calibration targeting the affected competency map areas. After the calibration hub generates adjustment recommendations, they must undergo a compatibility check of the curriculum system to ensure that newly added modules do not create logical conflicts or competency gaps with existing modules; this check process includes closed - loop detection of prerequisite relationships and verification of class hour load balancing. This set of rules transforms the cultivation program from a static document into a flexible framework that can be continuously revised by multi - agent signals, enhancing the responsiveness of vocational undergraduate education to digital changes while avoiding structural disarray caused by frequent adjustments[5].

3.2 Digital Twin- Driven Learning Progress and Resource Matching Strategy

Digital twin technology provides a computable reference model for learning progress diagnosis and resource matching. The learning behavior data of each learner, including operation sequence duration, error rate, number of retry attempts, and help- seeking node locations, are collected in real time and mapped into the digital twin space, forming an individualized capability evolution replica. This replica is compared frame by frame with the standard capability evolution curve to identify the positions and types of deviations that exceed the threshold. Deviations can be attributed to different causes such as cognitive overload, prerequisite competency deficiencies, or unfriendly resource interfaces, and the digital twin system accordingly triggers differentiated resource scheduling instructions.

The resource matching strategy automatically generates resource combination plans based on the type and degree of deviation. For progress lags caused by prerequisite competency deficiencies, the system traces back to the unclosed competency nodes in the competency map and pushes corresponding micro - module courses or virtual simulation training units, with the push order following the topological sorting of node dependency relationships. For cognitive overload, the system reduces the number of concurrent learning tasks and extends the available time window for individual modules, while also invoking simplified - difficulty alternative training versions that reduce the number of interfering variables while maintaining the core operational logic. The granularity of resource allocation can be refined down to the prompting strategies and feedback methods for individual operation steps, such as adding visual guidance or reducing temporal constraints at specific inspection stages. The digital twin- driven matching strategy circumvents the resource misallocation problem inherent in traditional unified - progress instruction, ensuring that each learner receives resource supplies commensurate with their current state along their capability evolution path. Moreover, the cumulative data from resource scheduling records can be used to continuously optimize the confidence intervals of the standard curve.

3.3 Progressive Evaluation and Feedback Pathway Based on the Competency Map

The competency map, serving as the benchmark framework of the evaluation system, decomposes the capabilities required for digital positions into observable and quantifiable competency nodes and their association edges. Each competency node corresponds to a specific technical operation or judgment activity, while the association edges characterize the dependency relationships and hierarchical structures among the nodes. The construction of the competency map is grounded in the operation sequence analysis of enterprise digital tasks and expert cognitive task analysis, ensuring that the granularity of nodes matches the precision of actual action units in the positions. The evaluation process no longer targets only the final output results; instead, it records learners' pass status and operation quality at each node within the competency map.

The progressive evaluation adopts a dual mechanism of node unlocking and path accumulation. Learners are required to unlock subsequent nodes level by level according to the prerequisite relationships preset in the competency map; nodes that are not passed must be retested or retrained before progression can continue, with the retest versions maintaining equivalent difficulty in parameter configurations but differing in specific numerical values from the original tests. The evaluation results simultaneously generate two forms of feedback: vertical feedback and horizontal feedback. Vertical feedback indicates the learner's current position on the competency path and the remaining distance to the terminal nodes, presented through progress bars and node density heatmaps. Horizontal feedback marks the differences between the learner's operational characteristics at each node and the standard operation model, specifying the deviation parameters, such as the percentage of torque value deviation from the nominal value, step- skipping positions in the data reading sequence, or the time difference by which response latency exceeds the threshold. The feedback pathway is closed back to the next training recommendation, forming an iterative cycle of evaluation- positioning- correction- reevaluation. Within each cycle, the system records the deviation convergence curve to assess correction efficiency. This progressive evaluation system makes the capability generation process visible and traceable, providing precise data anchors for the operational regulation mechanism and offering continuous calibration references for the capability evolution model in the digital twin system.

Conclusion

This study conducts a systematic analysis of the adaptive reconstruction of vocational undergraduate talent cultivation models under the background of enterprise digitalization, addressing three levels: identification of imbalance manifestations, identification of elements and relationship reconstruction, and operational regulation mechanisms. The study clarifies the changes in the time scale and spatial distribution of skill demands triggered by the reshaping effect of digital technologies on production organization forms, and reveals the adaptation lag mechanism of traditional cultivation models in dynamic capability generation. In terms of reconstruction pathways, the study proposes the dual shift in knowledge and competency of training objectives, the flexible organizational logic of the modular integrated curriculum system, and the restructuring of the virtual-real integrated teaching structure based on work-field iteration. To ensure the effective operation of the reconstructed model, the study constructs multi-agent collaborative dynamic calibration rules for cultivation programs, digital twin-driven learning progress and resource matching strategies, and a progressive evaluation and feedback pathway based on the competency map. These three components form a closed-loop regulation chain that spans from objective setting and resource allocation to competency verification.

Future research may further explore the differentiated construction methods of competency maps corresponding to different types of digital positions, as well as the dynamic self-optimization mechanism of the standard capability evolution curve within the digital twin system. In addition, the transferability validation of the adaptive reconstruction model across industries and disciplinary domains also represents a direction worthy of in-depth investigation.

References

[1] Huang, C. X., & Zi, C. F. (2025). Research on integrating financial literacy education into the cultivation of enterprise digitalization management talents in vocational undergraduate education — Taking Guangxi Vocational University of Agriculture as an example. Modern Business Trade Industry, (05), 61-63.

[2] He, J., & Wang, Z. Y. (2024). Research on measures to improve the talent cultivation model for enterprise digitalization in vocational undergraduate institutions. Modern Business Research, (01), 140-142.

[3] Kou, K., & Wang, Z. Y. (2024). Research on optimization of talent cultivation for enterprise digitalization management major in vocational undergraduate education based on employment orientation. Delta, (01), 245-247.

[4] Wang, Z. Y. (2024). Countermeasures for talent cultivation in the enterprise digitalization management major of vocational undergraduate education under the employment background. Liberal Arts Enthusiasts, (05), 11-13.

[5] Yuan, W. J. (2022). Research on talent cultivation models for accounting and finance majors in vocational undergraduate education under the background of enterprise digitalization. Marketing Circle, (13), 68-70.