

The Construction of Evaluation Indicators for the Integration Degree of Industry and Education in Higher Vocational Colleges, Led by the New Quality Productive Forces Development Strategy

Yikun Wang*

LAN ZHOU VOCATIONAL TECHNICAL COLLEGE, lanzhou, 730070, China

*Corresponding author: monicawang1734@163.com

Abstract: The penetration of New Quality Productive Forces factors challenges the industry-education integration system in higher vocational colleges with accelerated technological iteration and a compressed knowledge half-life. The traditional linear collaboration model, which is based on equipment sharing and internship placement, fails to meet the demands of dynamic matching. Based on the nonlinear coupling characteristics of the integration system, this paper deconstructs its three-layer structure-strategic synergy, resource exchange, and performance feedback-and their evolutionary mechanisms. It clearly defines the evaluation orientation centered on integration density, depth, and elasticity as core categories. Focusing on three main threads-the speed of technological iteration, the reconstruction of production factors, and the transformation of industrial forms-this paper extracts indicators for adaptability (technology response delay, knowledge coverage deviation), synergy degree (coding conversion rate, joint usage coefficient, role overlap index), and value-added capacity (skill transfer breadth, anomaly handling efficiency, process contribution rate, implicit cost reduction coefficient). By employing a combined weighting strategy and an integration maturity classification (ranging from loose contact to ecological symbiosis across four levels), this paper constructs a composite index nonlinear synthesis model and a dynamic calibration mechanism, thereby providing a methodological tool for the quantitative diagnosis and hierarchical judgment of the industry-education integration degree.

Keywords: New Quality Productive Forces; higher vocational colleges; industry-education integration degree; evaluation indicators; integration maturity; composite index

Introduction

The degree of industry-education integration directly determines the matching accuracy between talent cultivation in higher vocational colleges and industrial demands. The infiltration of New Quality Productive Forces factors has triggered a structural reorganization of technical standards and process logic on the industrial side. The limitations of traditional linear collaboration and static resource sharing models are becoming increasingly prominent, and there is an urgent need to construct an evaluation tool for the integration degree that reflects the quality of dynamic matching and the efficiency of system evolution. Existing evaluation methods tend to focus on the coverage of cooperation and the stock of resources, while they neglect the substantive impact of integration behaviors on the reproduction of technical knowledge. Moreover, they lack consideration for multi-level interaction effects and differences in the speed of technological iteration. Based on the logic of technical skill formation, this study clarifies the theoretical connotation and dimensional structure of the integration degree. It designs a domain-sensitive indicator framework around three main threads-technological iteration, factor reconstruction, and form transformation-and then forms a calibratable evaluation model through combined weighting and composite index synthesis, thereby providing a quantitative basis for identifying integration shortcomings and optimizing resource allocation.

1. Theoretical Connotation and Dimensional Deconstruction of the Industry-Education Integration Degree under the Guidance of New Quality Productive Forces

1.1 The Embedding Logic of New Quality Productive Forces Factors into the Industry-Education Integration System

New Quality Productive Forces factors manifest as data-driven technologies, intelligent production units, and networked organizational forms. Their embedding into the industry-education integration system of higher vocational colleges is not a simple resource superposition; rather, it is achieved by altering the knowledge carriers and transmission paths of technical skill formation. Traditional industry-education integration relationships mostly take equipment sharing and internship placement as their main interfaces. The introduction of New Quality Productive Forces factors prompts the integration system to shift from linear collaboration to nonlinear coupling. The accelerated speed of technological iteration and the compressed knowledge half-life require the education side and the industry side to achieve dynamic matching at the cognitive level. The core of this embedding logic lies in the transformation mechanism from production factors to teaching factors. That is, the technical standards, process parameters, and procedural logic from the industry side must undergo pedagogical reconstruction before they can become effective inputs to the integration system^[1].

The realization of the embedding process relies on two types of intermediary carriers: one is technical intermediaries, such as digital twin platforms and industrial internet interfaces, which map real-time data flows from production sites into virtual tasks in teaching scenarios; the other is organizational intermediaries, including cross-departmental project teams and technology transformation nodes, which are responsible for coordinating the ownership and transformation paths of intellectual property. These two types of intermediaries together constitute the channels through which New Quality Productive Forces factors penetrate from the industry side to the education side, and they determine the response speed and adaptation accuracy of the integration system. The degree of smoothness of the channels is directly reflected as the time lag difference between technology updates and curriculum updates in the industry-education integration system. The smaller this time lag is, the higher the execution efficiency of the embedding logic is.

1.2 The Multi-Level Structure of the Industry-Education Integration Degree and Its Evolutionary Mechanism

The industry-education integration degree is not a single-dimension quantifiable attribute; rather, it is a multi-level structure covering the strategic synergy layer, the resource exchange layer, and the performance feedback layer. The strategic synergy layer reflects the degree of consensus between higher vocational colleges and industrial entities on talent cultivation objectives, technology research and development directions, and resource allocation priorities. This layer determines the directional consistency of the integration system. The resource exchange layer involves specific activities such as personnel mobility, equipment sharing, data interoperability, and co-ownership of intellectual property. The frequency and depth of these exchanges constitute the basic observational surface of the integration degree. The performance feedback layer focuses on the impact of integration behaviors on the competency improvement of technical and skilled personnel and on the efficiency of solving technical problems on the industrial side, thereby forming a closed-loop regulation mechanism.

The evolution of this multi-level structure follows a path from loose coupling to structured integration, and its driving force originates from the dual pressures of increasing technological complexity and the deepening division of labor. In the initial stage, the integration degree mainly relies on temporary cooperation through individual projects or interpersonal networks, and the structure is loose and easily affected by personnel changes. As technological iteration accelerates, the industry side's demand for customized skill combinations of talents increases, which forces the education side to adjust its professional group settings and curriculum modules, thereby promoting the gradual explicit manifestation of the strategic synergy layer. At the same time, the resource exchange layer shifts from one-way supply to two-way embedding. For example, the industry side's process improvement needs are directly transformed into project tasks on the teaching side, and the teaching side's research and development outcomes are fed back into production line optimization. This evolutionary mechanism indicates that the improvement of the industry-education integration degree is not a linear increase; rather, it exhibits stepwise characteristics when thresholds of each layer are breached^[2].

1.3 The Value Orientation and Core Category Definition of the Integration Degree Evaluation

The value orientation of the integration degree evaluation should be based on the intrinsic requirements of the technical skill formation logic, rather than the simple accumulation of external evaluation indicators. Different from the measurement of the general degree of school-enterprise cooperation, the evaluation of the industry-education integration degree focuses on the closeness of the structural connection between the education system and the industry system and its explanatory power for the adaptive output of talents. A deviation in value orientation will lead the evaluation tool to overemphasize quantifiable contract numbers or equipment values, while neglecting the substantive impact of integration behaviors on the process of technical knowledge reproduction. Therefore, the evaluation of the integration degree needs to prioritize defining the evaluation object as “the operational efficiency of the integration system” rather than “the coverage of cooperative activities.” The former emphasizes the quality of dynamic matching, while the latter focuses on the stock of static resources.

The definition of the core categories is carried out around three dimensions: integration density, integration depth, and integration elasticity. Integration density refers to the frequency and diversity of effective interaction events between higher vocational colleges and the industrial side per unit of time, which reflects the level of system activity. Integration depth measures the level of technical knowledge contained in the interaction events, and it distinguishes among three levels: the transfer of operational skills, the optimization of process parameters, and the development of original technologies. Integration elasticity describes the system’s ability to maintain integration effectiveness in the face of technological upheavals or market demand fluctuations, and it involves the rapid reorganization ability of the curriculum system and the cross-domain adaptability of the teaching staff. The combination of these three dimensions constitutes the basic category framework for the integration degree evaluation, and the subsequent construction of the indicator system must complete operational definitions and measurement boundary delineations within this framework.

2. Selection and Hierarchical Structure of Evaluation Indicators for the Industry-Education Integration Degree in Higher Vocational Colleges

2.1 Design of Integration Adaptability Indicators Based on the Speed of Technological Iteration

The speed of technological iteration represents the update frequency of core processes or operational standards in a specific vocational field, and this variable directly affects the matching time lag between teaching content in higher vocational colleges and industrial demands. The design of integration adaptability indicators needs to focus on two core parameters: “technology response delay” and “knowledge coverage deviation.” Technology response delay measures the time period required from the introduction of a new process on the industrial side to the completion of the corresponding curriculum module update on the teaching side. The shorter this period is, the higher the adaptability is. Knowledge coverage deviation is quantified by comparing the coincidence rate and redundancy rate between the job skill list on the industrial side and the graduation requirements on the teaching side. A low coincidence rate reflects a deviation of training objectives from industrial reality, while a high redundancy rate suggests a waste of teaching resources^[3].

The observation of adaptability indicators requires distinguishing the measurement scales corresponding to different levels of technological iteration speed. For high-frequency iteration fields, such as industrial robot control programs and digital twin simulation parameters, adaptability indicators focus on the modularity degree of teaching resources and the rapid reorganization capability, specifically including the proportion of replaceable modules in the curriculum content and the frequency with which the teaching team completes technical training per unit of time. For low-frequency iteration fields, such as basic mechanical processing techniques, adaptability indicators instead focus on the stability of operational precision and the achievement rate of standard working hours. The difference in indicators between the two types of fields reflects that integration adaptability is not a uniform threshold but rather a relative value that dynamically adjusts with the speed of technological iteration. The indicator design also introduces the gap coefficient between early adopters and laggards in the technology diffusion curve, which is used to correct the adaptability measurement bias caused by internal technological differentiation on the industrial side.

2.2 Extraction of Integration Synergy Degree Indicators Oriented Toward the Reconstruction of Production Factors

The reconstruction of production factors manifests as the reallocation and functional reorganization of three types of factors-labor, technical data, and organizational processes-within the industry-education integration system. The integration synergy degree indicators need to be extracted from two dimensions: the direction of factor flow and the efficiency of factor transformation. The direction of factor flow examines whether the interaction paths of technical knowledge, operational specifications, and problem contexts between higher vocational colleges and the industrial side form a two-way closed loop. One-way flow (for example, the industrial side delivering equipment to the school without the school providing technical feedback) indicates a low synergy degree. The efficiency of factor transformation measures the rate at which process data from the industrial side, after pedagogical processing, is reconverted into usable technical solutions on the industrial side. The higher this rate is, the more the synergy system possesses self-reinforcing characteristics^[4].

The specific extraction of synergy degree indicators includes three operationalizable variables: first, the conversion rate of technical knowledge coding, that is, the proportion of tacit operational experience provided by the industrial side that is systematized into teaching documents and sent back to the industrial side for adoption; second, the joint usage coefficient of equipment and data resources, which measures the time allocation weight and cross-utilization rate of the same production equipment or the same set of process data between teaching tasks and production tasks; third, the overlap index of personnel roles, which calculates the proportion of individuals who simultaneously undertake teaching tasks and technical development tasks on the industrial side within the total teaching staff, as well as the depth of hierarchy at which such personnel participate in technical decision-making. The three variables are not independent of each other. A system with a high synergy degree typically exhibits simultaneous increases in all three variables that support each other, while a system with a low synergy degree presents a differentiated pattern in which one variable is excessively high while the other variables stagnate.

2.3 Decomposition of Integration Value-Added Capacity Indicators in Response to the Transformation of Industrial Forms

The transformation of industrial forms covers trends such as the shift of production organization methods from large-scale standardization to flexible customization, the extension of value creation links from manufacturing to services, and the evolution of product lifecycle management from linearity to circular succession. The integration value-added capacity indicators are decomposed into two complementary dimensions: educational value addition and industrial value addition. The former measures the marginal contribution of integration behaviors to learners' technical adaptability and problem-solving abilities, while the latter measures the marginal contribution of integration behaviors to process improvement and cost control on the industrial side. The superposition of the two dimensions constitutes the overall value-added capacity of the integration system, and the absence of either dimension makes it impossible to fully describe the actual level of integration value-added capacity.

The decomposed indicators under the educational value addition dimension include: the breadth of technical skill transfer, that is, the range of technical changes in adjacent positions that a learner can adapt to after completing training for a specific position; and the efficiency of abnormal situation handling, which measures the learner's accuracy rate of autonomous decision-making and the resolution time when facing non-standardized production anomalies. The decomposed indicators under the industrial value addition dimension include: the contribution rate of process parameter optimization, that is, the proportion of process improvement proposals put forward by teachers and students of higher vocational colleges that are adopted by the industrial side and result in measurable efficiency gains; and the coefficient of implicit cost reduction, which measures the reduction in recruitment and screening costs, the loss during the adaptation period of new employees, and the expenses for external technical consulting due to integration behaviors. The synthesis of the two types of indicators requires nonlinear weighting, because there may be an alternating dominance relationship between educational value addition and industrial value addition. At a stage with lower technological maturity, educational value addition is more significant, while at a stage with higher technological maturity, industrial value addition gradually becomes dominant.

3. Weight Allocation and Synthesis Model of the Evaluation Indicator System for the Industry-Education Integration Degree

3.1 Inter-Dimensional Correlations of Integration Degree Indicators and the Weighting Strategy

The inter-dimensional correlations of integration degree indicators manifest as the non-orthogonal relationships and interaction effects among the three core dimensions (integration adaptability, integration synergy degree, and integration value-added capacity). The adaptability dimension focuses on technology response delay and knowledge coverage deviation; the synergy degree dimension focuses on the direction of factor flow and the efficiency of transformation; and the value-added capacity dimension measures the marginal contributions of the education side and the industry side. The correlations among the three are not a linear superposition. An improvement in adaptability may reduce short-term synergy degree, because rapid technological response requires breaking the steady-state structure of existing resource exchanges. High value-added capacity often presupposes a high synergy degree, but high adaptability does not necessarily lead to high value-added capacity. This complex correlation requires the introduction of a correction mechanism for inter-dimensional interaction terms in the weighting strategy, thereby avoiding systematic bias caused by weight allocation based on the assumption of independence^[5].

The weighting strategy adopts a combined weighting path, integrating the advantages of both subjective weighting and objective weighting methods. At the subjective level, the group decision-making model in the analytic hierarchy process is used, where experts in the field of technical skill formation generate an initial weight vector through pairwise comparisons of the relative importance among the dimensions. An interaction effect judgment matrix is required to capture the synergistic and antagonistic relationships between the dimensions. At the objective level, based on the composite measure of the coefficient of variation and information entropy, the information load of each indicator is calculated using pre-collected observational data on the integration degree. Indicators with a higher degree of data dispersion receive higher objective weights. The final weight vector is synthesized through multiplicative normalization, and a weight adjustment parameter is introduced to balance the contribution ratio between subjective judgment and data characteristics. This combined strategy can effectively avoid the estimation bias of a single weighting method in the context of dimensional interactions.

3.2 Calculation Method of the Composite Index Based on Integration Maturity Classification

The integration maturity classification divides the industry-education integration system into four progressive levels: the loose contact level, the structural collaboration level, the system embedding level, and the ecological symbiosis level. Each level corresponds to specific behavioral characteristics of integration and indicator threshold ranges. The calculation of the composite index requires level identification as a prerequisite. The calculation method adopts the technique for order preference by similarity to ideal solution under the multi-attribute decision-making framework, and it is corrected by combining graded anchor points. First, the ideal value interval and the critical value boundary for each indicator are determined. The ideal value interval comes from the observation distribution of higher vocational colleges of the same type that are at the system embedding level and above, while the critical value boundary is set based on the quantile breakpoints between the loose contact level and the structural collaboration level.

The generation of the index is divided into two steps. The first step calculates the dimension-level scores. It maps the observed values of each indicator to the $[0,1]$ interval through a membership function. The membership function adopts an S-shaped curve to reflect the nonlinear cumulative characteristics of the indicators from low levels to high levels. The aggregation of indicators within a dimension adopts the weighted geometric mean, which emphasizes the synergistic achievement requirements of the indicators within the dimension rather than their mutual compensation. The second step synthesizes the overall integration degree index. It inputs the three dimension scores into a nonlinear synthesis model. This model assumes that there is limited compensability among the dimensions, that is, a low score in one dimension cannot be completely replaced by high scores in other dimensions. The substitution coefficient is determined by the antagonistic parameters obtained from the inter-dimensional correlation analysis. The final index value falls within the $[0,1]$ interval and corresponds to the judgment rules of the four-level classification of integration maturity. A fuzzy interval is introduced at the boundaries to avoid information loss caused by rigid classification.

3.3 Reliability and Validity Verification of the Evaluation Indicator System and the Dynamic Calibration Mechanism

The reliability verification is carried out from two levels: internal consistency and measurement stability. For internal consistency, Cronbach's alpha coefficient and the hierarchical reliability coefficient are used to examine the item homogeneity of the overall indicator system and each dimension respectively. For an indicator system that includes multi-dimensional interaction terms, the covariance reliability index between dimensions needs to be additionally calculated to assess the consistency level of items across dimensions. The measurement stability is tested through test-retest reliability and parallel-forms reliability. The correlation coefficient of the integration degree index for the same higher vocational college is calculated at two observation time points with an interval set to three to six months. At the same time, two parallel indicator sets with equivalent measurements are designed for cross-validation. When the correlation coefficient falls below the set threshold, it indicates ambiguity in the operational definition of the indicators or the need for revision of the observation protocol.

Validity verification covers content validity, construct validity, and criterion-related validity. For content validity, the expert review method is adopted, where independent experts in the fields of technical skill formation and educational measurement rate the degree of matching between the indicators and the dimension definitions, calculate the content validity index, and screen out indicator items that fall below the threshold. For construct validity, confirmatory factor analysis is used to test the goodness of fit of the dimensional structure, and the differences in fit indices between the hypothesized three-dimensional model and alternative models (one-dimensional model, two-dimensional model) are compared. When the goodness of fit of the three-dimensional model is significantly better than that of the alternative models, construct validity is established. For criterion-related validity, the graduates' technical adaptation cycle and the efficiency of solving technical problems on the industrial side are taken as external criteria, and the correlation coefficient between the integration degree index and the criterion variables is calculated. The dynamic calibration mechanism sets a parameter update for the indicator system every two evaluation cycles. The update basis includes the indicator discrimination decay curve and the temporal drift detection of inter-dimensional correlations. When the discrimination index of an indicator drops beyond the set threshold or a structural change occurs in the inter-dimensional correlation coefficients, the weight adjustment and critical value resetting process are triggered.

Conclusion

This paper completes a complete framework for the evaluation indicators of the industry-education integration degree in higher vocational colleges under the guidance of the New Quality Productive Forces development strategy, ranging from the definition of theoretical connotations to indicator screening, weight allocation, and the synthesis model. The study reveals that the industry-education integration degree covers a multi-level structure of strategic synergy, resource exchange, and performance feedback, and its evolution follows a stepwise path from loose coupling to structured integration. The adaptability, synergy degree, and value-added capacity indicators extracted based on the three main lines of technological iteration speed, production factor reconstruction, and industrial form transformation break through the traditional evaluation's reliance on static cooperative activities and achieve the measurement of dynamic matching quality and system value-added efficiency. The combined weighting strategy and the composite index synthesis method based on integration maturity classification address the issues of non-orthogonal correlations and limited compensability among dimensions. The reliability and validity verification and the dynamic calibration mechanism provide technical guarantees for the continuous optimization of the evaluation system. Future research can expand the adaptability test of the indicator system to different types of higher vocational colleges and explore the differentiated setting of weight parameters; introduce longitudinal tracking data to verify the predictive validity of the integration degree index on the medium- and long-term technical adaptability of graduates; and construct a closed-loop feedback mechanism between evaluation results, teaching diagnosis, and resource allocation, thereby promoting the extension of the evaluation tool from measurement diagnosis to intervention optimization.

Fund Projects

Research on the Construction of the Evaluation Indicator System for the Industry-Education Integration Degree in Higher Vocational Colleges Based on the New Quality Productive Forces Development Strategy

Project No.: 2024XYXD-6

References

- [1] Sheng Qingsong. "Exploration of the Construction Path of the Industry-Education Integration Community in Higher Vocational Colleges." *Health Vocational Education* 44.09(2026): 12-16.
- [2] Jiang Tao. "The Construction Path of the Industry-Education Integration Interest Community in Higher Vocational Colleges in the New Era." *Jiangsu Commercial Forum* .04(2026): 127-131.
- [3] Liu Huaping. "Research on the Construction of the Professional Ethics Education System in Higher Vocational Colleges from the Perspective of Industry-Education Integration." *Education and Teaching Forum*: 1-4.
- [4] Wang Huixia. *Research on the Construction of the Evaluation Indicator System for Industry-Education Integration in Higher Vocational Colleges Based on the CIPP Model*. 2022. Guangdong Polytechnic Normal University, MA thesis.
- [5] Liu Zhuchun, Zhang Dan, and Chen Biao. "Research on the Construction of the Professional Evaluation Indicator System in Higher Vocational Colleges under the Background of Industry-Education Integration." *Equipment Manufacturing Technology* .01(2022): 193-195.