Construction of Teacher Performance Evaluation System in Private Higher Vocational Colleges Based on AHP and Factor Analysis

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Abstract: On the basis of sorting out the related research on teacher performance in private higher vocational colleges, this paper constructs the teacher performance evaluation system in private higher vocational colleges from the perspective of teacher ability composition, aiming at the existing problems in the current teacher performance evaluation in private higher vocational colleges. In the selection of indicators of the system, literature analysis, social research and policy interpretation are adopted to screen out the preliminary evaluation indicators, which are revised and improved through expert interviews to determine the evaluation indicators. The importance of each index was scored by questionnaire survey, and the recovered data were analyzed by SPSS software combined with AHP (analytic hierarchy process) and factor analysis, and the weight of each index was finally determined.

1   INTRODUCTION

In the *Opinions on Promoting the High-quality Development of Modern Vocational Education*, it is mentioned that the income of vocational schools through school-enterprise cooperation, technical services, social training and self-run enterprises can be used as the source of performance pay in a certain proportion (Opinions on Promoting the High-quality Development of Modern Vocational Education, 2021). The implementation of performance evaluation is a general trend, but at present, the performance evaluation of private higher vocational colleges has some problems, such as lagging evaluation index, unreasonable setting of index weight, imperfect evaluation mechanism, and inconsistent with the running characteristics of private higher vocational colleges, which restrict the development of private higher vocational colleges to a certain extent (North China University of Water Resources and Electric Power, 2020). In order to change this situation, many scholars have conducted researches from multiple directions and multi-dimensions. Cheng Weiku (Cheng 2021) constructed the evaluation system from five dimensions: teacher evaluation orientation, annual evaluation, teaching quality evaluation method, professional title evaluation and employment, and post-employment management. Yang Chunmei (Yang 2019) constructed an evaluation system from four dimensions: benefit, stakeholders, teaching process and teacher learning and growth; Zhang Lu (Journal of ecological engineering vocational college, 2014) used analytic hierarchy process (AHP) in the construction of the system. The system evaluation index constructed by Wang Jihua (Wang 2020) comes from five aspects: teaching evaluation, professional promotion, teacher training, competition and campus culture construction. Wang Yan (Wang 2020) took the construction of ethics, work process, work performance and social service ability as the main evaluation indicators; Liu Xin (Liu 2017) used the balanced scorecard method when building the system. These methods are worthy of reference in this paper, but most of these scholars are based on a specific college to analyze, general adaptation is not strong. This paper aims to build a set of private higher vocational college teacher evaluation system based on the requirements of vocational education

reform on teachers' ability and quality, expand and improve the theory of teacher management, apply to the daily management and evaluation of teachers, provide ideas for the construction of teachers, so as to promote the continuous progress of vocational education.

2 CURRENT SITUATION OF TEACHERS' PERFORMANCE EVALUATION IN PRIVATE VOCATIONAL COLLEGES

The current performance evaluation of private higher vocational colleges mainly has the following problems:(1) Unreasonable evaluation index setting. Modern vocational education pays attention to teachers' abilities in many aspects, attaches more importance to theoretical basic education than to teachers' practical ability, and attaches importance to both skill training and humanistic quality. However, the current evaluation of teachers' performance mainly focuses on academic level and scientific research ability, but not on professional and technical practical ability, vocational education and teaching research, social service and evaluation (Wang 2012). The index setting of "emphasizing birth, neglecting ability, emphasizing theoretical teaching, neglecting practical teaching, emphasizing academic research, neglecting technology application" is the most important problem in teacher evaluation of higher vocational colleges at present (Zhou 2019). This is contrary to the requirements of modern vocational education, so it is necessary to build a new evaluation system. (2) Lack of teachers' participation in the formulation of performance evaluation system. The teacher performance system in most schools is formulated by administrative personnel in accordance with the intention of superior leaders and their own experience, combined with the evaluation methods of teachers in other similar institutions, and teachers rarely participate in the formulation process. Due to the different positions, the performance evaluation system has many unreasonable points, which will affect the enthusiasm of work over time. (3) The evaluation method is unreasonable. At present, the main methods of teacher performance evaluation include 360-degree evaluation method, leadership evaluation method and democratic evaluation method. All of these methods have the problem of strong subjectivity and lack of objective authenticity of evaluation results. Li Peili et al. believe that "speaking by numbers" is easier to convince teachers

than other ways (Li, Zhang, 2007), so it is necessary to establish a set of evaluation methods using systems and standards. (4) Unclear positioning. At present, the evaluation system of few schools takes into account the characteristics of private colleges and universities, which have less financial funds and need to be responsible for their own profits and losses. As a result, the performance management mechanism is not consistent with the development strategy and school-running orientation of the college, and does not fully reflect the school-running characteristics of the college.

3 OVERALL CONSTRUCTION IDEA

The goal of this study is to solve the existing private vocational college teacher performance evaluation system unreasonable. To be specific, it is necessary to closely follow the national strategic deployment in vocational education, investigate the demand of society and enterprises for talents, and clarify the core quality of talent training in vocational colleges. This paper analyzes what kind of vocational teaching ability teachers in vocational colleges should have in order to achieve the corresponding training objectives, and evaluates the ability of teachers in vocational teaching. Therefore, the essence of teacher performance evaluation is the evaluation of teachers' vocational teaching ability. The key point of the construction of evaluation system is the identification of teachers' vocational teaching ability, and the conversion of ability into evaluation index and the setting of weight. In order to ensure that the evaluation system is scientific and reasonable, many aspects of research are carried out when the index is established, and the SPSS software is used to combine factor analysis and AHP to analyze the data when the weight is determined.

4 ESTABFIGURE LISHMENT OF PERFORMANCE EVALUATION SYSTEM INDICATORS

4.1 Selection of Indicators

The indicator establishment process in this paper includes the following steps:(1) Policy analysis. This paper analyzed seven policy documents related to modern vocational education from 2014 to 2021,

and extracted 17 items of teachers' competence and quality in vocational colleges, such as teachers' ethics and style, production-education integration, and practical teaching ability. (2) Social research and statistics on vocational education. In March 2021, Educator magazine and relevant institutes of education conducted an extensive survey for vocational colleges, families and enterprises across the country and formed a Large-scale Questionnaire Report on the Development of China's Vocational Education [114]. According to the data of the report, 21 items of teachers' competence and quality are extracted, such as the ability to guide students' skill competition and social service ability. (3) Literature analysis. In this paper, the literature related to "higher vocational teacher performance" was sorted out and 26 evaluation indicators were extracted, such as professional practice and scientific research performance (4) Expert interview. The teachers' abilities extracted in the first three steps are sorted into the first draft of the evaluation index system. Eleven vocational education experts were invited to verify the index system based on the characteristics of private colleges and universities, eliminate unreasonable indicators and add other indicators that are not perfect.

4.2 Establishment of Indicators

In accordance with the practice of expert interviews and field investigations in schools during index screening, this paper takes teachers' ethics as the index of the one-vote rejection system and does not participate in weight calculation. In addition, 6 first-level indicators, 11 second-level indicators and 34 third-level indicators were finally determined.

Level indicators	Second-level indicator	Third-level indicator
Organizational discipline	Organizational discipline	Positive work attitude
		Be disciplined in your work
		Attendance is good
Education and teaching ability	The teaching effect	Quality of classroom teaching
		Classroom management situation
		Award for Teaching work
		Students' feedback
	The teaching reform	Course resource construction
		Teaching reform project research
		Curriculum reform project research
		Compiling and publishing teaching materials and handouts
	Research results	The paper
		patent
		Longitudinal subject
		Horizontal topic
Professional practical ability	The practice teaching	Guide practical training courses
		Guide graduation design
		Guide students in business practice
		Guide students in innovation and entrepreneurship
	Work in the training room	The fusion of production and education
		Construction of on-campus training room
		Construction of off-campus training base
	Industry skills	Business Experience
		Professional Qualification Certificate
External communication ability	Social services	External technical services
		External technical consultation
		External training provided
	Social acceptance	Social part-time job, social honor
		Guide students to win prizes in competitions
		Teachers provincial and municipal awards
	Financial gains	Enrollment workload
Professional re-learning ability	Professional re-learning ability	Degree in ascension
		Title promotion
		Further study and training

Figure 1. Teacher performance evaluation index

5 DETERMINATION OF WEIGHT OF PERFORMANCE EVALUATION SYSTEM

Since the importance of each indicator is different, it is necessary to assign weight to each indicator. In this paper, the index system is made into a quantitative evaluation table, which is distributed to front-line teachers, teaching administrators, teaching auxiliary staff, administrative staff and other teaching related personnel in the way of questionnaire survey, and the recovered questionnaire data is used as the basic data to determine the weight of the index. SPSS software was used for statistical processing of questionnaire data, combined with AHP and factor analysis to determine the final weight.

5.1 Questionnaire Survey

In this survey, questionnaires were distributed through the questionnaire star, with 34 three-level evaluation indicators as variables and six first-level indicators as six dimensions, and the importance of each variable was scored by the five-level system respectively. A total of 183 questionnaires with valid data were collected.

5.2 Sample Data Analysis

The data analysis of the sample includes reliability analysis and validity analysis. This study first carried out reliability analysis (Cronbach's α coefficient) from the six dimensions of teachers' ethics, education and teaching ability, scientific research ability, professional practice ability, external communication ability and professional relearning ability, and then conducted validity analysis of the above indicators in order (KMO and Bartley sphere test). In order to test the validity of the questionnaire data answers and the rationality of the questionnaire design.

5.2.1 Sample Reliability Analysis

This paper used SPSS software to analyze the reliability of questionnaire data and sample validity. The Cronbach 'Salpha coefficients of the six first-level indicators were all greater than 0.8, indicating the high reliability of the questionnaire. Then, validity test was conducted. Since the evaluation indicators of this paper come from policy interpretation, literature research and expert interviews, the content is

true and valid, and the content validity meets the requirements, so the construction validity was mainly tested here. After analysis, the KMO of the questionnaire was 0.907, greater than 0.6, and the Bartlett sphericity test showed that $P = 0.000$, less than 0.05, indicating that the data met the condition of structural validity test by factor analysis. Then factor information concentration analysis and validity analysis were carried out, a total of 6 factors were extracted, and the characteristic root values were all greater than 1. The variance explanation rate values of the 6 factors were 14.462%, 14.242%, 13.743%, 10.783%, 6.737%, 5.450%, and the cumulative variance explanation rate after rotation was 65.417%. More than 50%. Factor loading coefficient absolute value is greater than 0.4, the organization discipline corresponding factor 4, corresponding education teaching ability factor 2, corresponding factor 6 scientific research ability and professional practice ability corresponding factor 3, foreign exchange capacity corresponding factor 1, professional learning ability corresponding factor 5, factors and research items and consistent with the expected results, the relation between data effective degrees.

5.3 Selection of Indicator Weight Determination Method

Because there are three levels of indicators in this paper, it is suitable to use the analytic hierarchy process to determine the weight of indicators, but the analytic hierarchy process has certain subjectivity. At the same time, there are a large number of indicators in this paper, and dimensionality reduction is needed in the analysis, which is just suitable for factor analysis to determine the weight. Therefore, this paper combines the two methods. The weight of the first-level index is determined by factor analysis method, and the weight of the second-level and third-level indexes is determined by reuse analytic hierarchy process, which can avoid the defects caused by a certain method.

5.3.1 Determining the Weight of First-Level Indicators

According to the variance interpretation rate values of the six factors and the cumulative variance interpretation rate value after rotation in the sample reliability analysis, the corresponding weights of each index are shown in Figure 2:

Item	Organizational discipline	Education and teaching ability	Scientific research ability	Professional practical ability	External communication ability	Professional re-learning ability
Explained rate of variance after rotation	10.783%	14.242%	5.450%	13.743%	14.462%	6.737%
Cumulative variance explanation rate after rotation	65.417%					
The weight	16.48%	21.77%	8.33%	21.01%	22.11%	10.30%

Figure 2. Weight of first-level indicators

5.3.2 Determination of Three-Level Index Weight

This paper uses the AHP to determine the weight of the secondary index and the tertiary index.

Establish a Hierarchical Structure System. The hierarchical structure system consists of three levels, the top level is the construction of higher vocational teachers, the middle level is 6 first-level indicators, the bottom level is 11 second-level indicators, and each second-level indicator contains several third-level indicators, a total of 34 third-level indicators.

Construct Pairwise Comparison Matrices. In order to judge the importance of each indicator in the performance evaluation index system, it is necessary to construct a judgment matrix to make a pairwise comparison of each indicator layer by layer. Firstly, the average scores of 183 questionnaires of 34 third-level indicators were calculated respectively. Then, each second-level indicator was taken as a dimension, and the average scores of third-level indicators of this dimension were divided by two to obtain the judgment matrix, as shown in Figure 3:

The data in the judgment matrix of row I and column j are denoted as aij, aij=ai/aj, where ai-- the average score of Ai term and aj -- the average score of Aj term.

The average	Item	A_1	A_2	A_3	...	A_j
a_1	A_1	1	a_1/a_2	a_1/a_3	...	a_1/a_j
a_2	A_2	a_2/a_1	1	$a_2/a3$	...	a_2/a_j
a_3	A_3	a_3/a_1	a_3/a_2	1	...	a_3/a_j
...	...	...	...	...	1	...
a_j	A_j	a_j/a_1	a_j/a_2	a_j/a_3	...	a_j/a_j

Figure 3. AHP judgment matrix

Calculate the Eigenvector and Weight Value, and do Consistency Check. The maximum eigenroot and corresponding eigenvector of each pairwise comparison matrix are calculated, and the consistency test of the evaluation results of the judgment matrix is made. If the test passes, the weight calculation results in the judgment matrix are valid. When CR<0.1, consistency is considered to be

satisfied; otherwise, pairwise comparison matrices are reconstructed.

$$CR = \frac{CI}{RI}$$

Where: CI is the consistency test index, $CI = \frac{\lambda_{max}-n}{n-1}$, λmax-- is the maximum characteristic root of the judgment matrix.

RI-- Random consistency proportional coefficient, the value of RI is related to the order "n" of the judgment matrix, and the specific value is shown in Figure 4:

n order	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
RI values	0	0	0.52	0.89	1.12	1.26	1.36	1.41	1.46	1.49	1.52	1.54	1.56	1.58	1.59
n order	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
RI values	1.5943	1.6064	1.6133	1.6207	1.6292	1.6358	1.6403	1.6462	1.6497	1.6556	1.6587	1.6631	1.6670	1.6693	1.6724

Figure 4. RI table of random consistency

5.3.3 Determination of the Weight of Second-Level Indicators

The calculation method of the weight of the second-level index is the same as that of the third-level index. Each first-level index is taken as a dimension, and the second-level index below each dimension is scored by experts, so as to construct the judgment matrix, calculate the feature vector and weight value, and do the consistency test.

5.3.4 Determination of Comprehensive Weight

The comprehensive weight formula of each index is: = the weight of first-level indicators* weight of second-level indicators*Three-level indicator weight

6 CONCLUSION

In the process of designing the index system, this paper investigates the current situation and social needs of performance evaluation of private higher vocational colleges. When setting the index weight, it fully considers the wishes of front-line teachers, which can promote the development of private higher vocational colleges more than the existing performance evaluation system. SPSS software combined with AHP and factor analysis is used to set the weight for each evaluation index, and a quantifiable evaluation index system is constructed. In the process of using, each school can set the scoring standard for each index, and the combination of weight

and standard is fairer than the current evaluation method. The weight scale of the evaluation system constructed in this paper shows that, among the six competencies that teachers should possess, teaching and education ability, professional practice ability and external communication ability can most affect the results of teacher performance evaluation.

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