Research on Vocation Education Performance Evaluation Based on Fuzzy Analysis

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Abstract. How to evaluate vocation education performance is one of the difficulties and hot research fields for the researchers related. The paper presents a new model for evaluating vocation education performance based on the principle of analytic hierarchy process and fuzzy comprehensive evaluation. First an evaluation indicator system of vocation education performance is designed through analyzing the characteristics of vocation learners' behavior; Secondly in constructing the comprehensive evaluation model for vocation education performance, analytic hierarchy process and fuzzy comprehensive evaluation are combined and two level fuzzy evaluation is adopted to satisfy the dynamics, subjective and transitional characteristics of indicators and improve evaluation accuracy. Thirdly datum from three vocational colleges are taken for examples to verify the validity and feasibility of the model and the experimental results show that the model can evaluate vocation education performance practically and can help vocation education service providers take corresponding concrete measures to enhance its education performance.

Introduction

In the modern information era, vocation education is gradually prospering and spreads to the education systems of all the industries. Vocation education can effectively give play to the advantages of existing education resources, and brings new education concept, education methods and learning methods, making thousands of experts, scholars, teachers and students in new technologies constantly have a try and think about how to develop the vocation education utilization value. Whether vocation education is of high quality, whether it can reach anticipated education purpose and realize education value need a comprehensive, objective and overall evaluation system and a practical evaluation method. Thus, establishing perfect and reasonable evaluation standard and puting them into practice and evaluating them by adopting proper methods becomes an important topic to be solved [1].

Up to now, mathematical models adopted by evaluation of vocation education performance mainly include the following categories. ① Analytic hierarchy process is a good method for quantitative evaluation via quantitative method, having the functions of establishing the ideal weight structure of evaluated object value and analyzing the weight structure of actually-built value by evaluated object; however, the method has strong limitations and subjectivity, with large personal error, not suitable for complicated system with lots of evaluation indicators[2]. ② BP neural network evaluation method makes use of its strong capability in processing nonlinear problems to carry out evaluation of vocation education performance; the method has advantages like self-learning, strong fault tolerance and adaptability; however, the algorithm is easy to be trapped into defects like local minimum, over-learning, strong operation specialization[3]; ③ Fuzzy comprehensive evaluation is a method carrying out comprehensive evaluation and decision on system through fuzzy set theory, the greatest advantage of which is that it works well on system evaluation of multi-factor and multi-level complicated problems. However, the membership of fuzzy evaluation method as well as the

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definition and calculation of membership function are too absolute, difficult to reflect the dynamics and intermediate transitivity of evaluation indicators of vocation education performance[4,5].

Fuzzy evaluation is a method that accurately solves inaccurate and incomplete information, the greatest advantage of which is that the fuzziness and initiative of human thinking can be naturally processed. Hence, this paper will design a indicator system for vocation education performance evaluation and use analytic hierarchy process to overcome the disadvantages of original fuzzy evaluation thus making colleges convenient to carry out vocation education performance evaluation.

Analysis and Establishment of Evaluation Indicator System

Vocation education performance evaluation is a complicated comprehensive operation system constituted by multiple elements, the numerous elements and subsystems of which exist in different forms, jointly assembly and forming competitiveness. This paper, based on the principle vocation learner behavior analysis, in the light of connotation characteristics of competitiveness evaluation Vocation education performance, especially on the basis of competitiveness analysis of experts consultations, combined with literatures, establishes a wide and scientific evaluation indicator system of vocation education performance evaluation [2,3,4]. The indicator system here include two categories. One category is vocation learner behavior which concludes 4 second-grade indicators, that's initial state (including software condition for study, adaptability of vocation learning environment, hardware condition for study, learning motivation), learning attitude (including completion status of study plans, participation status of teaching activities, communication with classmates, completion status of difficult tasks, self-learning abilities, study notes and records, completion status of homeworks , examination status), communication and cooperation(including questioning frequency, opinion giving in discussion zones, study summary ability in discussion, communication ability with teachers and classmates, ability to put porward teaching suggestions, ability to answer questions, teamwork abilities), resource utilization(including ability to utilize network recourse, ability to record notes, ability to choose resources ,ability to release information ,ability to release information, ability to solve practical problems). Another category is indicators of vocation education provider which concludes 3 second-grade indicators, that are evaluation of vocation curriculums, evaluation of vocation education management, evaluation of teaching effects.

Establishment of Multi-hierarchy Fuzzy Evaluation Model

Steps of Fuzzy Overall Evaluation Method. Fuzzy overall evaluation in this paper is conducted according to the following five steps. The first the second steps are establish evaluation element set and confirm evaluation set respectively which can see reference 7. The third step is confirm the weight of evaluation indicator, in which AHP is introduced to obtain the weight wi of each evaluation indicator ui. The set constituted by each weight wi is called weight set W, as shown in formula 1.

$$W = \{w1, w2, w3, \ldots wn\} \sum_{i=1}^{n} w_i = 1 \qquad w_i \geq 0 \tag{1}$$

There are generally the following steps to confirm indicator weight by AHP which include three steps, that are judgment matrix construction the weights calculation of all indicators. All of above steps can see reference 7. In step 3, Quantitative indicator used for measuring judgment matrix is called consistency indicator CI, as shown in formula 2.

$$CI = (\lambda max - n)/n - 1 \tag{2}$$

In formula 2[7], λmax is the maximum eigenvalue of judgment matrix, n is the number of comparison indicator. λmax is calculated as reference 7.

Step 4:Single-factor Fuzzy Evaluation, Suppose that evaluation object carries out evaluation according to the ith factor in factor set U ui (i=1, 2, 3, …, n), the subordination of which as to the jth factor in evaluation set V vj (j=1，2，3，…，m) is expressed as rij, formula 3 can be used to show the evaluation result of the ith factor ui.

$$R_i = \{ri1, ri2, ri3, \ldots rim\} \tag{3}$$

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Ri in formula 3 is single-factor evaluation set, so formula 4 can be obtained, i.e. single-factor evaluation set of each factor.

$$R = \begin{bmatrix} R_1 \\ R_2 \\ \vdots \\ R_n \end{bmatrix} = \begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1m} \\ r_{21} & r_{22} & \cdots & r_{2m} \\ \vdots & \vdots & \vdots & \vdots \\ r_{n1} & r_{n2} & \cdots & rnm \end{bmatrix} \tag{4}$$

R in formula 4 is called single-factor evaluation matrix. Rij can be obtained through experts grading method, subordination function method or other managerial mathematical methods.

Step 5: Evaluation model building for overall evaluation. In consideration of difference importance of each factor, i.e. different indicator weights, it is necessary to combine the weight set W and R of all the evaluation indicators, to carry out overall evaluation, building evaluation model formula 5[7].

$$B = W \circ R \circ \begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1m} \\ r_{21} & r_{22} & \cdots & r_{2m} \\ \vdots & \vdots & \vdots & \vdots \\ r_{n1} & r_{n2} & \cdots & rnm \end{bmatrix} = (b_1, b_2, \ldots b_m) \tag{5}$$

In formula 5, B is the result set of fuzzy overall evaluation, bj (j=1, 2, 3, …, m) is called fuzzy overall evaluation indicator, which judges the indicator subordination of the jth evaluation element in evaluation set while comprehensively considering the impact of all the indicators on evaluation object.

In the above evaluation process, symbol "o" is fuzzy synthetic operator, also called fuzzy operator, generally having the following four forms[7].

Model 1 is adopted. M(∧， ∨)——Major Factor Determining Type, see formula 6 "∨" in formula 6 represents large-taking symbol, "∧" represents small-taking symbol, the model features the focus on major factors, and that other factors have little impact on results.

$$b_j = \bigvee_{i=1}^{n} (w_i \wedge r_{ij}) \qquad (j = 1,2,\ldots m) \tag{6}$$

Multi-hierarchy Fuzzy Overall Evaluation. In actual cases, if the evaluation object is multiple factors and the weight distribution among all the factors is relatively balanced, we can adopt multi-hierarchy model for evaluation. Following is the introduction to build third-grade model.

Step1:Divide Factor Set.Divide Factor U into several hierarchies U={ u1, u2, u3, …, un }, conditions satisfied formula 7. U={ u1, u2, u3, …, un } is called the first factor set.Suppose ui={ ui1, ui2, ui3, …, uik }, i=1,2, …, n is called the second factor set; uij={ uij1, uij2, uij3, …, uijl }, i=1,2, …, n, j= i=1,2, …, k is called the third factor set.

$$\begin{aligned} u_i \cap u_j \neq \varphi, \qquad & when \qquad i \neq j \\ u = \bigcup_{i=1}^{n} & u_i \end{aligned} \tag{7}$$

Step2:Carry out first-hierarchy fuzzy overall evaluation on uij. Suppose that the weight set of uij={ uij1, uij2, uij3, …, uijl } is wij={ wij1, wij2, wij3, …, wijl },According to formula 5, overall evaluation is wijoRij=Bij, i=1,2,…, n,j= i=1,2, …, k.

Step 3: Carry out second-hierarchy fuzzy overall evaluation on ui. Suppose that the weight set of ui={ ui1, ui2, ui3, …, uik } is wi={ wi1, wi2, wi3, …, wik }, according to formula 5, overall evaluation is wioRi=Bi, i=1,2, …， n.

Step 4: Carry out third-hierarchy fuzzy overall evaluation on u. Suppose that the weight set of U={ u1, u2, u3, …, un } is W={ w1, w2, w3, …, wn }, according to formula 5, overall evaluation is WoR =B, at last, adopt weighted average method to get evaluation result.

Experiment Confirmation

Experimental data come from database of three vocation colleges of Nanchang University, and Southeast Jiaotong University and Jiangjiu college. Relevant data of 5000 learner of each university are selected as the basis for data training and experimental verification in the paper, totally 15000 learns' data for study data that come from practical investigation and visit of two specific vocation education institutions and students. In order to make the selected learners' data representatives, 3000 learners(1000 learner from each university) with more than 3 years learning experience, 9000 learners with 2 years learning experience, 3000 learners with less than 2 years learning experience. Limited to paper space, the evaluation of intermediate results is omitted here, only providing part of evaluation results and final comprehensive evaluation results, see table 1.

Table 1 Evaluation results of different vocation colleges

	Vocation education provider	Vocation learner behavior				Final evaluation
		Initial state	Learning attitude	Communication and cooperation	Resource utilization	
Nanchang University	4.552	3.751	4.321	4.871	5.744	4.467
Southeast Jiaotong University	3.761	3.621	3.889	4.323	4.998	3.955
Jiangjiu College	3.872	3.324	3.541	4.876	4.987	3.411

Conclusion

Comprehensive evaluation of education performance is an effective method for guaranteeing vocation learning quality, lying in the core status of the entire evaluation system of vocation education. Thus, there is a favorable application prospect for the analysis and competitiveness evaluation of vocation education based on the principle of fuzzy analysis. This paper, on the basis of the principle of learner behavior analysis, analyzes and builds comprehensive evaluation system of vocation education, makes use of multi-hierarchy fuzzy evaluation method to establish comprehensive evaluation model for vocation education, also carries out case study taking the data of distance training schools of three different universities as an example. Meanwhile, the multi-hierarchy fuzzy evaluation method built in this paper can be reference for the analysis and evaluation of other multi-factor systems.

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