

Research on the Quality Evaluation System of College-enterprise Cooperation Talents Training Based on Fuzzy Comprehensive Evaluation*

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Abstract—This paper adopts the Analytic Hierarchy Process and the fuzzy comprehensive evaluation model to realize the grading evaluation of the quality of college-enterprise cooperation talents training. Based on the survey and evaluation on 263 samples of college-enterprise cooperation graduates from Changchun Guanghua University, 263 samples of students were evaluated according to the output of the model. The results are widely recognized by counselors, tutors, enterprises and employers. In the same way, the overall recognition rate reached 95.1%. The result of the experiment shows that the evaluation system is scientific, reasonable and feasible, and can provide some reference and basis for the comprehensive evaluation of the quality of college-enterprise cooperation personnel training.

Keywords—college-enterprise cooperation; the quality of talents training; fuzzy comprehensive evaluation; index system

I. INTRODUCTION

The college-enterprise cooperation is the inherent need of university transformation and survival and development, is a systematic project, is also an effective way to cultivate high-quality applied talents, and an important carrier of deepening the cooperative education of production, teaching and research. The construction of the evaluation system for the training quality of college-enterprise cooperation talents is the first important factor to guarantee the sustainable

development of college-enterprise cooperation [1-3]. It can reasonably and accurately evaluate the cooperative running effect under the condition of deep integration between college and enterprise, and provide important basis for the decision-making of teaching quality management, specialty setting optimization, training scheme formulation, curriculum content innovation and cooperative system design.

Firstly, the evaluation matrix of the talent training quality of college-enterprise cooperation is constructed in this paper, and the 263 samples of graduates from Changchun Guanghua University are taken as the object of investigation and evaluation. Using the fuzzy comprehensive evaluation algorithm, the evaluation matrix of talent training quality is established. Through programming, 263 samples of students are evaluated and satisfactory results are achieved.

II. EVALUATION INDEX SYSTEM OF TRAINING QUALITY OF COLLEGE-ENTERPRISE COOPERATIVE TALENTS

Against the background of college-enterprise cooperation, the quality evaluation of applied talents training is a multi-level, non-linear, dynamic and fuzzy complex [1] [2] [3] [4]. Through consulting and discussing with relevant experts for many times, and on the basis of accumulating years of deep cooperation between college and enterprises, the evaluation is made from three aspects: college, enterprise and student, and a series of evaluation indexes are obtained. Then, the hierarchical design is carried out according to the subordinate relationship of the relevant indicators by using the analytic hierarchy process.

Finally, the quality of the training of college-enterprise cooperation talents is determined as the target level A. The

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critterion level B includes four aspects: the basis of college-enterprise cooperation(include: The attention degree of colleges and enterprises, agreements for long-term co-construction between college and Enterprise, college and enterprise resource investment, college and enterprise of funds input, The number of college-enterprise cooperative

specialty);the process management of college-enterprise cooperation; the effect of college-enterprise cooperation; and the comprehensive quality of students(include: Measure level C includes 21 three-level indicator as shown in "Table I".

TABLE I. EVALUATION INDEX SYSTEM FOR THE QUALITY OF COLLEGE-ENTERPRISE COOPERATION

target level A	first grade index B(weight)	second grade index C(weight)
the quality of the training talents of college-enterprise cooperation	the basis of the basis of college-enterprise cooperation(0.2)	The attention degree of colleges and enterprises (0.2)
		agreements for long-term co-construction between college and Enterprise (0.3)
		college and enterprise resource investment (0.2)
		college and enterprise of funds input (0.2)
		The number of college-enterprise cooperative specialty(0.1)
	the process management of college-enterprise cooperation(0.2)	The rules and regulations on the training of college -enterprise cooperative talents(0.25)
		teaching management and supervision based on Dual-Subject of college-enterprise(0.25)
		teachers training in college and enterprise (0.2)
		communication and interaction between college and enterprise (0.1)
		college and enterprise develop teaching resources together (0.1)
		recruitment and employment of college and enterprise (0.1)
	The effect of college-enterprise cooperation (0.3)	enhancing innovative ability (0.15)
		employment rate and counterpart rate (0.3)
		The satisfaction of parents (0.1)
		satisfaction of employers (0.2)
		sustainable development of college-enterprise cooperation (0.15)
	the comprehensive quality of students (0.3)	input and output of college and enterprise (0.1)
		Thought(0.2)
		Knowledge(0.2)
		Ability(0.3)
		Quality(0.3)

When establishing the model, the connotation of each index in the second-level C level of measure is analyzed, and then the quantitative score is given according to the main observation points corresponding to the connotation of each index. Through consulting and discussing with relevant experts for many times, and on the basis of the experience of the author's college in-depth cooperation between college and enterprises, the connotation of secondary indicators and main observation points are determined. For example, the secondary indicators of "regulations and regulations for training college-enterprise cooperation talents" include: the management system of students off-campus practice, the management norms of graduation design under the joint guidance of college and enterprises, the management methods of enterprise curriculum assessment, and the management norms of enterprise practical training teaching, etc. The second-level indicators of "college-enterprise dual-subject teaching management and supervision" include: teaching management personnel, professional teaching steering committee, and college-enterprise Dual-subject teaching quality monitoring committee and so on. The main observation points of the secondary indicators of "teacher training between college and enterprise" include: dual-teacher and dual-ability teacher training plan and

implementation, mutual assignment and exchange of teachers between college and enterprise, etc.

On the basis of the above detailed analysis of the connotation of each secondary index and the main observation points, the weight of each index is determined for the establishment of model and data analysis, and is shown in "Table I". As can be seen from "Table I", the importance of each indicator in the whole system is different. Among the first-level indicators, "the basis of college-enterprise cooperation" and "the process management of college-enterprise cooperation" have the same weight, and account for 40% of the total, reflecting the quality of college-enterprise cooperation talent training and the long-term investment and attention process of both sides. At the same time, it can be seen from the "Table I" that "The effect of college-enterprise cooperation", that is, the satisfaction of employers, parents, students and society, is also the key factor that can characterize the quality of talent cultivation, and its weight accounts for 30% of the whole. Therefore, the evaluation of the knowledge, ability and quality of student can not completely evaluate the quality and effect of college-enterprise cooperation personnel training.

III. DESIGN OF FUZZY EVALUATION ALGORITHMS

Fuzzy comprehensive evaluation applies the principle of fuzzy transformation and the principle of maximum membership degree, and takes into account the various factors related to the evaluated things, and makes a comprehensive evaluation of them [5] [6] [7] [8]. The specific algorithm steps are as follows:

A. Establishing a Set of Evaluation Factors

The set of evaluation factors is a common set consisting of various factors affecting the evaluation object. If there are n factors to be evaluated, then the set of evaluation factors is marked as: $U = \{u_1, u_2, \dots, u_n\}$.

B. Establishing a Set of Comment

If there are m remarks for each factor, the set of comment is marked as: $V = \{v_1, v_2, \dots, v_m\}$.

C. Establishing Factor Weight Set

Determining the weight distribution of each factor at all levels is actually the subordinate degree of each factor to the quality of college-enterprise cooperation talents training [4-6]. According to the investigation and repeated argumentation of dozens of experts from both sides of the university and enterprise, the weight distribution is determined and marked as shown in Table 1. After consistency test, there is no logical error.

D. Single Factor Fuzzy Evaluation

By evaluating the group from a single factor, we can get the degree of subordination of the evaluation object to each element of the evaluation set. The number of the remark is given according to the factors accounted for the proportion of the number of the evaluation group, the single factor evaluation set is as a row, and the single factor evaluation set matrix can be obtained.

E. Fuzzy Comprehensive Evaluation

Fuzzy comprehensive evaluation first carries on the single-level fuzzy comprehensive evaluation to the low-level factors, and on the basis of the single-level fuzzy comprehensive evaluation, carries on the comprehensive evaluation to the upper-level factors. The weighted average method is used to process the evaluation results.

IV. THE QUALITY EVALUATION OF COLLEGE-ENTERPRISE COOPERATION TALENTS TRAINING BASED ON FUZZY EVALUATION ALGORITHMS

A. Evaluation Factors Set U

According to the first-level, second-level and third-level indicators mentioned above, the corresponding factor set is determined.

$A =$ "the quality of the training of college-enterprise cooperate-on talents" = $\{B_1, B_2, B_3, B_4\}$;

$B_1 =$ "the basis of the basis of college-enterprise cooperation" = $\{B_{11}, B_{12}, B_{13}, B_{14}, B_{15}\}$;

$B_2 =$ "the process management of college-enterprise cooperation" = $\{B_{21}, B_{22}, B_{23}, B_{24}, B_{25}, B_{26}\}$;

$B_3 =$ "The effect of college-enterprise cooperation" = $\{B_{31}, B_{32}, B_{33}, B_{34}, B_{35}, B_{36}\}$;

$B_4 =$ "the comprehensive quality of students" = $\{B_{41}, B_{42}, B_{43}, B_{44}\}$.

B. Comment Set V

In this study, the comprehensive evaluation of college-enterprise cooperation graduates is divided into four levels: $V = \{\text{Excellent, Good, General, Poor}\}$. Although the status of the quality of talents training is differentiated in the definition of commentary set, in the actual statistical process, especially in the questionnaire survey process, the comment setting of each index must be easy to understand and in accordance with the context.

C. Fuzzy Evaluation Matrix

From the above factor set and comment set, the corresponding fuzzy evaluation matrix can be obtained. Firstly, all indicators should be differentiated by qualitative and quantitative methods. There are eight qualitative indicators, including $\{\text{The attention degree of colleges and enterprises, The rules and regulations on the training of college-enterprise cooperative talents, communication and interaction between college and enterprise, enhanced innovation ability, sustainable development of college-enterprise cooperation, input and output of college and enterprise, Thought, Quality}\}$, the remaining 13 are quantitative indicators. Quantitative and qualitative indicators are quantified as follows:

For qualitative factors, the main form is questionnaire survey. In order to obtain accurate evaluation results comprehensively and objectively, the respondents covered the leaders of relevant departments, professional teachers, counselors, leaders and engineers of cooperative enterprises, and some parents' representatives. Equivalent evaluation was used for relevant qualitative evaluation indicators. A total of 100 questionnaires were distributed and 100 were recovered, all of which are true and effective. For qualitative indicators, the quantitative methods are as follows: for example, 100 people evaluate about one of the secondary indicators of the first-level indicator "the basis of college-enterprise cooperation". Among them, 60 people select "excellent", 20 people select "good", 15 people select "general" and 5 people select "poor". Then we first quantify it as follows: excellent: 60/100, good: 20/100, general: 15/100, poor: 5/100, so the row matrix of one item that can constitute the basis of college-enterprise cooperation is (60/100, 20/100, 15/100, 5/100), which can be analogized to the row matrix of other secondary indicators.

For quantitative indicators, such as the second indicator of "college-enterprise cooperation effect" in the first indicator, "parents' satisfaction rate", the actual satisfaction rate is directly normalized. For "knowledge" in the indicators,

it is directly normalized through the grade credit of the key specialized course for each student.

In addition, the "quality" and "thought" in the indicators are treated as qualitative indicators, which are evaluated by counselors and professional teachers.

Above algorithms are implemented in Matlab 7.0.

V. CONCLUSION

Because there are many indicators and levels in evaluation system, and each factor contains several sub-factors, the factors should be graded and evaluated, starting from the lowest level, gradually upward, until the highest level, so as to get the final results. In view of the above

model, the evaluation matrix of the second-level factors is obtained from the lowest level, that is, the third-level factors, and then the evaluation matrix of the first-level indicators is obtained. For example, through matrix multiplication, we can obtain the $Z=\{0.135, 0.797, 0.021, 0.047\}$, and then according to the principle of maximum membership, the maximum number is 0.797 for the evaluation grade of "good", then the evaluation of the college-enterprise cooperation graduates is "good" grade, and so on. The evaluation results of 40 students majoring in computer science are shown in "Table II". Due to limited space, the evaluation results of 223 other students are omitted.

TABLE II. THE EVALUATION RESULTS OF 40 STUDENTS MAJORING IN COMPUTER SCIENCE

identifier	Evaluation matrix	result	identifier	Evaluation matrix	result
1001	{0.106,0.471,0.398,0.025}	Good	1021	{0.692,0.103,0.117,0.088}	Excellent
1002	{0.512,0.332,0.046,0.110}	Excellent	1022	{0.283,0.477,0.101,0.139}	Good
1003	{0.258,0.611,0.109,0.022}	Good	1023	{0.309,0.456,0.141,0.094}	Good
1004	{0.294,0.418,0.101,0.187}	Good	1024	{0.248,0.239,0.415,0.098}	General
1005	{0.188,0.389,0.276,0.147}	Good	1025	{0.100,0.701,0.114,0.085}	Good
1006	{0.204,0.415,0.311,0.070}	Good	1026	{0.192,0.334,0.415,0.059}	General
1007	{0.266,0.241,0.409,0.084}	General	1027	{0.032,0.329,0.471,0.168}	General
1008	{0.562,0.303,0.129,0.006}	Excellent	1028	{0.263,0.591,0.028,0.118}	Good
1009	{0.195,0.701,0.089,0.015}	Good	1029	{0.034,0.778,0.101,0.087}	Good
1010	{0.290,0.217,0.492,0.001}	General	1030	{0.219,0.557,0.067,0.157}	Good
1011	{0.117,0.734,0.102,0.047}	Good	1031	{0.083,0.683,0.191,0.043}	Good
1012	{0.173,0.144,0.589,0.094}	General	1032	{0.176,0.710,0.099,0.015}	Good
1013	{0.114,0.678,0.105,0.103}	Good	1033	{0.688,0.104,0.112,0.096}	Excellent
1014	{0.238,0.591,0.101,0.070}	Good	1034	{0.213,0.527,0.089,0.171}	Good
1015	{0.271,0.245,0.421,0.063}	General	1035	{0.092,0.726,0.011,0.171}	Good
1016	{0.633,0.201,0.126,0.040}	Excellent	1036	{0.267,0.511,0.102,0.120}	Good
1017	{0.209,0.115,0.534,0.142}	General	1037	{0.008,0.789,0.123,0.080}	Good
1018	{0.178,0.460,0.311,0.051}	Good	1038	{0.651,0.179,0.029,0.141}	Excellent
1019	{0.671,0.204,0.115,0.010}	Excellent	1039	{0.121,0.238,0.251,0.390}	Poor
1020	{0.101,0.728,0.154,0.017}	Good	1040	{0.620,0.191,0.181,0.008}	Excellent
In general, Excellent:8/40; Good:23/40; General:8/40; Poor:1/40.					

In this paper, the hierarchical analysis method and the fuzzy comprehensive evaluation model are used to realize the grading evaluation of the quality of college-enterprise cooperation talents training. Through the investigation and evaluation of 263 samples of college-enterprise cooperation graduates, the model and algorithm are realized by computer programming. According to the output of the model, 263 samples of students are evaluated comprehensively. Among them, 89 people are rated as excellent, 132 people as good, 40 people as general and 2 people as poor. The results are widely recognized by counselors, tutors, enterprises and employers. The evaluation of 100 people is consistent with that of employers and counselors. In the same way, the overall accuracy rate reached 95.1%. The result of the experiment shows that the evaluation system is scientific, reasonable and feasible, and can provide some reference and basis for the comprehensive evaluation of the quality of college -enterprise cooperation talents training.

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