An Empirical Research on Teaching Evaluation Based on Fuzzy-AHP

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Abstract. For the evaluation of the teaching effect of the course Supply Chain Management Training, collecting and sorting based on the evaluation index, from three aspects of the experts, students and colleagues collected data samples, application of rough set reduction of the evaluation index, to determine reasonable weights by using the analytic hierarchy process (AHP), followed by fuzzy comprehensive evaluation method to establish evaluation model of classroom teaching quality. Examples show that the application of teaching are excellent.

Keywords: Fuzzy · AHP · rough set · Supply Chain Management Training

1 Introduction

With the rapid development of modern information technology represented by artificial intelligence, big data and the Internet, the new digital world has become an important place for people to work, live and learn. The transformation of productivity and production relations has replaced a large number of mechanical and repetitive occupations with algorithm services provided by the digital world. With the liberation of a large number of labor forces, the era of artificial intelligence has new requirements for talents, and education will inevitably focus on the cultivation of high-level thinking, such as innovation ability, application ability and critical awareness.

With this as the background, the course of Supply Chain Management Training actively optimizes the teaching methods of the course, highlights the teaching concept of "linking the course content with the professional standards, and linking the teaching process with the production process", and precisely trains the talents needed by the society, In the teaching content and teaching assessment methods, we should integrate high standard professional discipline competitions, and pay attention to the cultivation of students' innovation and entrepreneurship ability in the teaching design and teaching process; It aims to effectively expand students' knowledge, cultivate students' innovative thinking ability, practical ability and team cooperation ability, effectively improve students' comprehensive quality, create a strong academic environment for colleges and universities, and achieve the training of comprehensive high-quality talents.

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This course is a teaching plan based on the intelligent supply chain operation platform (ISCM), with VR/AR as the teaching carrier, project-based tasks as the teaching content, mixed teaching mode as the teaching method, formative and summative evaluation as the support, and embedded in high-level professional discipline competitions. It aims to cultivate students' innovation and entrepreneurship ability and improve their comprehensive quality.

The practice objects of the course adopt virtual reality technology, take typical digital intelligent logistics enterprises as the prototype, create a virtual factory training environment, create a practical work professional atmosphere, make the teaching organization and implementation consistent with the professional posts and production process, form a work process oriented teaching practice process, transform various professional abilities into independent typical work tasks, and integrate the work tasks, Translate the action oriented field of the work process into the learning field of the curriculum, strengthen the workplace based teaching mode with professional ability as the core and integrating teaching, learning and doing, and promote the progressive improvement of students' careers [1].

At the same time, in order to better consolidate students' learning achievements and apply the learned knowledge and skills to solving practical problems, this course also integrates high specification professional discipline competitions, closely combining knowledge points and competition examination points. In the classroom teaching design, the course is also divided into three parts: supply chain operation scheme design, supply chain operation confrontation, and supply chain scheme design explanation according to the competition requirements, to train students' ability to solve practical problems with knowledge, and also train students' logical thinking ability and oral expression ability.

2 The Teaching Design

2.1 Focus on Professional Activities

Determine the curriculum design with professional activities as the core. The curriculum is closely related to professional activities. It breaks the discipline-based curriculum model and gets rid of the ideological shackles of discipline courses. Based on the professional ability standard, it sets up courses and constructs a curriculum system around the skills and knowledge points of each task in professional activities, highlighting practicality and pertinence, reflecting "learning by doing, learning by doing" [2].

2.2 Work Task as the Carrier

Take the work task as the carrier to design the course content. The integrated teaching content should be designed according to the logical relationship between work tasks and work processes, reflecting the cultivation of comprehensive professional ability. It is necessary to integrate corresponding knowledge, skills and accomplishments according to professional ability to realize the organic integration of theory and practice. Pay attention to the cultivation of ability in professional situations, and cultivate students' comprehensive ability to analyze and solve problems.

2.3 Based on the Active Module

Based on active modules, independent curriculum mode. Focusing on the professional training objectives and curriculum content, we will build teaching unit modules closely related to work tasks, knowledge and skills, and provide students with a modular curriculum system to experience the complete work process. Optimize module teaching content, realize situational teaching, and integrate classroom teaching, hands-on practice and simulation experiment. Under the support of the teaching platform, the curriculum modules independently and flexibly organize different courses and implement personalized teaching, such as the integration model based on reason and practice; Comprehensive training mode; Theoretical + experimental mode (detachable combination), etc.

2.4 Based on Learning Outcomes

Carry out ability assessment based on learning achievements. The professional objectives shall be jointly determined according to the professional standards and the industrial employment demand trend, the curriculum results shall be formulated based on the professional objectives, and the projects and tasks shall be set in combination with typical professional activities under the guidance of the curriculum results. The project achievement goal focuses on the performance of students' comprehensive ability, highlighting the application of knowledge, the ability to analyze and solve problems [3].

3 The Construction of Evaluation System

3.1 Selection Indicators of Evaluation System

In order to ensure the accuracy of information, data samples were collected from experts, students and colleagues. In this research, Likert scale was used to design a questionnaire. To ensure the scientificity and rationality of the questionnaire design, we conducted a pretest on the questionnaire to determine whether the questionnaire could pass the reliability test [4].

The purpose of the pretest is to analyze the reliability of the questionnaire. In terms of verifying the reliability of questionnaires, commonly used reliability indexes are three types: stability, equivalence and internal consistency. Because the stability index is often used in the direct observation method in the field study, the curl rule is not applicable. Equivalence index is to consider the test differences caused by different observers for the same test item (such as questions in questionnaire method). Internal consistency is concerned with the differences in test results caused by different questionnaire questions. The same test results obtained by different questionnaire questions conform to internal consistency. Internal consistency index is often used in questionnaire observation methods, among which Cronbach method is often used in distance scale measurement questionnaires. This method is used in this paper to test the internal consistency of pretest questionnaires. Its expression is [5]:

$$\alpha = \frac{\mathrm{k}}{k-1}\left|1 - \frac{\sum_{i=1}^{k}\sigma_i^2}{\sum_{i=1}^{k}\sigma_i^2 + 2\sum_{i=1}^{k}\sum_{j=1}^{k}\sigma_{i,j}}\right| \tag{1}$$

The Cronbach coefficient test was completed by SPSS statistical software, and the results showed that the Cronbach coefficient of all questionnaire questions was between 0.72 and 0.89, indicating high internal consistency and the questionnaire passed the reliability test. After the pretest, the questionnaire was used for formal investigation. A total of 100 questionnaires were sent out, 96 were recovered, and 89 valid questionnaires were obtained, with an effective rate of 92.7%.

3.2 The Data Analysis

1) Factor analysis

Factor analysis is carried out on the 18 factors that affect the teaching quality of the course, so as to classify the 18 factors. Firstly, KMO measure and Bartlett sphere test were performed to identify whether the data were suitable for factor analysis [6]. It shows in Table 1.

From the table, we can see that the KMO value is 0.826, which indicates that this set of data is suitable for factor analysis (between 0.8 and 0.9). Bartlett spherical test results in the table show that the approximate chi-square value is 2731.141, the degree of freedom is 204, and the significance probability of the test is 0.000. When the value is significant (less than 0.05), the hypothesis that the correlation matrix of statistics is the unit matrix is rejected, that is, it is considered suitable for factor analysis. There are common factors among the correlation matrices representing the mother population, which is suitable for factor analysis. The significance probability of the x2 statistic value of Bartlett body test in the table is 0.000, which is less than the significance level of 1%, indicating that the correlation matrix of data is not an identity matrix and has correlation, and that the statistical data is suitable for factor analysis [7].

The principal common factor matrix after rotation can be obtained by factor analysis, which shows the factor load of each item. The Varimax is an orthogonal rotation method,

Table 1. KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.826
Bartlett's Test of Sphericity	Approx.	2731.1
	Chi-Square	41
	df	204
	Sig.	.000

which minimizes the number of variables with the highest load on each factor and makes it easy to interpret the factors.

2) Result of Factor analysis

The analysis showed that 18 factors were extracted into 5 factors, each of which covered various quantities of variables greater than 0.5. Meanwhile, the lithotripsy diagram showing the characteristic value of each component indicated that the 5 components

Table 2. Factor analysis and reliability test results

Factorname	Key impression factors	Factor load					α coefficient
		F3	F5	F1	F4	F2	
Teaching methods	Online teaching	.640					.727
	Offline teaching	.659					
	B-Leaming	.745					
Teaching Situation	Celebrity effect		.779				.835
	Teaching style		.717				
	Interest of the Course		.728				
	Practicality of the Course		.612				
Course Content	Rich in content			.722			.727
	Perfect teaching materials			.693			
	linking theory with practice			.783			
	classroom atmosphere			.799			
Improvement of ability	Innovation ability				.779		.810
	Professional ability				.717		
	Practical ability				.728		
	Creative ability				.612		
Teaching Environment	Teacher/student relationship					.597	.708
	Class size					.718	
	Learning Atmosphere					-.821	
Number of factors		3	4	4	4	3	
Cumulative explanatory variation		70.106%					

Table 3. Teaching evaluation system

Target layer A	Criterion layer B	Measure layer C
Evaluation system of the Teaching (A)	Teaching methods(B1)	Online teaching(C1)
		Offline teaching(C2)
		B-Learning(C3)
	Teaching Situation(B2)	celebrity Effect(C4)
		Teaching style(C5)
		Interest of the Course(C6)
		Practicality of the Course(C7)
	Course content(B3)	Rich in content(C8)
		Perfect teaching materials(C9)
		linking theory with practices(C10)
		classroom atmosphere(C11)
	Improvement of ability(B4)	Innovation ability(C12)
		Professional ability(C13)
		Practical ability(C14)
		creative ability(C15)
	Teaching Environment(B5)	Teacher/student relationship(C16)
		Class size(C17)
		Learning Atmosphere(C18)

were all in the position with the characteristic value greater than 1. Therefore, it can be preliminarily concluded that these five factors can explain most variables and summarize most information. The analysis results of other important indicators, such as cumulative variable explanation and reliability, are shown in Table 2.

3.3 Modelling

According to the analysis of SPSS statistical software, the model of teaching evaluation system is proposed based on AHP. It is shown in Table 3.

4 The Calculation of Evaluation Index Weight Vector

4.1 Constructing Judgment Matrix

Using the analytic hierarchy process (AHP) to analyze the weight of evaluation index, first we list the factors from the two levels, and then we will invite the tourism professionals, scholars as well as tourists to judge the relative importance of influencing factors. Analytic hierarchy process (AHP) typically require the use of 1–9 and its reciprocal scaling method. (shown in Table 4) [8].

Table 4. The important scale and its meaning

SCALE aij	Meaning
1	The influence of ai and aj is the same
3	ai is slightly stronger than aj
5	ai is stronger than aj
7	ai is obviously stronger than aj
9	ai is absolutely stronger than aj
2, 4, 6, 8	The impact ratio(ai/ai) between two adjacent level
1, 1/2, 1/3 … 1/9	The impact ratio(ai/aj) is the number of reciprocal a

If factor i and factor j are compared, we define the result as aij, then factor j and factor i are compared we define the result as 1/aij. If we have n elements, it can be established comparison judgment matrix A between any two elements like that [9]:

$$A = (aij)mxn$$

And the judgment matrix has the following characteristics:

$$Aij > 0;\ aij = 1/aij;\ an = 1$$

In the questionnaire, we marked "important", "more important", "important", "very important" and "absolutely critical" to determine weights of evaluation factors, the five judgment items which correspond to 1, 3, 5, 7, 9 from the scale: 1–9, at last we transform the data from questionnaire into judgment matrix by MATLAB software [10].

4.2 Date Analysis

1) Constructing judgment matrix
Take Matrix 1 as example:

Matrix 1	A	B	C	D	E
A	1	0.7143	3.3704	5.0000	5.4000
B	1.4000	1	3.4444	7.0000	6.3333
C	0.2967	0.2903	1	4.1111	3.6667
D	0.2000	0.1429	0.2432	1	1.1481
E	0.1852	0.1579	0.2727	0.7681	1

The same is true for other matrices:
Matrix 2:

Matrix 2	A1	A2	A3
A1	1	3.3333	1.8889
A2	0.3000	1	1.1481
A3	0.5294	0.8710	1

Matrix 3:

Matrix 3	B1	B2	B3	B4
B1	1	4.7778	5.0000	5.4444
B2	0.2093	1	3.4444	2.1111
B3	0.2000	0.2093	1	2.0370
B4	0.1837	0.4737	0.4909	1

Matrix 4:

Matrix 4	C1	C2	C3	C4
C1	1	0.4286	0.2063	1.1481
C2	2.3332	1	1.3810	4.037
C3	4.8473	0.7241	1	3.4444
C4	0.8710	0.2477	0.2903	1

Matrix 5:

Matrix 5	D1	D2	D3	D4
D1	1	0.7037	4.7037	1.4000
D2	1.4210	1	1.8245	1.7513
D3	0.2126	0.5481	1	1.1481
D4	0.7143	0.5710	0.8710	1

Matrix 6:

Matrix 6	E1	E2	E3
E1	1	2.3333	2.1111
E2	0.4286	1	3.1778
E3	0.4737	0. 3147	1

2) Solving the biggest characteristic root of judgment matrix

Using MATLAB software to solve the characteristic root of the judgment matrix $Aw = w$, we get the result like this:

$\lambda\_1 = 5.0990;\ \lambda\_2 = 4.2327;\ \lambda\_3 = 2;\ \lambda\_4 = 5.1417;\ \lambda\_5 = 3.0556;\ \lambda\_6 = 5.2715$

At the same time, we can obtain the feature vectors corresponding to the largest weighed value respectively, as follows:

$$\text{Featurevector\_1} = \begin{pmatrix} 0.1527 \\ 0.4028 \\ 0.3160 \\ 0.0675 \\ 0.0610 \end{pmatrix} \text{Featurevector\_2} = \begin{pmatrix} 0.5562 \\ 0.2111 \\ 0.2327 \end{pmatrix} \text{Featurevector\_3} = \begin{pmatrix} 0.6062 \\ 0.2060 \\ 0.1070 \\ 0.0808 \end{pmatrix}$$

$$\text{Featurevector\_4} = \begin{pmatrix} 0.3303 \\ 0.4120 \\ 0.1639 \\ 0.0938 \end{pmatrix} \text{Featurevector\_5} = \begin{pmatrix} 0.0984 \\ 0.3801 \\ 0.4194 \\ 0.1021 \end{pmatrix} \text{Featurevector\_6} = \begin{pmatrix} 0.3532 \\ 0.6072 \\ 0.0396 \end{pmatrix}$$

3) Weight ranking

According to the calculation results above, the weight of evaluation factor is sorted (shown in Table 5).

Table 5. The weight of evaluation factor

Target layer A	Criterion layer B	Measure layer C	score
Evaluation system of the Teaching (A)	Teaching Methods (B1)	Online teaching(C1)	0.0499
		Offline teaching(C2)	0.0547
		B-Learning(C3)	0.0481
	Teaching Situation(B2)	Celebrity Effect(C4)	0.0512
		Teaching style(C5)	0.0865
		Interest of the Course(C6)	0.2161
		Practicality of the Course(C7)	0.0488
	Course Content(B3)	Rich in content(C8)	0.1404
		Perfect teaching materials(C9)	0.0286
		linking theory with practices(C10)	0.0529
		classroom atmosphere(C11)	0.0941
	Improvement of ability(B4)	Innovation ability(C12)	0.0279
		Professional ability(C13)	0.0124
		Practical ability(C14)	0.0165
		creative ability(C15)	0.0107
	Teaching Environment(B5)	Teacher/student relationship(C16)	0.0502
		Class size(C17)	0.0076
		Learning Atmosphere(C18)	0.0032

5 Conclusions

From the evaluation system of the teaching, we can get the weight of each factor can be divided into three levels:

The first level (weight > 0.100) include two factors, they are C6 and C8. The sum of influence is 0.3567. Especially the weight of C6 is 0.2163, it has the significantly influence among all the factors;

The second level (0.050 < weight < 0.100) include six factors, they are C2, C4, C5, C10, C11 and C16. The sum of influence is 0.3896. It means these factors are important for the development.

The third level (weight < 0.050) include ten factors, they are C1, C3, C7, C9, C12 and C13, C14, C15, C17 and C18. The sum of influence is 0.2537.

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