Research and practice of teaching quality evaluation system based on the method of system engineering

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Abstract. Engineering practice teaching quality is related to many factors, through the systematic analysis of the various aspects of engineering practice in the teaching process and by using the system engineering method to establish the engineering teaching quality evaluation model, proved that the evaluation model is scientific and practical.

Introduction

The higher engineering education is the practical application of engineering, the training will be good at science and technology into productive forces as the goal of engineers. In 2010, the country put forward the "excellent engineer" implementation of the strategic plan, engineering practice teaching is the key to achieve this goal, to improve the students' practical ability and innovation ability is the ultimate goal.. Therefore, further strengthen the construction of teaching quality evaluation system for engineering practice, so as to guide the engineering practice teaching reform, comprehensively enhance the quality of teaching practice of Engineering technology.

Engineering practice teaching is different from the experimental teaching, it is based on professional knowledge, enrich students' knowledge structure optimization, enhance practical ability, cultivate innovative thinking as the ultimate goal. At present, teaching quality evaluation of engineering practice is mainly referring to the experimental teaching evaluation system, so the evaluation result has certain limitations.

This paper uses the method of systematic engineering analysis of the whole process of engineering practice teaching, the factors affecting the quality of teaching combining, combined with the investigation and experiment, establish the teaching quality evaluation model of three layers of engineering practice, the model is solved by the AHP and Fuzzy system tools, quantitative evaluation system, practice has proved that the method is very practical.

Engineering practice teaching quality evaluation index system design

First, using the 1-9 scale method is put forward by Professor Saaty of the United States operational research experts, different evaluation index comparison judgment matrix; Second, for judging the eigenvalues of the matrix, to find the largest eigenvalue $\lambda_{\max}$ and the feature vector W ; finally the judgment matrix consistency test with Saaty average random consistency index, and the calculation process is as follows:

(1) first, to determine each column element matrix is normalized, the elements of the general term for:

$$\bar{P}_{ij} = \frac{P_{ij}}{\sum_{k=1}^n P_{ik}} \quad (i, j = 1, 2, 3, \dots, n) \quad (1)$$

(2) the judgment matrix of each column normalized by row sum

$$\bar{W} = \sum_{k=1}^n \bar{P}_{kj} \quad (i, j = 1, 2, 3, \dots, n) \quad (2)$$

Table 1 engineering practice teaching quality evaluation system

Target layer A	Rule layerB	Measure layer C
The quality evaluation of practice teaching	teaching system B1	The fit of the school personnel training mode C11
		The consistency of training objectives and professional training project C12
		Practice teaching and theory teaching mutual penetration C13
	Teaching FilesB2	The training plan, outline, task, complete instructionsC21
		The outline of the complete training project C22
		Engineering practice teaching quality evaluation standard C23
	The implementation of teaching B3	Technology and skills training projects have specific standards and requirements and implementation details C31
		The training project in technology and skills training examination and assessment in strict accordance with the provisions C32
		Teaching personnel training with clear responsibilities C33
	Teaching guide B4	The training project clearly, safety education in place, the content is clear and prompt, appropriate training C41
		Operating norms, accurate and skilled, skilled, diverse forms of flexible, proper methods C42
		Tour guide, patient and meticulous C43
	Teaching Feedback B5	Complete the training project on time, skilled operation, complete specification training report C51
		Most of the students skills to achieve a good standard C52
		Most of the students can make comprehensive use of technology to solve the major practical problems C53
		Most of the students can master the technology and processing methods, the equipment of machining process C54
	Teaching FeedbackB6	The students to practice the teaching feedback B61
		To carry out scientific research, technical services and social occupation training effectiveness B62
		Feedback from employers to the graduates' practical ability B63

(3)The normalized vector

$$\bar{W} = [\bar{W}_1, \bar{W}_2, \dots, \bar{W}_n]^T \quad (3)$$

$$\bar{W}_i = \frac{\bar{W}_i}{\sum_{j=1}^n \bar{W}_j} \quad (i, j = 1, 2, 3, \dots, n), \quad \bar{W} = [\bar{W}_1, \bar{W}_2, \dots, \bar{W}_n]^T \text{ is the eigenvector.}$$

(4)The largest eigenvalue calculation of judgment matrix

$$\lambda_{\max} = \sum_{i=1}^n \frac{(PW)_i}{nW_i} \quad (PW)_i \text{ is } PW \text{ } i \text{ Component element.}$$

(5)Consistency check:: Calculation of consistency index $CI = \frac{\lambda_{\max} - n}{n - 1}$, Calculation of random

consistency index $CR = CI / RI$, CR is Smaller, the better consistency of judgment matrix, it is usually considered that when $CR < 0.1$, To satisfy the judgment matrix consistency test; otherwise, should adjust the judgment matrix.

According to AHP method, the index weight to table 2- table 8.

Table2 Practice teaching quality evaluation A judgment matrix

A	B1	B2	B3	B4	B5	B6	weight w_A	Consistency test
B1	1	2	3	4	5	5	0.342	$\lambda_{MAX} = 6.361$ $CI = 0.072$ $CR = 0.058 < 0.1$
B2	1/2	1	2	3	4	4	0.223	
B3	1/3	1/2	1	2	3	3	0.142	
B4	1/4	1/3	1/2	1	2	2	0.183	
B5	1/5	1/4	1/3	1/2	1	2	0.062	
B6	1/5	1/4	1/3	1/2	1/2	1	0.048	

Table3 The teaching system of B1 judgment matrix

C1	C11	C12	C13	weight w_{C1}	Consistency test
C11	1	2	3	0.539	$\lambda_{MAX} = 3.009$ $CI = 0.005$ $CR = 0.009 < 0.1$
C12	1/2	1	2	0.297	
C13	1/3	1/2	1	0.164	

Table4 The teaching file B2 judgment matrix

C2	C21	C22	C23	weight w_{C2}	Consistency test
C21	1	3	5	0.637	$\lambda_{MAX} = 3.039$ $CI = 0.019$ $CR = 0.033 < 0.1$
C22	1/3	1	3	0.258	
C23	1/5	1/3	1	0.105	

Table5 The implementation of teaching B3 judgment matrix

C3	C31	C32	C33	weight w_{C3}	Consistency test
C31	1	2	3	0.539	$\lambda_{MAX} = 3.009$ $CI = 0.005$ $CR = 0.009 < 0.1$
C32	1/2	1	2	0.293	
C33	1/3	1/2	1	0.164	

Table6 Teaching guideB4Judgment matrix

C4	C41	C42	C43	weight w_{C4}	Consistency test
C41	1	1/2	1/4	0.137	$\lambda_{MAX} = 3.039$ $CI = 0.019$ $CR = 0.033 < 0.1$
C42	2	1	1/3	0.283	
C43	4	3	1	0.625	

Table7 teaching effectivenessB5Judgment matrix

C5	C51	C52	C53	C54	weight w_{C5}	Consistency test
C51	1	2	3	5	0.483	$\lambda_{MAX} = 4.019$ $CI = 0.006$ $CR = 0.006 < 0.1$
C52	1/2	1	2	3	0.272	
C53	1/3	1/2	1	2	0.157	
C54	1/5	1/3	1/2	1	0.088	

Table8 Teaching FeedbackB6Judgment matrix

C6	C61	C62	C63	weight w_{C4}	Consistency test
C61	1	3	5	0.637	$\lambda_{MAX} = 3.039$ $CI = 0.019$ $CR = 0.033 < 0.1$
C62	1/3	1	3	0.258	
C63	1/5	1/3	1	0.105	

The mathematical evaluation of Fuzzy data processing

Fuzzy have the factor set, evaluation set and fuzzy relation matrix, according to the teaching quality evaluation index system of the engineering technique training, the quantitative evaluation of discipline fuzzy comprehensive evaluation method, a layer of factor set down as $U_{B1} = \{U_{C11}, U_{C12}, U_{C13}\}$, other factors set $U_{B2}, U_{B3}, U_{B4}, U_{B5}, U_{B6}$ similar, the two layer factor set down as $U_A = \{U_{B1}, U_{B2}, U_{B3}, U_{B4}, U_{B5}, U_{B6}\}$, The evaluation set V is a system may set the running state of the teaching evaluation grade set $V_1 = \{V_1, V_2, V_3, V_4, V_5\}$. Research results indicate that if the rates of excellence,

good, middle, pass, and fail ,according to the factor set and evaluation set U fuzzy relation between the presence of V,to establish the model of relation matrix R, (U,V,R) Fuzzy evaluation model is composed of three elements, enter a power allocation vector W, then the evaluation results, the comprehensive evaluation scores.

(1) according to the evaluation system and evaluation indexes of the quality of teaching, by the enterprise experts 3 people, 5 professional leaders, the teaching management staff of 5 people, students fill out the questionnaire of teaching quality engineering practice on behalf of 10 people, the statistics of each evaluation index in the evaluation of the number of U grade V, and then normalized, as a result of membership in the evaluation level, the fuzzy evaluation matrix. Table 9 is the statistical results of 13 level of machinery, table 9 data were normalized, the results are as follows:

Table9 Single factor statistical engineering practice teaching

First level indicator	Two stage index	excellent	good	medium	Pass	fail	proportion
B1	C11	11	7	2	3	0	0.539
	C12	9	13	1	0	0	0.297
	C13	10	6	4	2	1	0.164
B2	C21	8	11	2	2	0	0.637
	C22	7	14	2	0	0	0.258
	C23	8	8	3	3	1	0.105
B3	C31	10	7	5	1	0	0.539
	C32	9	5	6	1	2	0.293
	C33	12	9	2	0	0	0.164
B4	C41	7	8	6	2	0	0.137
	C42	9	10	4	0	0	0.238
	C43	11	6	3	2	1	0.625
B5	C51	10	5	3	3	2	0.483
	C52	6	7	8	2	0	0.272
	C53	8	5	5	2	3	0.157
B6	C54	10	7	3	2	1	0.088
	C61	11	3	6	2	1	0.637
	C62	3	5	7	5	3	0.258
	C63	2	7	5	5	4	0.105

$$R_{B1} = \begin{bmatrix} 0.478 & 0.304 & 0.087 & 0.130 & 0.000 \\ 0.391 & 0.565 & 0.043 & 0.000 & 0.000 \\ 0.435 & 0.261 & 0.174 & 0.087 & 0.043 \end{bmatrix} \quad (4)$$

$$R_{B2} = \begin{bmatrix} 0.348 & 0.478 & 0.087 & 0.087 & 0.000 \\ 0.304 & 0.609 & 0.087 & 0.000 & 0.000 \\ 0.348 & 0.348 & 0.130 & 0.130 & 0.043 \end{bmatrix} \quad (5)$$

$$R_{B3} = \begin{bmatrix} 0.435 & 0.348 & 0.217 & 0.043 & 0.000 \\ 0.391 & 0.213 & 0.261 & 0.043 & 0.087 \\ 0.522 & 0.391 & 0.087 & 0.000 & 0.000 \end{bmatrix} \quad (6)$$

$$R_{B4} = \begin{bmatrix} 0.304 & 0.348 & 0.261 & 0.088 & 0.000 \\ 0.391 & 0.435 & 0.174 & 0.000 & 0.000 \\ 0.478 & 0.261 & 0.130 & 0.087 & 0.043 \end{bmatrix} \quad (7)$$

$$R_{B5} = \begin{bmatrix} 0.435 & 0.217 & 0.130 & 0.130 & 0.087 \\ 0.216 & 0.304 & 0.348 & 0.087 & 0.000 \\ 0.348 & 0.217 & 0.217 & 0.087 & 0.130 \\ 0.435 & 0.304 & 0.130 & 0.087 & 0.043 \end{bmatrix} \quad (8)$$

$$R_{B6} = \begin{bmatrix} 0.478 & 0.130 & 0.261 & 0.087 & 0.043 \\ 0.130 & 0.217 & 0.304 & 0.217 & 0.130 \\ 0.087 & 0.304 & 0.217 & 0.217 & 0.174 \end{bmatrix} \quad (9)$$

(2) The first-level evaluate. The factor matrix R_{B1} The input weights determined by AHP method $W_{C1}, Z_{B1} = W_{C1}, R_{B1}$, so:

$$Z_{B1} = \begin{bmatrix} 0.478 & 0.304 & 0.087 & 0.130 & 0.000 \\ 0.391 & 0.565 & 0.043 & 0.000 & 0.000 \\ 0.435 & 0.261 & 0.174 & 0.087 & 0.043 \end{bmatrix} \cdot (0.539 \quad 0.297 \quad 0.164) \quad (10)$$

After normalization,

$$Z_{B1} = (0.475 \quad 0.401 \quad 0.095 \quad 0.022 \quad 0.007) \quad (11)$$

Similarly available:

$$Z_{B2} = (0.342 \quad 0.505 \quad 0.091 \quad 0.057 \quad 0.005) \quad (12)$$

$$Z_{B3} = (0.410 \quad 0.317 \quad 0.211 \quad 0.037 \quad 0.026) \quad (13)$$

$$Z_{B4} = (0.437 \quad 0.317 \quad 0.153 \quad 0.066 \quad 0.027) \quad (14)$$

$$Z_{B5} = (0.370 \quad 0.244 \quad 0.207 \quad 0.111 \quad 0.067) \quad (15)$$

$$Z_{B6} = (0.348 \quad 0.171 \quad 0.268 \quad 0.134 \quad 0.079) \quad (16)$$

(3) The comprehensive evaluation of two level. Get a grade evaluation evaluation vector Z_{Bi} two grade evaluation matrix R_A .

$$R_A = \begin{bmatrix} 0.475 & 0.401 & 0.095 & 0.022 & 0.007 \\ 0.342 & 0.505 & 0.091 & 0.057 & 0.005 \\ 0.410 & 0.317 & 0.211 & 0.037 & 0.026 \\ 0.437 & 0.317 & 0.153 & 0.066 & 0.027 \\ 0.370 & 0.244 & 0.207 & 0.111 & 0.067 \\ 0.348 & 0.171 & 0.268 & 0.134 & 0.079 \end{bmatrix} \quad (17)$$

$Z = W_A \cdot R_A$, normalized,

$$Z = (0.416 \quad 0.376 \quad 0.136 \quad 0.051 \quad 0.02) \quad (18)$$

(4) The comprehensive evaluation score calculation. For each grade assignment by weighted average method, the matrix of each grade after the assignment of the V:

$$V = \begin{bmatrix} 95 \\ 85 \\ 75 \\ 65 \\ 55 \end{bmatrix} \quad (19)$$

$$\begin{aligned} D = ZV &= (0.416 \quad 0.376 \quad 0.136 \quad 0.051 \quad 0.02) \cdot \begin{bmatrix} 95 \\ 85 \\ 75 \\ 65 \\ 55 \end{bmatrix} \\ &= 0.416 * 95 + 0.376 * 85 + 0.136 * 75 + 0.051 * 65 \\ &\quad + 0.02 * 55 \\ &= 86 \end{aligned}$$

The calculated value of 86 points, the practical teaching of the comprehensive evaluation of 86 points, 85 points <86 points, close to the level of "excellent" etc.

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Reference

- [1] Bergin M .2011, "N Vivo 8 and Consistency in Data Analysis: Reflecting on The Use of A Qualitative Data Analysis Program" ,Nm se Researcher,Volume18,Number 3,PP 6-12.
- [2] Elaine Welsh,2002,"Dealing with Data:Using N Vivo in the QualitativeData Analisis Process".FOR UM: Qualitative Social Research,Volume 3,Number 2 Art .26.
- [3] Huang Guanhong, 6. System engineering method and application [M]. Guangzhou: Jinan University press, 2005.
- [4] Wu steel. Modern education evaluation based on [M]. Shanghai: Science Press, 2004.
- [5] Zhao Huanchen. A simple and easy method for decision making in analytic hierarchy process [M]. Beijing: Science Press, 1986.