



Application of Hierarchical Analysis Method in the Evaluation of Online and Offline Teaching Effect Method

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Abstract. In order to explore the influence of various elements of online and offline teaching on the teaching effect, this paper established a three-level evaluation system of online and offline courses by issuing questionnaires and using the analytic hierarchy process, and evaluated the weight of indicators at all levels in the course evaluation system. Based on the analysis of the relationship between the weight results of each indicator and the teaching practice, it is concluded that the value of teaching content, classroom teaching, teachers' teaching ability, students' learning efficiency and result monitoring and other factors have a greater impact on the teaching effect. We should pay attention to the selection and determination of education content, carefully design classroom teaching, improve teachers' ability, guide and develop students' learning interest, and establish a comprehensive Scientific and reasonable assessment and evaluation system.

Keywords: Analytic hierarchy process · Teaching effect evaluation · Evaluation index system · Evaluation matrix

1 Introduction

For higher education, the emergence of COVID-19 is a dividing line. After that, the world's higher education will be divided into "higher education in the pre-epidemic era" and "higher education in the post-epidemic era". Human beings will fully enter the era of "double-line teaching", and deeply enter the new era of "online teaching and offline teaching integration and symbiosis", that is, "double-line integrated teaching". However, how to evaluate the teaching effect of "double-line teaching" is the fundamental problem to be solved in the "double-line teaching" in the new era. Therefore, based on the thinking of online and offline course teaching in the post-epidemic era, this project is of great practical significance to explore the path of "dual-line integration" between online and offline and the analysis of teaching effects [1, 2].

Online teaching effect evaluation is a complex system engineering, teaching effect quality is affected by many factors, some of the factors are difficult to quantify, hierarchical analysis (AHP) [3] is a complex multi-objective decision problem as a system, the elements related to the decision into goals, guidelines, solutions, through qualitative

and quantitative analysis, suitable for a layered staggered evaluation index and target value and difficult to describe the target system of decision.

Using AHP and fuzzy comprehensive evaluation quantitative analysis online education evaluation index system, first through the hierarchical analysis (AHP) and delphi method (Delphi) combined to determine the relative importance of online education each index weight vector, and then through the questionnaire data of hierarchical comprehensive evaluation, finally to the results based analysis and discussion.

2 Identification of the Factors Influencing the Teaching Effect

In the preliminary research process, I read the research [4–8] related to the online teaching evaluation system and other topics, and focused on finding out the factors influencing the evaluation of online and offline teaching effect. According to the literature reading analysis, the literature was further sorted out, and the checklist of influencing factors of teaching effect was obtained, forming the three-level influencing factors of teaching effect: further analysis and classification of the influencing factors, and obtaining the second-level influencing factors, as shown in Table 1:

3 The Level of Influencing Factor Identification System is Established

3.1 Hierarchical Structure Model Building

According to the characteristics of online and offline teaching management, the highest level of the project is the evaluation of the teaching effect, the criterion level should be the influencing factor of the learning effect, and the measure level should be various activities that affect the construction of the intelligent site. The main purpose of using hierarchical analysis is to compare the degree of influence of each influencing factor.

The teaching effect evaluation should be set as U, teacher factor, student factor, teaching content, classroom teaching, teaching monitoring should be U1, U2, U3, U4 and U5, then the structure level content of this model is:

Target layer: $U = \{\text{teaching effect evaluation}\}$ Criterion: $U = \{U1, U2, U3, U4, U5\} = \{\text{teacher factor, student factor, teaching content, classroom teaching, teaching monitoring}\}$.

Measures layer: $U1 = \{U11, U12\} = \{\text{teaching attitude, teaching ability}\}$ $U2 = \{U21, U22, U23, U24\} = \{\text{students' general characteristics, students' starting point ability, students' learning efficiency, learning environment}\}$ $U3 = \{U31, U32\} = \{\text{the value of teaching content, how much of teaching content, the presentation method of teaching content}\}$ $U4 = \{U41, U42, U43\} = \{\text{teaching platform, classroom teaching, communication and interaction}\}$ $U5 = \{U51, U52\} = \{\text{process monitoring, result monitoring}\}$.

Table 1 Checklist of the factors influencing the teaching effect

order number	Level 1 influencing factors	Secondary impact factors	Third-level influencing factors
1	Teacher factor	Teaching attitude	Teachers' educational ideas
2			Teachers' ideological, political and moral level
3			The teacher's mental state
4		teacher's ability	The scientific and cultural level of the teachers
5			Teacher's teaching ability
6			Teacher's intelligence
7	Student factors	General characteristics of the students	Gender, grade
8			Motivation and interest
9			Cognitive development level
10			Intelligence, character, temperament, etc
11		Student's starting point ability	Knowledge starting point ability
12			Skills starting point ability
13			Attitude starting point ability
14		Students' learning efficiency	Cognitive ability (including retelling, finishing, organizational strategy)
15			Metacognitive strategies (e. g. planning, supervision, regulation strategies)
16			Resource management strategies (such as time management, learning environment management, manpower management, support from others, etc.)

(continued)

Table 1 (continued)

order number	Level 1 influencing factors	Secondary impact factors	Third-level influencing factors	
17		academic environment	Individual experience and thinking	
18			network environment	
19			learning environment	
20	Effectiveness of the teaching content	The value of the teaching content	Get the corresponding credits	
21			Get professional knowledge	
22			lifting power	
23			Check the gaps	
24			How much to teach	knowledge point
25				learning video
26		courseware		
27		electronic learning material		
28		Specifications, drawings		
29		exercises		
30		The presentation method of the teaching content	Electronic data	
31			recorded broadcast	
32			direct broadcast	
33	Effectiveness of classroom teaching	teaching platform	The stability of the network learning platform	
34			The richness of teaching resources	
35			The smoothness of teaching	
36		Classroom teaching	The rationality of the time allocation	
37			Answer the communication timeliness	
38			Objectivity of teaching attitude	

(continued)

Table 1 (continued)

order number	Level 1 influencing factors	Secondary impact factors	Third-level influencing factors
39		Communication and interaction	Teacher-led
40			Student-led
41	Teaching monitoring	Process monitoring	the class rate
42			Interaction rate
43			task performance
44		Results monitoring	Degree of course completion
45			score

3.2 Establish a Comparative Judgment Matrix

According to the concept of hierarchical analysis method, the judgment matrix of the target layer corresponding to the criterion layer is constructed through the comparison of various documented methods and the discussion with the relevant field staff and relevant experts.

$$D = \begin{bmatrix} 1 & 1 & 2/3 & 1 & 2 \\ 1 & 1 & 2/3 & 1 & 2 \\ 3/2 & 3/2 & 1 & 3/2 & 3 \\ 1 & 1 & 2/3 & 1 & 2 \\ 1/2 & 1/2 & 1/3 & 1/2 & 1 \end{bmatrix}$$

The process of determining the relative weight ranking of a certain layer of each element to the top layer of a certain element according to the comparative judgment matrix is called the ranking under the single criterion. There is usually the weight sorting of a certain criterion for each scheme and the weight sorting of the target for each criterion. There are many methods to calculate the weight, among which the legal and root methods are relatively mature and widely used methods. This paper is selected as legal for calculation.

$$D = \begin{bmatrix} 1 & 1 & 2/3 & 1 & 2 \\ 1 & 1 & 2/3 & 1 & 2 \\ 3/2 & 3/2 & 1 & 3/2 & 3 \\ 1 & 1 & 2/3 & 1 & 2 \\ 1/2 & 1/2 & 1/3 & 1/2 & 1 \end{bmatrix} \rightarrow \begin{bmatrix} 0.2 & 0.2 & 0.2 & 0.2 & 0.2 \\ 0.2 & 0.2 & 0.2 & 0.2 & 0.2 \\ 0.3 & 0.3 & 0.3 & 0.3 & 0.3 \\ 0.2 & 0.2 & 0.2 & 0.2 & 0.2 \\ 0.1 & 0.1 & 0.1 & 0.1 & 0.1 \end{bmatrix}$$

$$\rightarrow \begin{bmatrix} 1 \\ 1 \\ 1.5 \\ 1 \\ 0.5 \end{bmatrix} \rightarrow \begin{bmatrix} 0.2 \\ 0.2 \\ 0.3 \\ 0.2 \\ 0.1 \end{bmatrix}$$

3.3 Matrix Consistency Test

(1) Calculate Eigenvalues.

$$\begin{bmatrix} 1 - \lambda & 1 & 2/3 & 1 & 2 \\ 1 & 1 - \lambda & 2/3 & 1 & 2 \\ 3/2 & 3/2 & 1 - \lambda & 3/2 & 3 \\ 1 & 1 & 2/3 & 1 - \lambda & 2 \\ 1/2 & 1/2 & 1/3 & 1/2 & 1 - \lambda \end{bmatrix} = 0$$

To solve $\lambda_{\max} = 5$

(2) Calculate the consistency indicators.

$$C_1 = \frac{(\lambda_{\max} - n)}{(n - 1)} = \frac{5 - 5}{5 - 1} = 0$$

(3) Calculate the consistency ratio.

$$C_R = C_1 / R_1 = \frac{(\lambda_{\max} - n)}{(n - 1) \cdot R_1} = \frac{0}{0.9} = 0 < 0.1$$

Therefore, the consistency check results were passed

4 Weight Analysis of the Evaluation Indicators

According to the questionnaire, the weight of each influencing factor was obtained. The survey object was the teachers and students of a university in Anhui province. After the questionnaire was designed according to the online education evaluation index system. The questionnaire is distributed through the questionnaire star network. A total of 256 questionnaires were collected. After sorting out and verification, there were 254 valid questionnaires, with an effective rate of 99.22%. In the valid questionnaire, there were 5 teachers and 251 undergraduates, and the male–female ratio was 22.4% and 77.6%, respectively. According to the survey, the weight of each secondary influencing factor was multiplied by the weight of the first-level indicators to obtain the comprehensive weight, as detailed in Table 2.

The weight of the evaluation index indicates the influence degree of the evaluation index on the teaching effect. According to the evaluation index, the value of teaching content, classroom teaching, teachers' teaching ability, students' learning efficiency and result monitoring have a great influence on the teaching effect.

Table 2 Index weight

Level 1 evaluation indicators	weight	Secondary evaluation index	Weight (Average weight of 256 survey reports)	Comprehensive weight (Third level weight multiplied by second level weight)
U1	0.2	U11	0.486	0.097
		U12	0.514	0.103
U2	0.2	U21	0.110	0.022
		U22	0.224	0.045
		U23	0.417	0.083
		U24	0.249	0.050
U3	0.3	U31	0.446	0.134
		U32	0.191	0.057
		U33	0.363	0.109
U4	0.2	U41	0.388	0.078
		U42	0.406	0.081
		U43	0.206	0.041
U5	0.1	U51	0.475	0.048
		U52	0.525	0.052

5 Conclusion

From the above analysis and calculation of the data and judgment criteria can be obtained:

1. There are many influencing factors of teaching effect, so the influencing factors of teaching effect are identified, and a three-level index system of influencing factors is constructed according to the influencing factors. Among them, the first-level indicators mainly include teacher factors, student factors, teaching content, classroom teaching and teaching monitoring.
2. The weight of the evaluation index indicates the influence degree of the evaluation index on the influencing factors of wisdom. The secondary index mainly includes teaching attitude, teaching ability, students' general characteristics of students, students' starting ability, students' learning efficiency, learning environment, the value of teaching content, teaching content, the presentation method of teaching content, teaching platform, classroom teaching, communication and interaction, process monitoring and result monitoring. Among them, teachers' teaching ability, students' learning efficiency, the value of teaching content, classroom teaching and result monitoring and other factors have a great influence on the teaching effect.
3. The value of the teaching content is an important factor affecting the teaching effect. The purpose of education is the general requirements for the results of educational activities, and the quality specifications and standards determined for the cultivation

of talents. An important aspect is the selection and determination of educational content. Good education requires both creativity and standardization. In teaching, teachers should not only realize students' intellectual development, but also realize students' rich knowledge. Educational content is an important basis for checking the quality of teachers' education and students' learning, and also an important source for students' interest in learning.

4. Classroom is the main battlefield of teaching, the main window for teachers and students to communicate with each other, and also the main place to obtain teaching effect. The process for teachers and students to participate in and interact together and realize the teaching objectives creatively, classroom teaching needs new theories, new ideas and enthusiasm for reform, as well as new methods and technical means. Classroom teaching needs both "traction" and "guide"; it requires careful design and systematic reflection and wisdom.
5. The influence of teachers' teaching ability on the teaching effect is obvious. From the perspective of external environment, the government should establish industry standards from the national and industrial development level. Government departments should organize relevant technology enterprises to research and build data platforms to realize interoperability and provide efficient services. Formulate measures to train and update talent teams, and establish a regulatory platform.
6. The teaching effect largely depends on the learning efficiency of students, which shows that the learning effect is greatly related to students' own learning attitude and learning ability, which proves that learning is a subjective initiative activity, learning subjectivity, learning ability, learning drive directly determines the learning effect.
7. A comprehensive, comprehensive and reasonable assessment and evaluation system should be established, and its advantages should be used to enhance the classroom teaching effect and improve the teaching quality, so as to constantly stimulate students' innovation consciousness, desire and passion, cultivate practical operation ability and innovation ability, so as to achieve the goal of "promoting learning by examination and promoting teaching by evaluation". Teachers should not only take teaching as a dynamic process, but also take the assessment as one of the means of teaching quality evaluation to strengthen the usual process assessment.
8. This research is the basis of "civil engineering construction" online five years of teaching process, the future will continue to carry out the teaching mode based on this method, accumulate more practice data and practice teaching cycle, provide reliable basis for consideration and modify this method, makes the online teaching quality evaluation factor analysis method is increasingly perfect in practice.

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