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A NEW MODEL OF COURSE ASSESSMENT BASED ON THE FLIPPED CLASSROOM APPROACH APPLIED TO “MODERN LOGISTICS TECHNOLOGY” COURSE

***Chen Fang**, chenfang0921@163.com*
Zhejiang Ocean University, Zhoushan, People's Republic of China

As an innovative approach, flipped classroom changes the “studying in class + practicing after class” mode into “studying before class + explaining in class” by reversing the two stages that of knowledge transfer and knowledge internalization. The changing of teaching mode brings the changing of assessment methods, because the traditional assessment methods are no longer suitable to the requirements of a new teaching model. In this paper at first, the drawbacks of traditional assessment were described, and then the diversified course assessment index system in on-line and offline forms was established. The course assessment was evaluated using the combination of Analytic Hierarchy Process (AHP) and Fuzzy Comprehensive Evaluation (FCE). This new assessment method changes the traditional result-oriented evaluation to the process-oriented one, the teacher evaluation to the students’ evaluation, realizing the combination of quantitative and qualitative evaluation mode and promoting the students' autonomous learning, processive learning and experiential learning, giving full play to the feedback, improvement and strengthening function of the assessment.
Keywords: flipped classroom, course assessment, AHP-FCE.

1. Introduction

Modern Logistics Technology is a basic course, highlighting major and obtaining practical significance. Therefore, this course not only imparts knowledge, but forms personal direction and arouses students' interest. Students could identify areas of interest for future study.

The flipped classroom is when the teacher puts in the information environment learning resources in the form of videos. Students watch and learn the video resources before the class. Teachers and students work together to finish the homework in the classroom, work out collaborative inquiry, discuss questions and fulfill interactive activities in a new teaching mode. As an innovative form of classroom teaching, flipped classroom has subverted the inherent mode of traditional teaching, which is a major breakthrough in teaching reform under the condition of modern information technology development. Flipped classroom changes the “studying in class + practicing after class” into “studying before class + exploring in class” in the form of reversing the two stages of learning that of knowledge transfer and knowledge internalization [1]. The realization of flipped classroom can fully exert the activity of students, improve the interaction between teacher and students, and enhance students' learning ability and cooperation ability.

2. The insufficiency of current assessment methods

The course assessment is one of the most effective ways to test students' outcomes, which can be used to identify, regulate and promote the teaching. At the same time, it is an important link in the course teaching. Currently, like most other courses, the examining method of modern logistics technology included two parts, namely formal assessment (30%) and term examination (70%). The formal assessment is composed of attendance (30%), current results (30%) and homework (40%). However, for large groups’ teaching there is no way to make a general survey for each class. There are less students participating in class discussions, and the plagiarism phenomenon is serious. The final assessment is usually 'one test for life', and the teacher only judges by the fact that whether the students have completed the examination paper. In addition, the number of classes is small, so the teacher who might teach, give the same tests and grade work. This pattern means a course teacher has a larger subjectivity and randomness, which is not favorable for improvement of teachers' level and for mobilizing students' learning enthusiasm. Furthermore, a test consists of multiple choice questions, true and false statements, fill-in-the-blanks, quantitative problems, short answers, most of which are to test the memorized knowledge, ignoring the application of knowledge and personal development. Students mostly cram for the final; even someone who never pays attention in class will try to cheat at examination. Therefore, such a single, result-oriented and subjective assessment method neither assesses the extent of students' learning nor improves student's thinking, values, and efficiency. It is also not suitable for a new teaching model [2].

3. The mathematical model of AHP-FCE

The analytic hierarchy process (AHP) is a structured technique for organizing and analyzing complex decisions, based on mathematics and psychology. It has particular application in group's decision-making and is used globally in a wide variety of situations. This method makes use of both qualitative and quantitative analysis to develop the inter-relationship among the indexes and establish the judgement matrix. In parallel, fuzzy comprehensive evaluation (FCE) method is a comprehensive evaluation method based on fuzzy mathematics, which can transform the qualitative evaluation into the quantitative evaluation according to the membership degree theory of fuzzy mathematics. This method can solve the ambiguous and hard-to-quantify problems and, therefore, is suitable for solving various non-deterministic problems. Usually, the final examination uses a grading system (excellent, good, medium, passing, failing), but the definition of each level is not clear and the grade is ambiguous. So, the fuzzy comprehensive evaluation is an effective evaluation method and, particularly suitable, for the flipped classroom assessment. So, this paper combined AHP/FCE methods that provided a solution to the problem solving, which makes use of the AHP to calculate the weight values first, and, then, implement the FCE to carry out a from-quantitative-to-quantitative assessment.

The main process is as follows [3, 4]:

(1) Identifying the affecting factor set

For fuzzy evaluation, factors that affect the parameter's value determination should first be identified. If the known affecting factors are $u_1, u_2, ..., u_m$, the set these parameters can make up is $U = \{u_1, u_2, ..., u_m\}$, and this factor set is a common set.

(2) Determining factor weights set

Each factor has a different impact on, or importance to the value determination of parameters. In other words, the factors have different weights for parameter values. The set composed of various weights of all factors for parameter value determination is called the factor weights set, which is represented as $A = \{a_1, a_2, ..., a_m\}$. If a_i represents the weight of factor No. i, the weight of each factor should satisfy Equation (1).

$$\sum_{i=1}^{n} a_i = 1, a_i \geq 0 . \quad (1)$$

The Analytic Hierarchy Process operation can be divided into the following five steps:

Step 1: Define the decision-making problem.

Step 2: Create a hierarchical structure.

Step 3: Create a pairwise comparison matrix. Table 1 is the evaluation measurement and relative definition of AHP.

Step 4: Calculate the eigen values.

Step 5: Conformance test.

Eigen values in step 4 can be calculated in the following ways: Normalization of the Row Average (NRA), Average of Normalized Columns (ANC), Normalization of the Geometric Mean of the Rows (NGM), and Normalization of the Average Reciprocal of Columns. The consistency test in step five is to make sure that the evaluation results are consistent when the experts are conducting pairwise comparisons, which means that the experts' preference for criteria is transitive. Saaty suggested that consistency index (CI) and consistency ratio (CR) be used for the test. If CI and CR are both less than 0.1, it means that the pairwise matrix is consistent. If the matrix is not consistent, the equation of CI and CR is as follows:

$$CI = \frac{\lambda_{max} - n}{n - 1}, \quad (2)$$

λ_{max} is the largest eigenvalue of the matrix, n is matrix order (number of parameters).

CR = CI/RI

CR < 0.1ok

C:R = Consistency ratio

C:I: = Consistency index

R:I: = Random index, (3)

where n is the number of evaluation criteria; RI is random index whose value increases if the number of criteria increases, as shown in Table 2.

Table 1

Evaluation Measurement and Relative Definition of Analytic Hierarchy Process

Evaluation measurement	Definition
1	Equal importance
3	Slight importance
5	Essential importance
7	Very strong importance
9	Absolute importance
2, 4, 6, 8	Intermediate

Table 2

Table of Random Indexes

Order N	1	2	3	4	5	6	7	8
RI	0	0	0.58	0.90	1.12	1.24	1.32	1.41

(3) Establishing a parameter evaluation set

An evaluation set is the set of various possible evaluation results given by evaluators for the evaluation objects, shown as V. $V=\{v_1, v_2, ..., v_n\}$; vi(i = 1, 2, ..., n) represents all of the possible evaluation results. The purpose of fuzzy evaluation is to obtain an optimal evaluation result from the evaluation set based on the comprehensive consideration of all affecting factors. As vi and V have the relation of common set, the evaluation set is also a common set.

(4) Building a single factor evaluation matrix

A single factor fuzzy evaluation system evaluates single factors to determine the membership of an evaluation object to an evaluation set. The evaluation object is evaluated as the No. i factor u_i in the factor set, and the membership of No. j factor V_i in the evaluation set is r_{ij}, so the evaluation result of No. i factor u_i can be expressed as:

$$R_i = \frac{r_{i1}}{v_1} + \frac{r_{i2}}{v_2} + ... + \frac{r_{in}}{v_n} \quad (4)$$

where R_i is called a single factor evaluation set. As a fuzzy subset, it can be expressed as $R_i = \{r_{i1}, r_{i2}, ..., r_{in}\}$. Similarly, the single factor evaluation set corresponding to each factor is as follows:

$$\begin{aligned} R_1 &= \{r_{11}, r_{12}, ..., r_{1n}\} \\ R_2 &= \{r_{21}, r_{22}, ..., r_{2n}\} \\ &\vdots \\ R_m &= \{r_{m1}, r_{m2}, ..., r_{mn}\}. \end{aligned} \quad (5)$$

The memberships of each single factor evaluation set constitute a fuzzy matrix, where R is called the single factor evaluation matrix, as shown in Equation (6). R is a fuzzy matrix, and it can also be regarded as a U-V fuzzy relationship matrix, called fuzzy transformation.

(5) When conducting fuzzy composition, if the fuzzy evaluation matrix of a program to an evaluation object is:

$$R = \begin{bmatrix} R_1 \\ R_2 \\ \vdots \\ R_i \\ \vdots \\ R_n \end{bmatrix} = \begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1j} & \cdots & r_{1m} \\ r_{21} & r_{22} & \cdots & r_{2j} & \ddots & r_{2m} \\ \vdots & \vdots & \ddots & \vdots & \cdots & \vdots \\ r_{i1} & r_{i2} & \cdots & r_{ij} & \ddots & r_{im} \\ \vdots & \vdots & \ddots & \vdots & \ddots & \vdots \\ r_{n1} & r_{n2} & \cdots & r_{nj} & \cdots & r_{nm} \end{bmatrix} \quad (6)$$

then the comprehensive fuzzy evaluation with weighting considered and the product of fuzzy matrix is:

$$B = A \bullet R = [b_1, b_2, ..., b_j, ..., b_m] \quad (7)$$

In the above equation, the symbol "●" represents fuzzy composition. The weighted fuzzy matrix A and factor evaluation matrix R have a variety of compositions. This study will use different compositions to work out various evaluation results for comparison and analysis. The model selected is as follows:

when the composition is done by $M(\bullet, \oplus)$ algorithm

$$bj = \min\left\{1, \sum_{i=1}^{m} a_i r_{ij}\right\}; j = 1, 2, ..., n. \quad (8)$$

4. The course assessment based on AHP-FCE

4.1. Establishment of the evaluation indicator system

On the foundation of FCE, the selection of evaluation indexes will directly affect the accuracy of comprehensive evaluation. Basing on researches of domestic and foreign scholars for the examining model and the exam outline of the course, the new examination method of the Modern Logistics Technology is as follows：formal assessment and project result. In this paper, the evaluation system is composed of 4 indicators and 12 corresponding sub-indicators. This is shown in Table 3.

Table 3

The Evaluation Index System of Flipped Classroom Course Assessment

Level A	Level B		Level C	Evaluator
Course assessment of Modern Logistics Technology	Formal assessment	Before class X1	Test performance X11	Teacher
			The quality of raising question X12	Teacher and students
			Online learning time X13	Teacher and students
		In class X2	Attendance X21	Teacher and students
			Classroom discussion X22	Teacher and students
			Classroom notes X23	Teacher and students
		After class X3	Spread and transfer the knowledge X31	Teacher and students
			Homework X32	Teacher
	Project result	Final X4	The content of the topic X41	Teacher and students
			Team collaboration X42	Teacher and students
			The quality of project X43	Teacher and students
			Question and answer X44	Teacher and students

4.2. Determination of weights of AHP-based indicator system

The indicator system can be divided into three levels: level A, level B, level C from top to bottom. In the evaluation indicator system, the main criterion level and branch criterion level represent Level B indicator and Level C indicator respectively: $X = (X_1, X_2, X_3)$ and $X_1 = (X_{11}, X_{12}, X_{13})$, $X_2 = (X_{21}, X_{22}, X_{23})$, $X_3 = (X_{31}, X_{32})$, $X_4 = (X_{41}, X_{42}, X_{43}, X_{44})$ specifically.

According to the level structure of the evaluation indicator system of course assessment, the judgment matrix P of level B indicator X can be built based upon the importance of each factor, as shown in Table 4.

Table 4

Judgment Matrix P of indicator X Level B and conclusion

P	X1	X2	X3	X4
X1	1	1/2	4	3
X2	2	1	5	4
X3	1/4	1/5	1	1/4
X4	1/3	1/4	4	1
weight	0.296	0.478	0.069	0.157
λ_{max} = 4.194; CI = 0.0647; CR = 0.0727 < 0.1, Conform to the consistency requirement				

Upon calculation, the maximum eigenvalue of the judgment matrix P is $\lambda_{max} = 4.194$. In order to check the consistency of the matrix, it is required to calculate the consistency indicator.

$$CI = \frac{\lambda_{max} - n}{n - 1} = \frac{4.194 - 4}{4 - 1} = 0.065 \qquad (9)$$

The average random consistency indicator is RI = 0.89. The random consistency ratio:

$$CR = \frac{CI}{RI} = \frac{0.065}{0.89} = 0.073 \qquad (10)$$

Therefore, the AHP sequencing result is considered to be of high consistency, that is, the allocation of weight coefficient is very reasonable.

The corresponding eigenvector: (0.296 0.478 0.069 0.157).

Similarly, the weight ratios of Level C indicators X1, X2, X3 and X4 are as follows (Table 5–8).

Table 5

Judgment Matrix P_1 of Level C Indicator X_1 and conclusion

P_1	X_{11}	X_{12}	X_{13}
X_{11}	1	5	3
X_{12}	1/5	1	1/2
X_{13}	1/3	2	1
Weight	0.648	0.122	0.230
λmax = 3.004; CI = 0.0020; CR = 0.0038 < 0.1, Conform to the consistency requirement			

Table 6

Judgment Matrix P_2 of Level C Indicator X_2 and conclusion

P_2	X_{21}	X_{22}	X_{23}
X_{21}	1	2	5
X_{22}	1/2	1	3
X_{23}	1/5	1/3	1
Weight	0.582	0.309	0.109
λmax = 3.0037; CI = 0.0019; CR = 0.0036 < 0.1, Conform to the consistency requirement			

Table 7

Judgment Matrix P_3 of Level C Indicator X_3 and conclusion

P_3	X_{31}	X_{32}
X_{31}	1	1
X_{32}	1	1
Weight	0.5	0.5
λmax = 2.000; CI = 0; CR = 0 < 0.1, Conform to the consistency requirement		

Table 8
Judgment Matrix P4 of Level C Indicator X_4 and conclusion

P_4	X_{41}	X_{42}	X_{43}	X_{44}
X_{41}	1	1/2	1/4	1/3
X_{42}	2	1	1/3	1/2
X_{43}	4	4	1	2
X_{44}	3	3	1/2	1
Weight	0.094	0.133	0.479	0.294
λmax = 4.082; CI = 0.0273; CR = 0.0307 < 0.1, Conform to the consistency requirement				

4.3. Establishing decision set for the course assessment

We established an evaluation system, which adopts five evaluation ratings (excellent, good, medium, pass, fail) based upon group discussion and expert evaluation.

4.4. Establishment of the fuzzy relationship from the factors set to the decision set

There are qualitative and quantitative indexes in Table 3. For the quantitative index (x11, x32), we can convert hundred mark system into five grade system, such as excellent (90–100), good (80–89), fair (70–79), pass (60–69), fail (0–59). Assuming there are 20 tests in a semester, the result of a student is 8 times (90–100), 5 times (80–89), 5 times (70–79), 2 times (60–69), the fuzzy matrix of it is (0.4, 0.25, 0.25, 0.1, 0). The remaining indicators are qualitative ones. Assuming there are 39 students, one teacher, in total 40 in a class, for a certain index, 12 people think it is excellent, 15 think it is good, 13 think it is medium, so the fuzzy matrix of it is (0.3, 0.375, 0.325, 0.0).

The whole class and a teacher subjectively evaluate and grade all factors of the indicator system according to the actual conditions. Based upon the analysis of statistical data of sampling survey FCE matrix set can be gained. Here is an example of a student's performance in a semester.

$$R_{p1} = \begin{bmatrix} 0.2 & 0.4 & 0.2 & 0.2 & 0 \\ 03 & 0.5 & 0.1 & 0.1 & 0 \\ 0.2 & 0.4 & 0.3 & 0.1 & 0 \end{bmatrix};\ R_{p2} = \begin{bmatrix} 0.3 & 0.5 & 0.2 & 0 & 0 \\ 0.2 & 0.3 & 0.4 & 0.1 & 0 \\ 0 & 0.2 & 0.5 & 0.3 & 0 \end{bmatrix};$$

$$R_{p3} = \begin{bmatrix} 0 & 0.3 & 0.4 & 0.3 & 0 \\ 0.4 & 0.5 & 0.1 & 0 & 0 \end{bmatrix};\ R_{p4} = \begin{bmatrix} 0.2 & 0.3 & 0.4 & 0.1 & 0 \\ 0 & 0.2 & 0.4 & 0.4 & 0 \\ 0.1 & 0.2 & 0.3 & 0.4 & 0 \\ 0.4 & 0.5 & 0.1 & 0 & 0 \end{bmatrix}. \quad (11)$$

4.5. Fuzzy comprehensive evaluation

(1) Fuzzy evaluation of index layer

$$A_1 = W \bullet R = \begin{pmatrix} 0.648 & 0.122 & 0.230 \end{pmatrix} \bullet \begin{pmatrix} 0.2 & 0.4 & 0.2 & 0.2 & 0 \\ 0.3 & 0.5 & 0.1 & 0.1 & 0 \\ 0.2 & 0.4 & 0.3 & 0.1 & 0 \end{pmatrix} =$$

$$= \begin{pmatrix} 0.212 & 0.412 & 0.211 & 0.165 & 0 \end{pmatrix} \quad (12)$$

Upon normalization, the comprehensive evaluation vector is, so similarly,

$$A_2 = \begin{pmatrix} 0.236 & 0.406 & 0.294 & 0.064 & 0 \end{pmatrix}$$
$$A_3 = \begin{pmatrix} 0.200 & 0.400 & 0.250 & 0.150 & 0 \end{pmatrix} \quad (13)$$
$$A_4 = \begin{pmatrix} 0.184 & 0.298 & 0.264 & 0.254 & 0 \end{pmatrix}$$

(2) Fuzzy evaluation to the overall performance of the student

$$A = W \bullet R = \begin{pmatrix} 0.296 & 0.478 & 0.069 & 0.157 \end{pmatrix} \bullet \begin{pmatrix} 0.212 & 0.412 & 0.211 & 0.165 & 0 \\ 0.236 & 0.406 & 0.294 & 0.064 & 0 \\ 0.200 & 0.400 & 0.250 & 0.150 & 0 \\ 0.184 & 0.298 & 0.264 & 0.254 & 0 \end{pmatrix} =$$

$$= \begin{pmatrix} 0.218 & 0.391 & 0.262 & 0.136 & 0 \end{pmatrix}. \quad (14)$$

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ИННОВАЦИОННАЯ МОДЕЛЬ ОЦЕНКИ КУРСА «СОВРЕМЕННЫЕ ТЕХНОЛОГИИ ЛОГИСТИКИ» НА ОСНОВЕ ТЕХНОЛОГИИ «ПЕРЕВЕРНУТОГО КЛАССА»

Чэнь Фан

Чжэцзянский океанический университет, г. Чжоушань, Китайская Народная Республика

Технология «перевернутого класса» представляет собой инновационную форму процесса изучения учебной информации, в которой изучение материала идет перед занятием, а проверка усвоения материала и консультирование происходит на аудиторных занятиях, что модифицирует традиционную форму, когда изучение новой информации идет под руководством преподавателя, а дома студенты отрабатывают учебный материал. Изменение формы обучения приводит к изменению методов оценки, поскольку традиционные методы оценки больше не удовлетворяют требованиям новой учебной модели. В этой статье описаны недостатки традиционных методов оценки результатов обучения, и представлена диверсифицированная система оценки курса, интегрирующая онлайновые и оффлайновые формы. Результаты обучения были оценены с использованием метода многофакторного анализа представляющего собой комплексную оценку обучения. При новом методе оценки акцент делается на процессуальной и эмпирической составляющих усвоения содержания образования обучающимися, поощрении их самостоятельности, сочетании количественного и качественного способов оценивания, что способствует полноценной обратной связи, в отличие от традиционной оценки, ориентированной на результат.

Ключевые слова: технология «перевернутого класса», оценка курса, процесс аналитической иерархии, многофакторный анализ.

Чэнь Фан, преподаватель, Чжэцзянский океанический университет, г. Чжоушань, Китайская Народная Республика, chenfang0921@163.com

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