

# Research on Teaching Quality Evaluation System Based on Improved AHP

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**Abstract:** With the rapid development of “Internet + Education” and the spread of the COVID-19, large-scale online teaching has brought great challenges to teachers and students, and new teaching models and teaching effects have become the focus. Based on the improved analytic hierarchy process, this study constructed a scientific and complete indicator system to evaluate the difference in teaching quality between online and offline teaching methods from the four perspectives of content, platform, feedback, and atmosphere, and discussed the online and offline integrated education model. Provide new ideas for the “Internet + Education” innovation.

## 1. Introduction

The traditional teaching model is teacher-centered and focused on classroom teaching, which makes it difficult for some students to play their own initiative, and the basic knowledge learning is not solid enough, which is easy to cause forgetting. With the rapid development of the Internet and intelligent terminal equipment, human civilization has entered the era of “information and intelligence civilization” from the era of “machine industry civilization”, and education is about to move from the 3.0 era to the 4.0 era. The main carriers and dissemination tools of information are gradually transferred from books to the Internet and smart terminals or mobile smart terminals. The teaching method is shifting from “pure classroom” to “pure online” or “combination of online and offline”, and its organizational form is also changing from a single “other organization” (such as a traditional school) to “other organization” and “self-organization” “(Such as the learning community) combined and transformed.

The Ministry of Education of China issued relevant opinions and policies on strengthening the construction of online open courses in colleges and universities in 2015 and 2016, encouraging universities to apply online open courses. The continuous increase in policy support has created a favorable environment and conditions for the construction and application of MOOCs in domestic universities; and due to the outbreak of new crown pneumonia in early 2020, the Ministry of Education requires universities to make full use of online MOOCs and provincial and school Two-level high-quality online course teaching resources, relying on various online course platforms at all levels, and on-campus network learning spaces, actively carry out online teaching activities such as online teaching and online learning, and realize “stopping classes without stopping teaching, and closing classes without stopping school.”

However, it is undoubtedly a challenge for teachers and students who are accustomed to offline teaching. The teaching quality of online teaching in colleges and universities is not uniform, and there are many urgent problems that need to be solved. How to develop a reasonable index evaluation system for science It is the current key issue to evaluate the differences in teaching quality under different teaching modes reasonably, combine different teaching methods, maximize strengths and avoid weaknesses, and realize the organic integration of online and offline teaching methods.

Regarding the research on teaching quality under online and classroom teaching methods, many scholars have been involved in theoretical research in this area, and the research on related content is also slightly different. Mainly focus on the following aspects:

First, analyze some deficiencies in the current teaching situation. Liu Caiyan (2020)[1] pointed out that the quality of online learning of college students is not optimistic, and the learning motivation is more casual. Although traditional teaching is highly involved, it still has many disadvantages such as inconvenience and flexibility. Zhang Xiaoqian et al. (2016)[2] pointed out that teachers are not motivated to participate in online courses, and the teaching ability of teachers is not enough. There is a school's atmosphere of "emphasizing offline and online", encouraging college teachers to concentrate on traditional teaching, but not encouraging their active participation Online teaching, etc. Tong Kezhen (2016) [3] believes that the evaluation mechanism of online teaching is not "effective as soon as it is set up", and the pure "evaluation mechanism of online teaching" is obviously weak in managing online teaching.

Second, carry out classified research on the status of different teaching objects. Wang Limin (2020)[4] believes that for students, the essence of online teaching is "autonomous learning under the guidance of teachers"; for teachers, online teaching focuses on how to create better conditions to help students learn independently. Dong Weijiang et al. (2020) [5] found that modern online teaching methods are more popular with international students, and diversified teaching methods meet the different needs of students.

Third, the comparative study of online teaching and traditional teaching. ZhaoFei and FuYou (2018)[6] used a combination of systematic review and "meta" analysis to investigate and compare the pass rates of large-scale open online courses (MOOC) and traditional courses. Ma Xiaofei (2020)[7] adjusted the previous "online and offline integration" teaching mode accordingly, and provided everyone with "completely online" distance mixed teaching cases to obtain real-time and efficient teaching effects. Lu Dongfang et al. (2017)[8] proposed that the application of cloud curriculum platform to achieve online and offline integrated teaching has become a new perspective of higher education teaching reform, reflecting the deep integration of online and offline teaching, which can not only cultivate students' independent learning ability, but also Realize the guiding role of teachers. Chen Bo et al. (2019) [9] MOOC-based mixed teaching has brought changes to the classroom teaching of vocational colleges, but the assignment of pre-class learning tasks, mutual evaluation of homework, teacher participation in forum management and operation, and reorganization of the teaching process in the classroom Such specific tasks require further exploration and reform by teachers. Elizabeth Garira (2020) [10] uses interview method and questionnaire survey method to collect data, and analyzes it through thematic content analysis method.

In summary, a comprehensive evaluation of the quality of online teaching is of great value in promoting the integration of online teaching with offline teaching. This article will start from the perspective of students innovatively, improve the traditional AHP method, and determine the weight of different indicators more scientifically and objectively, and establish a comprehensive indicator evaluation system for teaching quality.

## **2. Data Source**

The data in this paper mainly comes from 409 questionnaires collected online.

The student group is the person who directly feels the quality of teaching. From the perspective of students, this article designs a set of simple and systematic online questionnaires to be distributed to students participating in online teaching across the country to investigate the importance of college students to different indicators Judgment. For the importance of each evaluation index, a five-level scoring system is adopted, with a score interval of 2-10 points. As of 2020.12.10, a total of 409 valid questionnaires have been collected. After simple statistical analysis, by analyzing whether each indicator is representative of the online teaching level, whether there is a dispute, whether it is a key factor affecting the learning process and efficiency, etc., and then correct the possible deviations in the initial indicator setting based on the feedback results , Finally formed 409 samples for subsequent analysis and research.

### 3. Establish an Evaluation Index System for Teaching Quality

#### 3.1 Determine Evaluation Indicators

Based on theoretical research, this project selects four dimensions that exist and differ for online and offline teaching: teaching content, learning platform, feedback effect and learning atmosphere, as the main dimensions for evaluating teaching quality. In order to fully consider the factors affecting teaching quality and comprehensively analyze and evaluate the quality of online and offline teaching, this paper studies the factor analysis of teaching quality by many domestic scholars, and finally reasonably determines the evaluation indicators for the analytic hierarchy process as shown in Table 1:

Table 1 Teaching Quality Evaluation Index and Degree of Importance

Target layer A	Criterion layer B	Importance	Index layer C	Explanation	Importance
Teaching Quality A	Teaching content (B1)	8.1080	Scientificity (C11)	The content is interesting by examples and scenes.	8.1702
			Degree of change (C12)	The content update time is short, and the new knowledge can be grasped in time.	7.8532
			Comprehensive (C13)	Comprehensive knowledge coverage and abundant resources for learning.	8.2084
			Sense of anticipation (C14)	Have curiosity and expectation about the content before class.	8.123
			Normative (C15)	The teacher's lecture content is standardized, method standards, and terminology are accurate.	8.1852
	Learning platform (B2)	7.9798	Stability (C21)	The learning platform/location is stable and the teaching is sustainable.	8.0522
			Diversity (C22)	Learning platforms / locations are diverse and not single.	6.839
			Comfort (C23)	Can enjoy the learning process.	8.261
			Adaptability (C24)	Quickly enter the learning state.	8.767
	Feedback effect (B3)	7.8439	Timeliness (C31)	Timely feedback and communication to the teacher during learning.	7.9858
			Interactive tendency (C32)	Able to interact with the teacher and willing to interact.	7.8248
			Effectiveness (C33)	There are more interaction opportunities and time.	7.7212
	Learning atmosphere (B4)	7.8014	Atmosphere building (C41)	Create a good learning atmosphere.	7.8014

The goal level is the main purpose of this study: the teaching quality corresponding to different teaching modes; the criterion level is the subdivision dimension under the main goal, namely sub goals, which are teaching content, learning platform, feedback effect and learning atmosphere; the index level is the measurable indicators for specific evaluation of teaching quality, with a total of 13 items, and the specific explanation is shown in the table above; and each item refers to The importance of the subject matter is calculated by the weighted average of the questionnaire data.

It can be seen from the degree of importance that college students generally believe that the most important indicator to measure the quality of teaching is adaptability, that is, whether it can quickly enter the state of learning; the diversity of learning platforms is considered to have the least impact on teaching quality index. Summarizing the importance of the index level, we can see that the teaching content is the most important in the criterion level, followed by the learning platform, and

the learning atmosphere is the least important. This also coincides with Sun Nan's (2017) view.

In addition, due to the high homogeneity of the survey target groups, the degree of importance fluctuates between 7-8 and the relative difference is small. Therefore, we consider standardizing the data to make the data more comparable.

### 3.2 Building Hierarchical Structure Model

After the three-level evaluation indicators are determined, a hierarchical structure model is established, as shown in Figure 1. Intermediate indicators are not only dominated by indicators of the upper layer, but also constrain the indicators of the next layer. The first-level indicator A is jointly determined by the second-level indicators B1, B2, B3, and B4. For the second-level indicators, B1 is related to the third-level indicators C11, C12, C13, C14, and C15; B2 is related to the third-level indicators C21, C22, C23 and C24 are related; B3 is related to the three-level indicators C31, C32, C33; B4 is related to the three-level indicators C41.

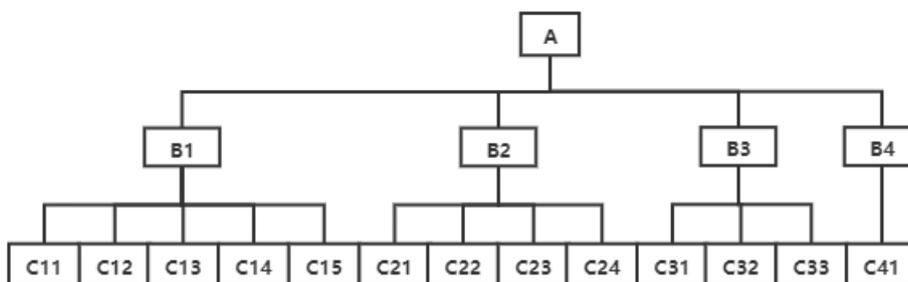


Fig.1 Hierarchical Model of Teaching Quality Evaluation

### 3.3 Determine the Index Weight

The analytic hierarchy process, abbreviated as AHP, is an important method to determine the weight. AHP refers to a decision-making method that decomposes the elements that are always related to decision-making into goals, guidelines, plans and other levels, and then conducts qualitative and quantitative analysis on this basis. It is developed by the famous American operations researcher Saatty, T.L. The professor proposed in the early 1970s. According to the nature of the problem and the overall goal to be achieved, it decomposes the complex problem into several levels, and at the lowest level, the weight of each factor is obtained through pairwise comparison.

Students are the direct target of teachers' teaching and the group with the most say in teaching quality evaluation. Through their intuitive experience, they can better determine the index that has a greater impact on teaching quality, so as to better establish an indicator system to reflect different teaching modes Differences in teaching quality. This article starts from the perspective of college students and determines the importance of various indicators by issuing questionnaires. At the same time, in order to avoid the subjectivity and arbitrariness of the scale division and determination in the traditional analytic hierarchy process, and effectively eliminate human interference, this article will learn from the practice of Xu Weiwei (2011), adopt the golden section scale, and innovatively uses the standardized data of deviation to divide the importance of different indicators by equidistant segments, and finally determines the weight of each indicator.

In order to better determine the weight of each index, the traditional AHP method needs to be improved. In the setting of the judgment matrix, this paper uses the data of the importance of each index to be standardized and calculates the difference value between them, and determines the scale according to the different intervals. After normalization, the matrix weight is obtained and the consistency test is carried out, which can be used as the final result after passing the consistency test. The specific measures are as follows:

Step 1: First, standardize the deviation of the indicators collected in the questionnaire. The standard deviation formula is shown in formula (1):

$$\frac{x_i - \min_{1 \leq j \leq n} \{x_j\}}{\max_{1 \leq j \leq n} \{x_j\} - \min_{1 \leq j \leq n} \{x_j\}} \quad (1)$$

Among them,  $x_i$  represents the degree of importance of each index,  $\{x_j\}$  represents a set composed of the degree of index importance under each criterion level, and  $a_i$  represents the data obtained after standardization.

Through standardization of deviation, the data can be linearly mapped to the interval of [0,1], which can solve the problem that the relative size of the original data is small and difficult to compare.

Step 2: use piecewise function to determine the importance of two indicators, divide the scale, and construct the judgment matrix. The scale determination formula is shown in formula (2):

$$a_{ij} = 0.618^{\lfloor \frac{a_{i1} - a_{i2}}{0.2} \rfloor} \quad (2)$$

Among them,  $a_i$  is the importance data obtained after the deviation standardization,  $a_{ij}$  is the final scale and “[ ]” is the rounding.

This article creatively proposes to use the formula method to determine the scale, and use the standardized data to subtract each other. The result falls on the interval of [-1,1], and the interval is evenly divided into 10 with a distance of 0.2. Segment, 11 nodes are obtained, which correspond to 11 scales one by one, and the quotient of the difference divided by 0.2 is rounded to determine the scale.

In the choice of scale, this article refers to Xu Weiwei (2011)[16] and adopts the golden scale method, that is, the two indicators are equally important, expressed by 1; one indicator is slightly less important than the other indicator, expressed by 0.618; the slightly important indicator is expressed by the reciprocal of 0.618, expressed by 1.6181; the less important indicator is expressed by 0.618<sup>2</sup>; the more important indicator is expressed by the reciprocal of 0.618<sup>2</sup>, and so on. By analogy, the scale of golden section method can be obtained as shown in Table 2:

Table 2 the Scale Of Golden Section Method

$a_{ij}$	Compare the importance of two goals
1.0000	Importance: i=j
1.6181	Importance: i>j
2.6183	Importance: i>>j
4.2368	Importance: i>>>j
6.8556	Importance: i>>>>j
11.0932	Importance: i>>>>>j
The reciprocal of the above numbers	The result of comparing j and i

Step 3: Solve the eigenvector W of the judgment matrix and normalize it to obtain the weight of each indicator.

Step 4: Check the consistency of the judgment matrix to check whether the judgment thinking is consistent when constructing the judgment matrix. The formula for consistency check is shown in formula (3):

$$CI = \frac{\lambda_{max} - n}{n - 1}, CR = \frac{CI}{RI} \quad (3)$$

Among them, CI is the consistency index,  $\lambda_{max}$  is the maximum characteristic root, and  $n$  is the order of the judgment matrix; CR is the test coefficient, and RI is the average consistency index, which is determined by the order of the judgment matrix, as shown in Table 3:

Table 3 Ri Order

Order	3	4	5	6	7	8	9
RI	0.58	0.9	1.12	1.24	1.32	1.41	1.45

Generally speaking, when  $CR < 0.1$ , it can be considered that the judgment matrix has satisfactory consistency; otherwise, the judgment matrix needs to be readjusted.

#### 4. Research Results

According to the calculation results, the weight of each index is obtained, and the corresponding judgment matrix is tested. It is found that the consistency index can be regarded as equal to zero, indicating that each judgment matrix has passed the consistency test and is a completely consistent judgment matrix. The final weight can be finally determined Used to construct an index system for teaching quality evaluation. The final evaluation index system is shown in Table 4:

Table 4 Teaching Quality Evaluation Index System

Target layer A	Criterion layer B	Weight	Index layer C	Weight
Teaching Quality A	Teaching content (B1)	0.618	Scientificity (C11)	0.200
			Degree of change (C12)	0.028
			Comprehensive (C13)	0.312
			Sense of anticipation (C14)	0.176
			Normative (C15)	0.284
	Learning platform (B2)	0.236	Stability (C21)	0.183
			Diversity (C22)	0.043
			Comfort (C23)	0.296
			Adaptability (C24)	0.478
	Feedback effect (B3)	0.090	Timeliness (C31)	0.754
			Interactive tendency (C32)	0.178
			Effectiveness (C33)	0.068
	Learning atmosphere (B4)	0.056	Atmosphere building (C41)	1.000

According to the above-mentioned teaching quality evaluation system, the comprehensive scoring formula for teaching quality can be obtained as formula (4):

$$A = 0.618B1 + 0.236B2 + 0.09B3 + 0.056B4 \quad (4)$$

It can be seen from the weight of each dimension at the criterion level that among the four dimensions for evaluating the quality of teaching, the teaching content dimension is the most important, the learning platform dimension is the second, and the learning atmosphere dimension is the least important. Consistent with the conclusion of the questionnaire.

## 5. Research Conclusion

Based on the innovative analytic hierarchy process in scale selection, this paper constructs a scientific and complete indicator system from four perspectives: content, platform, feedback, and atmosphere. And draw the conclusion of this article, for the main dimensions that affect teaching quality, teaching content has the greatest impact, followed by learning platform, and learning atmosphere has the weakest impact. For the improvement of teaching quality, we should focus on teaching content and strive to transform boring teaching content to make knowledge easy for students to digest and absorb, and improve teaching efficiency; secondly, the diversity of learning platforms should be appropriately improved to stimulate students' interest in learning. Be able to concentrate on studying. However, various forms cannot overwhelm the student and obscure the substantive content of the learning content.

In addition, innovations in the determination and selection of the analytic hierarchy process can circumvent the arbitrariness of the traditional analytic hierarchy process and avoid human interference. The final judgment matrix obtained has good consistency. At the same time, it makes the steps and procedures of the analytic hierarchy process clearer and more standardized, effectively reducing system errors.

## 6. Policy Recommendations

In order to effectively promote the combination of online and offline teaching methods, learn from each other's strengths, and promote the improvement of teaching quality, this article gives the following policy recommendations:

- (1)The complex and unclear course structure is disassembled and reconstructed to form several

independent and complementary teaching modules to enhance the autonomy and diversity of students' choices, so that students can conduct personalized learning according to their own interests.

(2)With the help of the Internet + platform, the interactivity in teaching is enhanced, so that teachers and students can form a good interactive atmosphere, so that students can learn and master knowledge in the “play”.

(3)Enriching the types of multimedia in the teaching process, through the comprehensive use of pictures, text, sound, images and 3D images, constructing vivid learning situations, attracting students' attention while guiding students to gradually deepen and build a knowledge system.

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