



# Research on the Evaluation Model of Online Teaching Effectiveness

Wei Sun\*, Ping Xiong

College of General Education, Guangdong University of Science and Technology, Dongguan, China

\*sunwei.19@163.com, xiongping@gdust.edu.cn

**Abstract.** According to online teaching practices and literature research during the outbreak of the epidemic, the satisfaction with online teaching varies depending on the positioning of schools. The main factors that affect the effectiveness of online teaching include students, teachers, media equipment, and so on. Setting aside factors such as students and media equipment, the article mainly constructs an online teaching evaluation model from the perspective of teachers. Data is obtained through expert interviews and front-line teachers research, and quantitative indicators are obtained using the AHP method. It is revealed that the first element affecting the effectiveness of online teaching in applied undergraduate colleges is the teaching methods of teachers, followed by the proficiency level of educational technology and the appropriate handling of teaching content, and finally, the teaching attitude and basic teaching skills of teachers. This conclusion reflects the cognitive characteristics of applied undergraduate students and the direction that teachers should strive for, which can provide useful guidance for online teaching.

**Keywords:** applied computing, education, distance learning, evaluation model, online teaching, application-oriented university.

## 1 Introduction

In the spring of 2020, a sudden outbreak of the epidemic disrupted all the normal classroom teaching order. The three-year epidemic prevented students from returning to school and engaging in regular classroom teaching. The online teaching model was fully launched, but the effectiveness of online teaching varied from person to person. Wu Wei<sup>[1]</sup> et al. conducted an online teaching questionnaire survey on 334 universities and 13997 teachers in China, the satisfaction of teachers with online teaching shows the following situation: the satisfaction of research universities with online teaching is higher than that of general undergraduate universities; The satisfaction of online teaching in general undergraduate colleges is higher than that in vocational colleges. The online teaching satisfaction of teachers in various universities in the eastern region is mainly influenced by their own factors, while teachers in various universities in the central and western regions are influenced by three factors: teach-

ers, students, and support guarantee. Fully explain the differences in educational levels and the effectiveness of online teaching. For research-oriented universities, students have strong self-discipline and learning abilities, and there is not a significant difference in the effectiveness of online and offline teaching, while for application-oriented undergraduate colleges, this is not the case. The online teaching ability of teachers, the self-discipline and learning ability of students all appear to be somewhat weak, and the online support guarantee has been severely tested.

Application-oriented undergraduate colleges and universities are generally upgraded from specialist to undergraduate, or a number of colleges and universities are merged to upgrade. From the level of teachers, some teachers' teaching ability is still only satisfied with the completion of undergraduate teaching content, and they are still coping with the assessment of qualified undergraduates and standardizing various teaching policies. Teachers' ability needs to be further improved. At the student level, students' weak learning foundation and cognitive ability, long-term learning habit of passively accepting knowledge, media equipment and other factors affect the effect of online teaching. Therefore, according to the characteristics of application-oriented undergraduate talents training and students' learning characteristics, an online teacher teaching effect evaluation model is established to promote and improve the quality of online teaching, and to provide reference and direction for comprehensive online teaching in mixed teaching and emergencies.

## 2 Research Method

Quantification of teaching is the only way to scientific management. One important method of modern scientific management is target management. To use goals for management, it is necessary to organically combine the determination of goals with the degree of achievement of goals, that is, to have a "scale" that can intuitively measure the degree of achievement and effectiveness of goals, and to carry out "quantification".

Analytic Hierarchy Process (AHP) is an evaluation and analysis method in systems engineering that quantitatively analyzes non quantitative events and objectively describes people's subjective judgments which was first proposed by Thomas L. Saaty, a scholar at the University of Pittsburgh in the 1970s. AHP is a systematic and hierarchical method that combines qualitative and quantitative analysis of problems. It is an effective method to transform semi qualitative and semi quantitative problems into quantitative problems, making people's thinking process hierarchical. By comparing the relevant factors layer by layer and testing the rationality of the comparison results layer by layer, it provides a more convincing quantitative basis for analyzing decisions. The Analytic Hierarchy Process (AHP) first hierarchizes complex problems, decomposes them into different constituent factors based on the problem and the desired goals, and aggregates and combines factors at different levels according to their interrelationships and membership relationships, forming a multi-level analytical structural model. Based on the characteristics and basic principles of the system, comparative analysis is conducted on the factors of each layer, and a judgment matrix

is constructed. The relative weights of each factor are obtained by solving the maximum feature roots and their eigenvectors of the judgment matrix.

### 3 Specific Implementation of Online Evaluation

According to the factors<sup>[2-4]</sup> that affect the effectiveness of online teaching in applied undergraduate colleges, there are mainly the following situations as listed in Table 1.

**Table 1.** Main factors affecting the effect of online teaching

Target layer	criterion layer	sub-criterion layer
teaching effect	student	learning attitude
		learning method
		cognitive ability
	teacher	teaching ability
		educational technology
	teaching equipment	controllability
	patency	

Using the Analytic Hierarchy Process<sup>[5-6]</sup>, it is necessary to first select important and critical evaluation indicators from the numerous and complex factors that affect the quality of online mathematics teaching, and construct a multi-level structural model based on their constraint relationships. The establishment of a multi-level structural model is a prerequisite for evaluating the effectiveness of online teaching quality. The number of levels in the structural model is determined by the complexity of the problem being examined and the accuracy requirements to be achieved in the evaluation. Generally speaking, we follow the principles of operability, simplicity, and practicality, and minimize the hierarchy of structural models as much as possible. This is beneficial for the subsequent calculation of weight vectors. The many factors that affect the effectiveness of online teaching, such as students, teaching equipment, and environmental factors, listed above cannot be objectively evaluated and are not conducive to operation. Therefore, taking the main factors that affect the effectiveness of online teaching, such as the teacher level, as an example, establish a multi-level structural model that affects the effectiveness of online teaching<sup>[7]</sup>.

### 3.1 Establishment of an Evaluation Index System for Online Teaching Effectiveness

#### Build a Multi-level Structural Model as Shown in Fig. 1

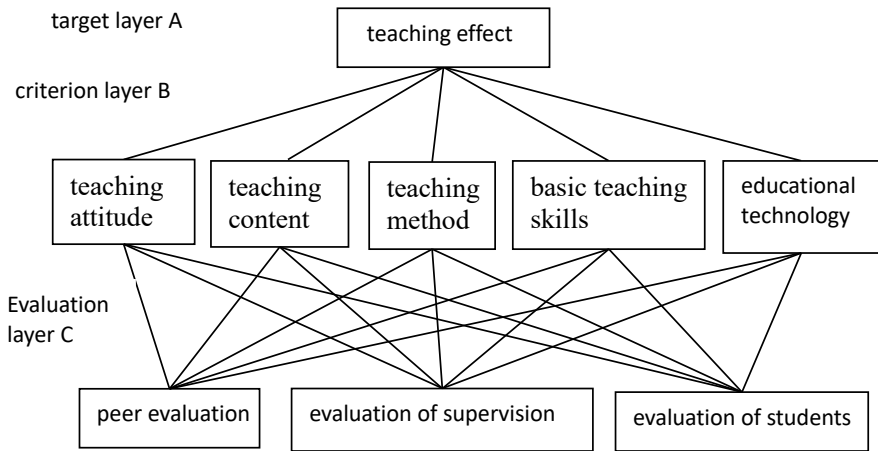


Fig. 1. A multi-level model affecting the effect of online teaching

**Teaching attitude:** Correct attitude, fully prepare lessons, carefully correct online homework, teaching and educating people.

**Teaching content:** According to students' cognitive structure and difficulties in online teaching, combined with Vygotsky's principle of the area of proximal development, reasonable and appropriate treatment of teaching materials, professional needs, result-oriented, OBE education concept as the principle, integration of teaching content, with the knowledge to solve practical problems. It embodies the characteristics of talents training in application-oriented colleges, which is applied, practical and innovative. At the same time into the curriculum ideological and political.

**Teaching methods:** Make full use of the advanced nature of modern education and teaching methods (such as MOOCs, flipped classroom, synchronous asynchronous SPOC, BOPPPS teaching method, etc.), integrate traditional teaching methods, so as to solve the difficulties and key problems in teaching. Focus on cultivating students' innovative spirit and good quality of independent and independent learning.

**Teacher's basic skills:** According to the characteristics of online teaching, time, space and sense of distance, the basic links of the classroom are organized orderly, reasonable and smooth. Stimulate students' learning enthusiasm and make students' participation higher. Reflect the teacher-led, student-dominated good learning atmosphere.

**Educational technology:** Proficient in all aspects of teaching website platform control. Such as check-in, homework correction, various forms of teacher-student interaction. Test paper design and distribution, student performance evaluation data analysis and sorting and so on.

**Construct Judgment Matrix**

According to the above multi-level model, the judgment matrix  $B$  and  $C$  can be constructed according to the interviews of experts and front-line teachers by Saaty's 9-scale method as shown in Table 2-3.

**Table 2.** The judgment matrix of the criterion layer to the target layer

for target layer	attitude $B_1$	content $B_2$	method $B_3$	skills $B_4$	technology $B_5$
teaching attitude $B_1$	1	1/2	1/3	1	1/2
content $B_2$	2	1	1	2	1
method $B_3$	3	1	1	2	1
basic skills $B_4$	1	1/2	1/2	1	1/2
technology $B_5$	2	1	1	2	1

**Table 3.** The judgment matrix of the evaluation layer to the criterion layer

for criterion layer $B$	Peer evaluation $C_1$	Supervisory evaluation $C_2$	Students evaluation $C_3$
Peer evaluation $C_1$	1	1/2	1/2
Supervisory evaluation $C_2$	2	1	1
Student evaluation $C_3$	2	1	1

From this we get the judgment matrix  $B$  and  $C$  as follows:

$$B = \begin{pmatrix} 1 & 1/2 & 1/3 & 1 & 1/2 \\ 2 & 1 & 1 & 2 & 1 \\ 3 & 1 & 1 & 2 & 1 \\ 1 & 1/2 & 1/2 & 1 & 1/2 \\ 2 & 1 & 1 & 2 & 1 \end{pmatrix}, \quad C = \begin{pmatrix} 1 & 1/2 & 1/2 \\ 2 & 1 & 1 \\ 2 & 1 & 1 \end{pmatrix}.$$

**3.2 Determination of the Weight Vector**

According to the above data, the relative weights of each factor are obtained by solving the maximum eigenvalue of the judgment matrix and its eigenvector. By using MATLAB to write calculation program, the weight vector of criterion layer B to target layer is  $W_1 = (0.1140, 0.2472, 0.2681, 0.1236, 0.2472)^T$ .

The weight vector of the evaluation layer C to the target B of the previous layer is  $W_2 = (0.2000, 0.4000, 0.4000)^T$ .

### 3.3 Conduct the Consistency Check

The consistency index CI of the judgment matrix is calculated, and the average random consistency index RI is checked  $CR = \frac{CI}{RI} = 0.004411 < 0.1$ .

The consistency ensures the effectiveness of the weight vector  $W_1$ .

The same verification shows  $W_2 = (0.2000, 0.4000, 0.4000)^T$  is acceptable.

### 3.4 Data Analysis

According to the weight data of the criterion layer to the target layer, the weights of teachers' teaching methods, teachers' proficiency in educational technology and handling of teaching content, teachers' basic skills and teaching attitudes on the influence of teachers' online teaching effects are 0.2681, 0.2472, 0.1236 and 0.1140, respectively. From the perspective of teachers, teaching methods rank first, teachers' proficiency in educational technology and handling of teaching content rank second, and teachers' basic skills and teaching attitude rank third and fourth respectively. The ranking of weight data fully reflects the significant differences between applied undergraduate college students and comprehensive university students in cognitive ability and online learning characteristics. As the knowledge foundation of students in application-oriented undergraduate colleges is not solid enough, their cognitive ability is weak, and their self-discipline is not strong, so the leading position of teachers is very crucial. The teaching method of teachers is particularly important, and the indispensable basis of online teaching is the mastery of modern educational technology. Only the skillful application of modern educational technology can make online teaching smooth and emotional, and the appropriate treatment of teaching content will overcome the fatigue and boredom caused by the distance and interaction barriers of online teaching. The basic skills of teachers, generally speaking, our teachers have passed the teacher qualification examination and several years of practice, and the basic teaching practice experience is possessed. Teaching attitude is the moral bottom line followed by our teachers' professional ethics, so teachers' basic skills and teaching attitude are ranked third and fourth respectively, which is consistent with the reality.

Teachers' score for each content is obtained as follows:

$$C'_j = \sum_{i=1}^5 \omega_i B'_{ji} \quad j = 1, 2, 3,$$

where  $B'_{ji}$  ( $i=1, 2, \dots, 5$ ) represents the score representing the teaching attitude, teaching content, teaching method, teaching basic skills and educational technology of online teaching respectively,  $\omega_i$  is the corresponding weight in  $W_1$ .

The final score of the teacher's online teaching effectiveness is the weighted sum as follows:

Teacher's score is  $\sum_{i=1}^3 \omega_{2i} C'_i$ , where  $C'_1, C'_2, C'_3$  represents the scores of peer, supervisor and student evaluation respectively,  $\omega_{2i}$  is the corresponding weight in  $W_2$ .

The weight of student evaluation and supervision evaluation is 0.4. The peer review was 0.2. When students in application-oriented undergraduate colleges grade teachers, they will more or less ignore the teaching level of teachers because of their preferences and emotional exchanges, so they need teachers who know teaching and professional skills to correct the teaching grade, and peer teachers who know professional skills may evaluate the teaching level of teachers from a professional perspective. However, the expert who knows the profession and has profound teaching theory and practice, the supervisor, can more comprehensively evaluate the teaching level of teachers. So the above evaluation weights are more in line with reality.

### 4 Illustrative Example

Let's take an example. Suppose five teachers A,B,C,D,E are under consideration. Each one's teaching effect are firstly scored from the above five aspects in table 4-6.

**Table 4.** Peer evaluation scores of each teacher on the target layer

	attitude $B_1$	content $B_2$	method $B_3$	skills $B_4$	technology $B_5$
A	92	93	91	92	90
B	93	93	92	93	91
C	95	95	90	94	91
D	92	90	94	90	93
E	94	94	91	94	90

**Table 5.** Supervisory evaluation scores of each teacher on the target layer

	attitude $B_1$	content $B_2$	method $B_3$	skills $B_4$	technology $B_5$
A	88	92	90	90	92
B	90	93	93	92	93
C	92	95	89	93	93
D	94	90	91	90	94
E	90	94	92	96	90

**Table 6.** Students evaluation scores of each teacher on the target layer

	attitude $B_1$	content $B_2$	method $B_3$	skills $B_4$	technology $B_5$
A	94	93	90	92	93
B	89	95	91	93	90
C	95	96	95	94	95
D	91	93	92	93	93
E	95	95	92	91	91

Aggregate the scores from three groups of people by taking the weight vector as  $W_1 = (0.1140, 0.2472, 0.2681, 0.1236, 0.2472)^T$ . the weighted score for each teacher are listed in table 7.

**Table 7.** The weighted scores of each teacher on the target layer

	A	B	C	D	E
$C_1$	91.4939	92.2468	92.5566	92.0510	92.2163
$C_2$	90.7698	92.5437	92.3173	91.7219	92.2756
$C_3$	92.1954	91.7699	95.1331	92.5132	92.7220

Next, take the weight vector  $W_2 = (0.2000, 0.4000, 0.4000)^T$ , the final scores and the ranking are obtained as shown in table 8.

**Table 8.** The final scores and the ranking to each teacher

	A	B	C	D	E
Score	91.4849	92.1748	93.4915	92.1042	92.4423
Ranking	5	3	1	4	2

From the above data, it can be seen that Teacher C's total score ranks first in the ranking, which is at the bottom in the evaluation of peers and supervisors, but ranks first in the score of students, indicating that although the teaching method of teacher C has not been recognized by peers and experts, it is suitable for the cognitive level of students and popular with students. This is the current student-centered teaching. A reality worth exploring; In the handling of teaching content, students, peers and supervisors are unified in the first place of the five teachers. Educational technology, teaching attitude and basic teaching skills ranked first in student evaluation, and also ranked top in peer and supervisor ratings. It shows that the evaluation model has certain reliability and validity.

## 5 Conclusion

According to the data analysis, the factors affecting the online teaching effect of applied undergraduate colleges are as follows: from the perspective of teachers, teaching methods rank first, teachers' proficiency in educational technology and handling of teaching content rank second, and teachers' basic skills and teaching attitude rank third and fourth respectively. This conclusion first reflects the cognitive characteristics of students in our application-oriented undergraduate colleges and the direction that teachers should strive in online teaching. As the knowledge foundation of the students in our application-oriented undergraduate colleges is not solid enough, the learning ability is not strong, and the self-restraint is not strong, it is difficult to carry out online teaching. Teachers must make comprehensive use of various teaching methods to mobilize students' enthusiasm to participate in online learning. To achieve this goal, teachers must be supported by the ability to master modern educational technology and deal with knowledge content appropriately, otherwise the effect of teachers' online teaching is just a reading machine. Why do teachers' teaching atti-



tudes and basic teaching skills rank in the third and fourth place? Combined with qualitative analysis, it is reasonable and reasonable. In general, the professional qualification and accomplishment of teachers determine that the teaching attitude and basic teaching skills of teachers are qualified and superior. Secondly, looking at the final online teaching evaluation score ranking, teachers with appropriate teaching methods, proficient in educational technology and proper handling of online teaching content are among the best in teaching evaluation results. The effectiveness of the evaluation method is fully explained.

There are many kinds of teaching evaluation methods. For application-oriented undergraduate colleges, the online teaching evaluation model of AHP based on the above five elements is simple, clear and easy to operate, and has certain reliability and effectiveness. The deficiency is that the evaluation elements are few! This evaluation model can provide reference, guidance and promotion for our subsequent offline teaching in emergency state and routine teaching combined with online and offline teaching. At the same time, it will serve as a reference for the further use of AHP in the reform of teaching evaluation.

## Acknowledgments

This work was partially supported by Innovation Strong School Project of Guangdong University of Science and Technology No. XJ2022001601 and GKY-2022CQTD-5, Humanities and Social Sciences Key Project of Guangdong University of Science and Technology No. GKY-2022KYZDW-9 and School level quality engineering of Guangdong University of Science and Technology No. GKZLGC2023139.

## References

1. Wu Wei, et al.(2020) Research on Regional and institutional Differences in Online Teaching satisfaction of university teachers. *Open Education Research*, 6:71-79.
2. Huang Wenxiang, Li Yadong, & Zhang Xisheng(2020).The Quality Status, Evaluation and Suggestions of Online Teaching in Undergraduate Universities in China.*China Higher Education*, 8:21-24.
3. Gou Feifei, Liu Zhentian.(2020) An Empirical Analysis of the Cognitive Evaluation of Online Teaching Platform Function and Environment Support of University Teachers. *Research in Educational Development*. 11:49-59.
4. Büyükg ze Hilal, Gün Feyza.(2017) Exploring Teaching Satisfaction of Public High School Teachers: Empirical Evidence from Turkey. *Acta Didactica Napocensia*.
5. Cain, J, Stowe, C. D., Ali, D., & Romanelli, F.(2019). How faculty recognized for teaching excellence interpret and respond to student ratings of teaching. *American Journal of Pharmaceutical Education*, 83.
6. Guillén Mena Vanessa, etc.(2023) Lessons learned from a study based on the AHP method for the assessment of sustainability in neighborhoods. *MethodsX*.
7. Cochran Smith Marilyn, Reagan Emilie Mitescu. (2022) Centering Equity in Teacher Education Evaluation: From Principles to Transformative Enactment. *Journal of Teacher Education*. 73(5): 449-462.

**Open Access** This chapter is licensed under the terms of the Creative Commons Attribution-NonCommercial 4.0 International License (<http://creativecommons.org/licenses/by-nc/4.0/>), which permits any noncommercial use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license and indicate if changes were made.

The images or other third party material in this chapter are included in the chapter's Creative Commons license, unless indicated otherwise in a credit line to the material. If material is not included in the chapter's Creative Commons license and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder.

