Online-Journals.org

iJET International Journal of Emerging Technologies in Learning

iJET | eISSN: 1863-0383 | Vol. 18 No. 16 (2023) | OPEN ACCESS

https://doi.org/10.3991/ijet.v18i16.41353

PAPER

Online Teaching Quality Evaluation: Entropy TOPSIS and Grouped Regression Model

Yan Zhang[1](✉), Chang Liu[2]

[1]School of Chemistry and Pharmaceutical Engineering, Huanghuai University, Zhumadian, China

[2]School of Mathematics and Statistics, Huanghuai University, Zhumadian, China

zhangyan@huanghuai.edu.cn

ABSTRACT

With the continuous progress in Chinese higher education, the quality of online teaching has become the key to influencing that of the operation and reputation of universities and colleges. Nevertheless, the results of traditional teaching quality evaluation methods are considerably influenced by objectivity due to limitations in single-index and outdated methods. Hence, the construction of a reasonable online teaching quality evaluation model for universities and colleges presents important research significance to optimize the existing evaluation process. An online teaching quality evaluation index system for teachers at 26 observation points was set up from the perspectives of teaching objectives, process, and effect. The Technique for Order Preference by Similarity to Solution (TOPSIS) scores of 215 teachers from six universities in Henan Province, China, were evaluated using the entropy TOPSIS method. In addition, the significance of influencing factors in the ranking results of online teaching quality by teachers was analyzed using a hierarchical regression model. Results demonstrate that the weights of teaching attitude, teaching contents, and cognitive objectives were the highest and occupied the top three positions with weights of 14.94%, 12.99%, and 12.96%. By using three level-1 indexes of teaching objectives, process, and effect as the explanatory variables, students' scores for teachers are all significant under the 1% level. According to the Chow test, the results are $F(4, 207) = 2.725$ and $p = 0.031 < 0.05$, indicating that using the online teaching duration of teachers as a grouping variable brings structural changes. Results can optimize online teaching quality evaluation and provide scientific references to evaluate the teaching quality of teachers.

KEYWORDS

online teaching, quality evaluation, entropy TOPSIS, grouped regression model

1 INTRODUCTION

The emergence of the Internet has led to the development of online education. With the establishment of the Khan Academy, online education attracted extensive attention. The development of massive open online courses (MOOCs) further

Zhang, Y., Liu, C. (2023). Online Teaching Quality Evaluation: Entropy TOPSIS and Grouped Regression Model. *International Journal of Emerging Technologies in Learning (iJET)*, 18(16), pp. 36–49. https://doi.org/10.3991/ijet.v18i16.41353

Article submitted 2023-05-13. Resubmitted 2023-06-17. Final acceptance 2023-06-17. Final version published as submitted by the authors.

© 2023 by the authors of this article. Published under CC-BY.

facilitates the prosperity of online video learning. This method can predominate as lifelong learning becomes the optimal scheme in the current information society to meet the needs of individuals and organizations in updating their knowledge base. Online teaching has become a common teaching activity mode and has been further promoted during the Coronavirus disease 2019 (COVID-19) pandemic. Online teaching has become an extensive need in China and even around the world. When online teaching becomes an ordinary teaching mode and is appreciated by more and more people, its quality issues become increasingly prominent. Online teaching implements teaching activities by using the network virtual environment as a medium and is carried out with strong compatibility and interaction. Synchronous or asynchronous teaching activities can be done online by using various interactive and sharing network platforms, where teachers and students make synchronous or asynchronous communication, and share real- and non-real-time learning resources by using voice and other online tools through live and recorded video. This method realizes trans-space-and-time communication and dialogue between teachers and learners in the virtual environment. The increasing development of information technology (IT) brings new thinking to teaching reforms for university and college courses. Based on information fusion technology, reform can continue to be promoted in terms of teaching contents, means, and modes for different majors in universities and offer important assistance to the development of students' consciousness of innovation.

Recently, IT development has brought great possibilities for the reform of specialized courses in universities and colleges. The government, educational administration departments, and schools have all not only deepened their understanding of the importance of continuously improving informatization levels in the reform of online teaching in universities and colleges but also continuously increased relevant inputs. The continuous improvement of sports service information levels in universities and colleges considerably aids in online teaching. Although online learning is indeed convenient for learners to study anytime and anywhere, teachers cannot guide students to carry out deep teaching activities. Hence, the general effect of the deep learning outcomes is not ideal. Although students reach certain learning levels, their depth is limited, and their overall deep learning is low. To a very large extent, online teaching quality determines the learning depth of students and therefore requires examination. Online teaching is undergoing such a critical stage that it is becoming a new way of "normal" teaching. Accordingly, the online teaching effect is of high concern among the public.

2 LITERATURE REVIEW

The field of international theoretical studies on teaching quality evaluation is well represented by several major European and American developed countries, each having relatively well-developed theoretical systems. In the 21st century, teaching quality evaluation began to attract considerable attention worldwide, and relevant research became increasingly systematic and scientific. In China, studies on university teaching quality started later. Several studies have been reported with references to foreign universities teaching quality evaluation theories. With respect to regular and online teaching quality evaluation, studies mainly focus on establishing the evaluation method, index systems, and questionnaire surveys. Jiang, Y. et al. [1] analyzed public sports education quality by using the fuzzy comprehensive evaluation method, an established sports performance evaluation index system, different weights, and finally developed a fuzzy comprehensive evaluation of

sports teaching quality. Several optimization suggestions were also proposed for the evaluation model. Spooren, P et al. [2] established a tool with 31 items, including 10 Likert-type scales, in discussing reliability and validity, emphasizing the value of scale technology in students' evaluations of teacher performances. Abdelhadi, A. et al. [3] investigated 63 students from engineering majors by using the student evaluation of teaching (SET) and found that meeting their needs in class seems to be an important factor in the teacher evaluation at the end of a semester. Teachers must pay attention to a series of factors by using a balanced method to improve their overall teaching performance. Sims, R. et al. [4] pointed out that in the online teaching environment, the comprehension of teachers, learners, and developers regarding the media may affect the ultimate effect of teaching quality evaluation; the study determined another post-development dimension during positive evaluation. This framework determines the key online learning factors and influences. Ward, M.E. et al. [5] analyzed the synchronous interactive online teaching quality of faculty from the University of Southern Mississippi in the spring of 2007 and found that, similar to face-to-face teaching mode; online teaching effectiveness can be realized. Lee, J. W. [6] discussed potential differences between Korean and American students in their perceptions of online education support service quality and online learning acceptability and satisfaction. Significant differences in such perceptions between Korean and American students are an important predictive factor of their acceptability and satisfaction with online learning. Kim, K.J. et al. [7] investigated more than 100 students of top online MBA courses and found that virtual teams were a major factor that influenced online learning experiences. Student suggestions to improve the quality of online MBA courses were also discussed. Zhao, F. [8] discussed a series of problems that influence online higher education quality and reviewed the standard of online teaching quality from different perspectives. This standard provided stakeholders at universities with a practical guideline to evaluate online teaching quality. Kentnor, H.E. [9] summarized key factors that influence teaching quality in remote teaching. Xu, D. et al. [10] estimated the influences of online and face-to-face course deliveries on student classroom performances by using an instrumental variable technique, and obtained a strong negative estimation of online learning in course duration and academic performance. Students all hope to focus on the evaluation and improvement of online course quality before further expanding online learning. McGorry, S. Y. [11] developed a model to measure the quality and learning of online courses and thus help decision-makers, teachers, and students make a scientific judgment on the quality of remote education delivered via the Internet. Castro, M.D.B. et al. [12] reviewed the literature using a meta-analysis, applied the ADDIE framework to the design and development of teaching materials, and analyzed the general situation of studies concerning online teaching quality evaluation. Syauqi, K. et al. [13] collected data from 56 students by using Likert-type scales through a questionnaire survey, which revealed that teachers' management of online learning failed to meet student expectations. Online learning does not provide better experiences and efficiency to master abilities, but it can bring momentum and convenience to their learning. Baloran, E.T. et al. [14] investigated the online learning quality of the Christian University of Indonesia and found that it has reached a good level of online teaching. Baltà-Salvador, R. et al. [15] studied the online education experiences of engineering undergraduates during the COVID-19 epidemic, and discovered significant correlations of academic development with online course quality, adaptation to courses, working environment, and student-teacher connections. He, Y. et al. [16] demonstrated that content and activity designs of network teaching can effectively improve learners' learning satisfaction, while object and evaluation designs could not. Yang, P. et al. [17] established a comprehensive service

quality evaluation model of online learning that was composed of hierarchical and rough set-neural network evaluation to verify the validity of the built index system. A careful literature review revealed that many studies have applied the method of combining qualitative and quantitative analyses during the evaluation of university or online teaching quality. A scientific and rigorous evaluation index system was built according to the practical situations of universities and colleges to plan various evaluation relationships (e.g., students' evaluation of teachers, peer evaluation, and self-evaluation) and combine the results. Several studies integrated general, formative, and predictive evaluations, and the results were more comprehensive. In particular, the online teaching quality of universities and colleges has become a base for further development with the increasing attention paid to higher education in China. To improve the quality management and efficiency of university teachers, their teaching methods, and the learning efficiency of students, many universities and colleges in China have implemented diversified teaching quality evaluation or monitoring modes. The present study applies the entropy TOPSIS and grouped regression models to teaching quality evaluation with the aim of solving the defects of traditional manual evaluation methods (e.g., time-consuming, labor-consuming, low efficiency, and poor information mining ability) and realizing informationized, scientific, and standard teaching quality evaluation.

3 METHODOLOGY

3.1 Models

To use entropy TOPSIS, Li, X. et al. [18] believed that entropy had to be calculated first, and established n evaluation indexes according to the need to evaluate m objects. An evaluation matrix (X) was obtained according to the evaluation results:

$$X = \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1n} \\ x_{21} & x_{22} & \cdots & x_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ x_{m1} & x_{m2} & \cdots & x_{mn} \end{bmatrix} \quad (1)$$

Where x_{ij} refers to the evaluation results for the jth factor of the ith object. Given that factors that reflect evaluation objects often have different dimensions and dimensional units, a range transformation was applied for dimensionless treatment of evaluation indexes to eliminate the incommensurability of indexes, as shown in (2) and (3). Specifically, positive indexes (the higher the value, the better) were processed according to (2).

$$r_j = \frac{x_{ij} - x_{\min(j)}}{x_{\max(j)} - x_{\min(j)}} \quad (2)$$

Negative indexes (the lower the value, the better) were processed according to (3).

$$r_j = \frac{x_{\max(j)} - x_{ij}}{x_{\max(j)} - x_{\min(j)}} \quad (3)$$

The relation judgment matrix (R) could be gained through dimensionless treatment:

$$R=\begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1n} \\ r_{21} & r_{22} & \cdots & r_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ r_{m1} & r_{m2} & \cdots & r_{mn} \end{bmatrix} \tag{4}$$

Where r_{ij} is the dimensionless treatment result of the original data (x_{ij}). Next, the weights of evaluation indexes were determined by using the entropy method. The weights of the index value (r_{ij}) under the index (j) were calculated as follows:

$$\begin{aligned} &P(r_{ij})=\frac{r_j}{\sum_{i=1}^{m} r_{ij}}, e_j=-k\sum_{i=1}^{m} P(r_{ij})\ln P(r_{ij}) \\ &k>0, k=\frac{1}{\ln m}, e_j\geq 0 \end{aligned} \tag{5}$$

Therefore, the diversity factor of index j was obtained: $g_j = 1–e_j$. For a given index j, the smaller the difference between r_{ij}, higher the value of e_j. If r_{ij} is all equal, then $e_j = 1$. Hence, the index with a greater g_j is more important. The weight vector of indexes can be defined as follows:

$$A=(a_1,a_2,\cdots,a_n), a_i=\frac{g_j}{\sum_{j=1}^{n} g_j} \tag{6}$$

TOPSIS calculates the positive (V^+) and negative (V^-) ideal solutions based on the standardized weighted evaluation decision-making matrix:

$$\begin{aligned} &V^+=(v_1^+,v_2^+,\cdots,v_j^+,\cdots,v_n^+) \\ &v_j^+=\{(\max_{1\leq i\leq m} v_{ij}\,|\, j\in J^-),(\min_{1\leq i\leq m} v_{ij}\,|\, j\in J^-)\} \end{aligned} \tag{7}$$

$$\begin{aligned} &V^-=(v_1^-,v_2^-,\cdots,v_j^-,\cdots,v_n^-) \\ &v_j^-=\{(\min_{1\leq i\leq m} v_{ij}\,|\, j\in J^+),(\max_{1\leq i\leq m} v_{ij}\,|\, j\in J^-)\} \end{aligned} \tag{8}$$

The Euclidean distances of different schemes to the positive and negative ideal solutions were calculated according to Eq. (9):

$$\begin{aligned} D_j^+&=\sqrt{\sum_{j=1}^{n}(v_{ij}-v_j^+)^2} \\ D_j^-&=\sqrt{\sum_{j=1}^{n}(v_{ij}-v_j^-)^2} \end{aligned} \tag{9}$$

Finally, the relative closeness of the schemes was calculated as follows:

$$C_i=\frac{D_i^-}{D_i^+ + D_i^-} \tag{10}$$

From (1)–(10), C_i from (10) was used as the online teaching quality evaluation results of different teachers and thus served as the explained variable. Various studies

have proven that the online teaching quality of teachers is closely related to their online teaching experiences. In this study, the online teaching time of teachers was used as the grouping variable. The grouped regression model proposed by Freda Kemp [19] was applied to analyze the influencing factors of online teaching quality evaluation results. In fact, grouped regression is actually a linear regression and can check the influences of explanatory variables on the explained variable under different groups. A difference T-test of the regression coefficient was also calculated, as shown in (11):

$$t = \frac{b_1 - b_2}{\sqrt{\frac{SSE_1 + SSE_2}{n1 + n2 - 4} \times \left(\frac{1}{SS_1} + \frac{1}{SS_2} \right)}}, df = n - 4 \tag{11}$$

Where b_1 and b_2 are the non-standard regression coefficients of two regressions, respectively; SSE_1 and SSE_2 are the residual sum of squares of two regressions, respectively. n_1 and n_2 are the effective sample sizes of two regressions, respectively; SS_1 and SS_2 are the sum of squares of deviations of an explanatory variable, respectively; df refers to degree of freedom; and n indicates the overall sample size.

3.2 Index system

To establish a scientific and reasonable online teaching quality evaluation index system is one of the research aims of this study. Students from engineering colleges were chosen as the research objects, and thus a teaching quality evaluation system for engineering colleges was set up based on the educational concept of OBE. Three level-1 indexes were used to reflect online teaching quality, including teaching objectives, process, and effect. Then, nine level-2 indexes containing the above and 26 questionnaire problems were selected to thoroughly measure online teaching quality. The index system is shown in Table 1.

Table 1. Index system of online teaching quality evaluation

Level-1 Indexes	Level-2 Indexes	Questionnaire Problems	No.
Teaching objectives	Cognitive objectives	Students can remember knowledge they learned before.	F-1-1-1
		Students can interpret and solve practical problems by using theories.	F-1-1-2
	Emotional objectives	Teachers are interested in questions of students.	F-1-2-1
		Teachers often show the beauty of life to students.	F-1-2-2
		Teachers are concerned for and adjust to the psychological problems of students.	F-1-2-3
	Skill objectives	Teachers can often guide students in imitation training.	F-1-3-1
		Teachers can often guide students in practical operations and training.	F-1-3-2
		Teachers can often guide students to master rhythms and maintain fluent actions.	F-1-3-3
		Teachers can continuously train the operation ability of students.	F-1-3-4

(Continued)

Table 1. Index system of online teaching quality evaluation *(Continued)*

Level-1 Indexes	Level-2 Indexes	Questionnaire Problems	No.
Teaching process	Teaching attitude	The teaching enthusiasm of teachers can stimulate students' yearning for education.	F-2-1-1
		Teachers often ask students who are not positive to answer questions in class.	F-2-1-2
	Teaching contents	Teaching content of teachers is easy to be understood and mastered by students.	F-2-2-1
		Teachers often present examples when introducing theories.	F-2-2-2
	Teaching method	Teachers are good at guiding the thinking of students.	F-2-3-1
		Teachers are good at teaching students in accordance to their aptitudes and use multiple teaching methods flexibly.	F-2-3-2
		Teachers are skilled in using teaching equipment and software.	F-2-3-3
Teaching effect	Emotional transformation	Students can draw inferences about other cases from one instance and analyze problems by using the learned knowledge.	F-3-1-1
		Students can design schemes independently and produce inventions as well as creations.	F-3-1-2
		Students can face setbacks positively and optimistically.	F-3-1-3
	Skill improvement	Students establish a scientific world view, life view, and values.	F-3-2-1
		Students can participate in operations and practices.	F-3-2-2
		Students can maintain coordinated actions in practical operations.	F-3-2-3
		Students can operate skillfully.	F-3-2-4
	Cognitive development	Students can connect old and new knowledge.	F-3-3-1
		Students can distinguish concepts and connotations and create a summary.	F-3-3-2
		Students can consciously make rational judgment and evaluation of objects.	F-3-3-3

3.3 Data source

In central China, Henan is a province with a large population. Influenced by the COVID-19 pandemic, all universities and colleges in Henan Province have carried out online teaching. Therefore, 6,584 students from 28 majors in six disciplines at six universities in Henan Province were chosen. A questionnaire survey was carried out to evaluate the teaching quality of 215 online teachers. Through questionnaire data processing, scores of students on 26 questionnaire problems from 215 teachers were obtained. The questionnaire applied a Likert-type, 5-point scale to collect the original data on the online teaching quality of teachers. Language descriptions were provided for different scores: 5 (strongly satisfactory), 4 (satisfactory), 3 (moderate),

2 (unsatisfactory), and 1 (strongly unsatisfactory). The descriptive statistics of students on the online teaching quality of 215 teachers are shown in Table 2.

Table 2. Descriptive statistical results

Name	Options	Frequency	Percentage (%)	Cumulative Percentage (%)
Gender of teachers	Male	154	71.63	71.63
	Female	61	28.37	100
Discipline	Inorganic chemistry	24	11.16	11.16
	Organic chemistry	36	16.74	27.91
	Analytical chemistry	64	29.77	57.67
	Medicinal chemistry	31	14.42	72.09
	Applied mathematics	30	13.95	86.05
	Statistics	30	13.95	100
Grade	Freshman	35	16.28	16.28
	Sophomore	45	20.93	37.21
	Junior	82	38.14	75.35
	Senior	53	24.65	100
Online teaching time	<3 years	140	65.12	65.12
	>3 years (including 3 years)	75	34.88	100
Total number of teachers		215	100	100

Table 2 shows that in this questionnaire survey, male teachers accounted for a higher proportion (71.63% of total effective respondents). Engineering teachers accounted for 29.77%. The proportion of teachers of juniors was relatively high (38.14%), and that of those who have provided at least 1 year (including 1 year) of online teaching services is 65.12%. According to frequency analysis results, the distribution basically meets the requirements of a sampling survey.

4 RESULT ANALYSIS

4.1 Entropy TOPSIS results

According to (4)–(6), the weights of nine level-2 indexes were calculated (Table 3).

Table 3. Summary of calculated weights based on entropy method

Level-2 Indexes	Information Entropy e	Information Utility Value d	Weight Coefficient w
Cognitive objectives	0.9911	0.0089	12.96%
Emotional objectives	0.9916	0.0084	12.29%
Skill objectives	0.9929	0.0071	10.38%
Teaching attitude	0.9898	0.0102	14.94%

(Continued)

Table 3. Summary of calculated weights based on entropy method *(Continued)*

Level-2 Indexes	Information Entropy e	Information Utility Value d	Weight Coefficient w
Teaching contents	0.9911	0.0089	12.99%
Teaching method	0.9929	0.0071	10.39%
Emotional transformation	0.9923	0.0077	11.28%
Skill improvement	0.9953	0.0047	6.88%
Cognitive development	0.9946	0.0054	7.89%

Table 3 shows that the weights of teaching attitude, teaching contents, and cognitive objectives were the highest, occupying the top three positions. The reason is mainly because in online teaching, many teachers have used live broadcasting, and degrading their attitude after a long time is easy. Generally, their teaching behaviors may be brought on by an accurate teaching attitude that is consistent. The teaching attitude of teachers is highly associated with the learning attitudes and behaviors of students. The online teaching attitude of teachers transfers their values and shows their opinions on the occupational significance and degree of recognition to their job. Moreover, university students undergo the process of forming and compacting values. The good online teaching attitude of teachers has unconscious effects on the formation of values and learning attitude changes of the students. The demonstration effect of teachers is developed to guide students to devote themselves to learning consciously and positively, strengthen their learning ability, transform knowledge into social production, improve social adaptation, and strengthen happiness and satisfaction. Moreover, the weight of teaching contents ranks second, mainly because its selection has significant effects on the teaching quality of teachers. Teaching contents are chosen in accordance with the existing cognitive structure of students and are adapted to their learning needs. Teachers introduce the core theoretical knowledge of the field and the latest research results to students, encouraging them to overcome difficulties and challenge the unknown world. Under the premise of meeting the "recent development fields" of students, teachers increase the complexity and challenges of teaching contents and guide students to use existing knowledge but also explore and create new ones. In indexes, questions can be set as "students all can understand and master contents taught by teachers", to allow students to assess whether the teaching is effective. The selection of teaching contents has relatively high effectiveness; it helps teachers understand the interests and needs of students, provides references for scientific selection, optimizes teaching content design, and provides a guiding effect. Ranking third are the weights of cognitive objectives. The reason is mainly because in Broome's division system of educational objectives, the cognitive domain is further divided into six levels, including memorization, understanding, application, analysis, evaluation, and creation. Cognitive objectives mean that students recognize and memorize abstract concepts and specific items and recall relevant knowledge. One of the core tasks of online teaching for teachers is to recall the learned knowledge from cognitive objectives, compare and distinguish knowledge, and interpret and solve practical problems with theories. Hence, teaching attitude, teaching content, and cognitive objectives are realized through a detailed decomposition of teaching objectives. These factors help students understand the teaching of teachers and their own learning, and thus evaluate the teaching effect objectively.

Subsequently, the TOPSIS ranking and scores of 215 teachers were estimated (Table 4). Teachers numbered 6–210 were not exhibited due to the limited space.

Table 4. TOPSIS ranking and scores of 215 teachers

Teachers	Distance to the Positive Ideal Solution D^+	Distance to the Negative Ideal Solution D^-	Relative Closeness C	Ranking
1	7.194	4.448	0.382	163
2	7.458	4.104	0.355	179
3	5.498	6.824	0.554	42
4	5.93	5.774	0.493	79
5	7.6	4.382	0.366	172
:	:	:	:	:
211	7.728	4.197	0.352	180
212	8.66	4.035	0.318	193
213	5.762	6.734	0.539	48
214	6.378	5.087	0.444	126
215	6.773	6.081	0.473	99

4.2 Grouped regression

The relative closeness (*C*) of 214 teachers in Table 4 was used as the explained variable, while students' evaluation scores of their teaching objectives, process, and effect were used as the explanatory variable. The online teaching time was used as the grouped variable, which was marked 0 if less than three years and 1 if three years and above. The regression results of STATA17.0 are shown in Table 5.

Table 5. Results of grouped regression model

Variables	Grouped Marks		
	Overall	0	1
Constant	–0.200**(–79.461)	–0.199**(–48.970)	–0.188**(–22.555)
Teaching objectives	0.079**(105.983)	0.079**(82.334)	0.079**(55.522)
Teaching process	0.077**(83.835)	0.075**(63.415)	0.078**(44.248)
Teaching effect	0.081**(89.298)	0.083**(69.706)	0.077**(47.139)
Sample size	215	140	75
R^2	0.997	0.994	0.992
Adjusted R^2	0.997	0.994	0.992
F-value	F(3,211)=25587.157, p=0.000	F(3,136)=7748.984, p=0.000	F(3,71)=2968.674, p=0.000
**p<0.01			

Note: **Significance below the 1% significance level.

Table 5 shows that students' evaluation scores on teaching objectives, process, and effect of teachers are all significant under the 1% level. In this study, these three conclusions are true, because of the following reasons: (1) Teaching objectives are used to assess whether the learning outcomes of students are realized rather than whether teachers can complete a task. During online teaching, teachers' ability to set up teaching objectives scientifically is highly important and helpful to the cognitive and full personal development of students. During the teaching activities, students not only acquire knowledge but also master skills. Similarly, students develop how to learn by strengthening emotional experiences and establishing accurate values. (2) The key to online teaching must be the learning of students. Teaching administration departments at all levels must pay attention to the teaching process. Given that students are the subjects of teaching activities and learning is their most basic task, realizing the teaching tasks as determined by schools during online teaching is necessary. This is the goal, which improves talent training quality and facilitates the comprehensive development of students. These are the common functions of teachers and students and comprise a complicated process of serving schools and talent training in society by using multiple educational means. (3) The teaching effect educates students for a certain period of time. Teaching performances are evaluated by using the completion of teaching objectives as one of the standards for using specific learning methods and strategies. Teaching evaluation asks students to "learn" to judge the "teaching" of teachers and classroom teaching outcomes by the learning effect.

Table 6. Chow test

Residual Sum of Squares SSE			Sample Size n			Number of Parameters k	F	df1	df2	p-Value
All	0	1	All	0	1					
0.008	0.005	0.002	215	140	75	4	2.725	4	207	0.031

Here is an explanation of Table 6. The Chow test can be used to check whether two groups of data have structural changes. In this study, the Chow test results were $F(4, 207) = 2.725$ and $p = 0.031 < 0.05$, indicating that using the online teaching time of teachers as the grouped variable may bring structural changes to the model. The main reason is that teachers with longer online teaching time are more skilled in using various online teaching techniques. If teachers are not good at using such tools in online courses, the effectiveness of teaching evaluation is low. Moreover, if the teaching time of teachers is shorter than a specific time length (e.g., 3 years), then their selection of online teaching methods is unreasonable and limited. The classroom teaching management of teachers is poor, resulting in low student-teacher interaction frequency and incomplete and limited communications. The functions of the teaching platform cannot completely meet the teaching needs, and the classroom atmosphere is not conducive to interference with the physical and practical environments of students. This conclusion also reminds university teachers of the extreme importance of online teaching time. The comprehensive online teaching quality of teachers can improve significantly if they have accumulated online teaching experiences, including using various online teaching tools, the effectiveness of teaching evaluation, the selection of teaching methods, and class management. Moreover, the teaching time also suggests to university administrative departments that teachers cannot copy offline classroom mode completely onto different online environments, but must update teaching concepts to realize substantial changes in online teaching.

5 DISCUSSIONS

With reform in higher education evaluation, perfecting the online teaching quality evaluation index system is the key to the corresponding teaching evaluation. This study rebuilds and improves the online teaching quality evaluation index system from the perspective of students, with the aim of providing references for university teaching reform. The online teaching quality evaluation does not only provide a systematic and comprehensive evaluation of the online teaching process but is also an important method to assess whether the teaching plan realizes the expected teaching objectives and is an indispensable link in daily teaching activities. This evaluation is also conducive to improving the university teaching level and perfecting the existing education system. Nevertheless, most existing teaching quality evaluation methods use priori knowledge and simple quantitative evaluation, which have strong subjectivity in evaluation indexes and difficulties in quantization. At present, in most studies, the teaching quality evaluation is generally composed of formative, readiness, and terminal assessments. With its many factors, such as teachers, students, and courses, the teaching process determines the teaching quality in different forms and to varying degrees. Hence, several important factors, such as the learning enthusiasm of students and the teaching level of teachers, must be included in teaching evaluation to obtain scientific and reliable results. Moreover, forming an evaluation consensus based on strengthening publicity is necessary because of the complexity of online teaching quality evaluation. Setting up special evaluation institutions, continuously updating the online teaching quality evaluation of universities according to changes in objectives, and standardizing the whole process must also be carried out to assure its success. Online teaching quality evaluation at universities has strong specialties and complicated contents. A reasonable evaluation method must therefore be chosen according to different goals and objects. Moreover, such a method can strengthen the professional training of the involved evaluators to improve the evaluation effect and implement its results. Only in this way can facilitating teaching and learning through evaluation be realized, thus achieving the evaluation objective. The online teaching quality evaluation index system is not constant but changes continuously with teaching contents, objectives, and means of universities. In the future, it is recommended to continuously strengthen relevant theoretical studies, optimize evaluation schemes by crossing disciplines such as pedagogy and statistics, perfect the evaluation index system, and realize the dynamic development of evaluation is recommended. In this study, online teaching quality evaluation based on entropy TOPSIS and a grouped regression model presented higher values of enlightenment.

6 CONCLUSIONS

The COVID-19 pandemic unceasingly intensified in 2020. With the continuous development of IT and informationized education, the position of online teaching courses in education has also improved. Nevertheless, online teaching is very complicated, and its quality evaluation has many challenges. To simply evaluate online teaching quality by using one or another method presents shortcomings. In this study, an online teaching quality evaluation system with 26 indexes is established. The sample includes 215 teachers from six universities and colleges in Henan Province, China, and their TOPSIS scores are estimated by using the entropy TOPSIS method. A hierarchical regression model is used to analyze the significance of factors that

influence the ranking of teachers in terms of online teaching quality. Three major conclusions can be drawn: (1) The weights of teaching attitude, teaching contents, and cognitive objectives are the highest, with values of 14.94%, 12.99%, and 12.96%, respectively; (2) The students' evaluation scores for teachers in terms of teaching objectives, process, and effect are all significant under the 1% level; (3) The Chow test results are F (4, 207) = 2.725 and p = 0.031< 0.05, indicating that using online teaching time of teachers as a grouped variable may bring structural changes to the model. Further research must continue to perfect the dynamic development of the evaluation index system, determine the internal logic relation between higher education quality evaluation and data statistical analysis, and explore the acquisition of teaching quality information by expanding channels based on big data.

7 REFERENCES

[1] Y. Jiang and Y. Wang, "Evaluation of teaching quality of public physical education in colleges based on the fuzzy evaluation theory," *Journal of Computational and Theoretical Nanoscience*, vol. 13, no. 12, pp. 9848–9851, 2016. https://doi.org/10.1166/jctn.2016.5939

[2] P. Spooren, D. Mortelmans, and J. Denekens, "Student evaluation of teaching quality in higher education: Development of an instrument based on 10 Likert-scales," *Evaluation & Evaluation in Higher Education*, vol. 32, no. 6, pp. 667–679, 2007. https://doi.org/10.1080/02602930601117191

[3] A. Abdelhadi and M. Nurunnabi, "Engineering student evaluation of teaching quality in Saudi Arabia," *The International Journal of Engineering Education*, vol. 35, 1, pp. 262–272, 2017.

[4] R. Sims, G. Dobbs, and T. Hand, "Enhancing quality in online learning: Scaffolding planning and design through proactive evaluation," *Distance Education*, vol. 23, no. 2, pp. 135–148, 2002. https://doi.org/10.1080/0158791022000009169

[5] M.E. Ward, G. Peters, and K. Shelley, "Student and faculty perceptions of the quality of online learning experiences," *International Review of Research in Open and Distributed Learning*, vol. 11, no. 3, pp. 57–77, 2010. https://doi.org/10.1016/S0074-7750(10)39010-0

[6] J.W. Lee, "Online support service quality, online learning acceptance, and student satisfaction," *The Internet and Higher Education*, vol. 13, no. 4, pp. 277–283, 2010. https://doi.org/10.1016/j.iheduc.2010.08.002

[7] K.J. Kim, S. Liu, and C.J. Bonk, "Online MBA students' perceptions of online learning: Benefits, challenges, and suggestions," *The Internet and Higher Education*, vol. 8, no. 4, pp. 335–344, 2005. https://doi.org/10.1016/j.iheduc.2005.09.005

[8] F. Zhao, "Enhancing the quality of online higher education through measurement," *Quality Assurance in Education*, vol. 11, no. 4, pp. 214–221, 2003. https://doi.org/10.1108/09684880310501395

[9] H.E. Kentnor, "Distance education and the evolution of online learning in the United States," *Curriculum and Teaching Dialogue*, vol. 17, no. 1, pp. 21–34, 2015.

[10] D. Xu and S.S. Jaggars, "The impact of online learning on students' course outcomes: Evidence from a large community and technical college system," *Economics of Education Review*, vol. 37, pp. 46–57, 2013. https://doi.org/10.1016/j.econedurev.2013.08.001

[11] S.Y. McGorry, "Measuring quality in online programs," *The Internet and Higher Education*, vol. 6, no. 2, pp. 159–177, 2003. https://doi.org/10.1016/S1096-7516(03)00022-8

[12] M.D.B. Castro and G.M. Tumibay, "A literature review: Efficacy of online learning courses for higher education institution using meta-analysis," *Education and Information Technologies*, vol. 26, pp. 1367–1385, 2021. https://doi.org/10.1007/s10639-019-10027-z

[13] K. Syauqi, S. Munadi, and M.B. Triyono, "Students' perceptions toward vocational education on online learning during the COVID-19 pandemic," *International Journal of Evaluation and Research in Education*, vol. 9, no. 4, pp. 881–886, 2020. https://doi.org/10.11591/ijere.v9i4.20766

[14] E.T. Baloran and J.T. Hernan, "Course satisfaction and student engagement in online learning amid COVID-19 pandemic: A structural equation model," *Turkish Online Journal of Distance Education*, vol. 22, no. 4, pp. 1–12, 2021. https://doi.org/10.17718/tojde.1002721

[15] R. Baltà-Salvador, N. Olmedo-Torre, M. Peña, and A.I. Renta-Davids, "Academic and emotional effects of online learning during the COVID-19 pandemic on engineering students," *Education and Information Technologies*, vol. 26, no. 6, pp. 7407–7434, 2021. https://doi.org/10.1007/s10639-021-10593-1

[16] Y. He and X. Fu, "Learning satisfaction of learners and curriculum design under different online teaching platforms," *International Journal of Emerging Technologies in Learning (iJET),* vol. 17, no. 10, pp. 227–239, 2022. https://doi.org/10.3991/ijet.v17i10.30937

[17] P. Yang and X. Liu, "Evaluation of comprehensive services of an online learning platform based on Artificial Intelligence," *International Journal of Emerging Technologies in Learning (iJET)*, vol. 17, no. 13, pp. 130–144, 2022. https://doi.org/10.3991/ijet.v17i13.32797

[18] X. Li, K. Wang, L. Liu, J. Xin, H. Yang, and C. Gao, "Application of the entropy weight and TOPSIS method in safety evaluation of coal mines," *Procedia Engineering*, vol. 26, pp. 2085–2091, 2011. https://doi.org/10.1016/j.proeng.2011.11.2410

[19] Freda Kemp, "Applied multiple regression/correlation analysis for the behavioral sciences," *Journal of the Royal Statistical Society: Series D (The Statistician)*, vol. 52, no. 4, pp. 691, 2003. https://doi.org/10.1046/j.1467-9884.2003.t01-2-00383_4.x

8 AUTHORS

Yan Zhang, with a Master's degree, is an experimentalist at the School of Chemistry and Pharmaceutical Engineering, Huanghuai University. Her research interests includes Teaching Reform and Computational Chemistry (E-mail: zhangyan@huanghuai.edu.cn).

Chang Liu, with a Master's degree, is a Lecturer at the School of Mathematics and Statistics, Huanghuai University. Her research interests includes Applied Statistics and Teaching Research (E-mail: 20212214@huanghuai.edu.cn).