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PAPER

Teaching Quality Evaluation of Online Courses Based on AHP-FCE Evaluation Technology

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ABSTRACT

The COVID-19 pandemic posed a considerable challenge to education and teaching. The concept of "Internet + Education" accelerated the construction and popularization of a large number of online teaching platforms, accompanied by the emergence of various massive open online courses and online classroom teaching platforms. Thus, evaluating the teaching quality of online courses has become essential. Diversified scientific evaluations of traditional teaching fail owing to problems such as single evaluation subjects, imperfect evaluation standards, and low evaluation efficiency. In this study, first, documents on evaluation index systems and evaluation methods for identifying the teaching effect of online courses are classified, and observation points of an online course teaching effect evaluation in 16 aspects before, during, and after class are proposed. Second, the index weights are determined based on analytic hierarchy process, and a fuzzy comprehensive evaluation model is established to evaluate the online course teaching effect in six application-oriented universities in Henan Province, China. Results show that the observation points of the online course teaching effect evaluation proposed in this study are scientific and reasonable. Specifically, among the observation point indices, X-16, X-2, and X-3 have substantial weight, and the overall average score of the online course teaching effect of the case study subjects is 3.756, with a –24.88% room for improvement compared with the full score of 5. The method can effectively evaluate the teaching quality of online courses scientifically and accurately. The results also have important reference value for elevating the quality assurance standards of online teaching, thereby perfecting the dynamic process of online teaching quality assurance and realizing the effectiveness of online teaching results.

KEYWORDS

online courses, teaching effect, teaching evaluation, AHP-FCE evaluation

1 INTRODUCTION

With the rapid popularization of computer and network technology, online teaching has been widely conducted in the field of higher education. Traditional

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education involves face-to-face teaching and learning between teachers and students at school and students paying attention to their teachers and classes. The teaching method is relatively simple, but teachers can observe students' learning status intuitively at the first meeting and communicate with them [1]. Although online teaching can address the limitations of time and space, owing to the lack of a "sense of immediacy," long-term online learning may easily lead to problems such as poor learning status, low interest, and unsatisfactory teaching quality. The teaching quality evaluation of online courses involves judging the completion degree and level of certain online course educational tasks and objectives scientifically and effectively; analyzing, summarizing, and processing systematically and objectively collected information in a reasonable and highly operable way; evaluating the value of the entire teaching process, phased process, and teaching results, produced by teaching activities; and identifying the weak links in the actual teaching process. The quality of online teaching in colleges and universities is frequently questioned by society, and the importance of online course teaching quality is constantly highlighted [2]. The evaluation of the online course teaching effect may directly affect the teaching quality, which is the key and core of university management and guarantee and foundation for the smooth development of teaching. Therefore, such an evaluation will have a positive impact on the acceleration of the development of a school and steady improvement of the teaching quality to build an ideal and scientific comprehensive evaluation system for the teaching effect of online courses in colleges and universities and evaluate the teaching effect of online courses using scientific comprehensive evaluation techniques. Therefore, the scientific quality evaluation of online course teaching is helpful to further improve relevant teaching management systems and elevate the teaching management level of colleges and universities.

2 LITERATURE REVIEW

Online education is not restricted by the teaching location, and teachers and students can arrange the learning location according to their needs and realize interactive learning through a network. Learners can ask teachers questions and discuss problems with peers through network tools, and teaching methods are diversified. However, online teaching also has obvious shortcomings, that is, it may weaken interactive experiences, reduce communication between students and teachers, and with the absence of supervision, it may strengthen the attraction of electronic products; therefore, students may relax their self-management, resulting in poor academic performance. Thus, the evaluation of online course teaching quality is the primary means for prompting learners to take online teaching seriously, improve their autonomous learning ability, and correct their learning attitude. Regarding the evaluation of online teaching quality, Jiang [3] proposed an online teaching quality evaluation optimization model based on a hierarchical PSO-BP neural network, which provided a new method for evaluating online teaching quality. Bangert [4] developed and verified a tool for evaluating the effectiveness of online teaching for students based on the seven principles of effective teaching. The author believed that teacher–student interaction, active learning, task time, and cooperation among students are the main factors affecting the quality of online teaching. In 26 projects, Bangert [5] completed the experimental teaching of 489 students enrolled in a WebCT course in Montana State University and showed that

the evaluation of the online teaching effect on the students is closely related to four factors: teacher–student interaction, active learning, time to complete tasks, and cooperation among students. Bao [6] proposed an online–offline mixed-teaching quality evaluation method based on mobile edge computing, constructed an online–offline mixed-sports quality evaluation index system, and performed factor analysis and cluster analysis on the important evaluation-level data of each index. The simulation results revealed that the method can effectively reduce the cost of and error in online–offline mixed-teaching quality evaluations and improve evaluation efficiency. Chen [7] proposed an RBF neural network model based on information fusion and optimization to improve the quality of college English teaching evaluations. The results indicated that the method is highly credible. To improve the quality of English teaching, Huang [8] presented an improved algorithm based on machine learning technology and Gaussian process, used the hybrid Gaussian process to explore the distribution characteristics of the samples, and improved the classic relevance vector machine model. The results demonstrated that the research model performs well in evaluating the English teaching quality in traditional models and network models. Meanwhile, Ibrahim [9] evaluated the online teaching quality of architectural design in the second semester of 2019/2020 in the Department of Architecture of Jordan University of Science and Technology and conducted a questionnaire survey. The results reported that online teaching was conducted regularly in the form of synchronous meetings during the pandemic, and the teachers and students were satisfied with the online teaching of the theoretical courses. Ternus [10] established an online teaching evaluation index system from three aspects: teachers' self-evaluation, peer evaluation, and managers' evaluation. The results showed that the learning effect on students can be improved through well-designed curriculum structures, relevant and credible information, and interaction and cooperation mechanisms. Hammonds [11] held that the Student Evaluation of Teaching (SET) is a means for recording and improving the quality of online teaching and discussed the related problems of online teaching quality and how to improve the effect of online teaching. Weng [12] collected valid questionnaires from college students in Taiwan Province, and analyzed the factors determining online teaching evaluation willingness. Yu [13] examined the problem of triangular intuitionistic fuzzy information fusion and proposed a method for dealing with group decision making in a triangular intuitionistic fuzzy environment. Taking teaching quality evaluation as an example, the author illustrated the group decision-making process and revealed that the method is feasible for teaching quality evaluations. Dittmar [14] believed that sharing the strategy of implementing a comprehensive development plan for higher education teachers is essential for online learning teachers to continuously improve their teaching skills and showed that collaboration among teacher teams can improve students' satisfaction with online teaching and promote teaching quality and continuous improvement. Vlachopoulos [15] investigated the viewpoints of 250 online tutors for technology and pedagogy and revealed that high-quality teaching in online higher education is closely related to teachers' basic skills and ability to be online effectively. Mahoney [16] introduced a mixed teaching design of classroom teaching and asynchronous thread discussion in an undergraduate psychiatric nursing course teaching module. A satisfactory online teaching design would have significant value to students' critical thinking and promote the quality of online teaching. Wang [17] investigated the current situation of online stomatology undergraduate education in the Chinese mainland during the critical

stage of the COVID-19 pandemic and indicated that "online learning content" received the highest support, whereas "teacher–student interaction" exhibited the lowest satisfaction level, and the difficulty of ensuring students' learning motivation is the main problem of online education. Matosas-López [18] used the behaviorally anchored rating scale to build an evaluation tool with behavioral scales to evaluate the teaching quality of university teachers under the blended learning mode. The results reported that the tool can provide clear and definite feedback and enable teachers to take concrete corrective measures. Chou [19] analyzed the positive and negative patterns of student emotions in SET and explored the influence of key emotions on high- and low-quality teaching. The survey results demonstrated that the students expressed different views on high- and low-quality teaching. Positive emotions can predict high-quality teaching, whereas negative emotions are significantly related to low-quality teaching. Wu [20] pointed out that teachers' self-evaluation of their online teaching mainly includes online teaching methods, online teacher–student interaction, and online teaching technology. Teachers with different background characteristics are significantly different in the three dimensions. Thus, teachers should improve their self-evaluation and establish a self-evaluation system for online teaching. As can be seen from the literature, with the promotion of various aspects, the wide use of teaching platforms has grown, and the evaluation of online course teaching quality has become the focus of an increasing number of university administrators. However, a complete system for online course teaching quality evaluations is lacking. Many online course teaching quality evaluations focus only on a small part of the knowledge and skills necessary to achieve educational goals, which can lead to narrow online teaching evaluations and educational activities. Therefore, in this study, multiple aspects are considered to innovate an evaluation model and achieve educational equity. In addition, the concrete indices of observation points in 16 aspects of three links, that is, before class, in class, and after class, in online course teaching activities is highlighted. Subsequently, students majoring in the arts in six application-oriented universities in Henan Province are surveyed using analytic hierarchy process (AHP) and fuzzy comprehensive evaluation (FCE) techniques to obtain enlightening results.

3 METHODOLOGY

3.1 AHP-FCE model

Weight solving based on AHP. First, an evaluation set was established, as seen in Formula (1).

$$u = \{u_1, u_2, \ldots\ldots, u_p\} \tag{1}$$

Second, a judgment matrix was constructed, with the value of the elements in the judgment matrix reflecting the respondents' understanding of the relative importance of each element, using a scale from 1 to 9 and it's reciprocal. However, when the importance of the comparative factors can be explained by a ratio with practical significance, this ratio can be taken as the numerical value of the corresponding elements of the judgment matrix, that is, the judgment matrix $S = (u_{ij})_{p\times p}$

was obtained. MATLAB 2017b was used to calculate the maximum characteristic root λ_{max} of the judgment matrix and its corresponding characteristic vector, which was the importance order of each evaluation factor, that is, the distribution of the weight coefficients. To test the consistency of the judgment matrix, the consistency index $CI = \frac{\lambda_{\max} - n}{n-1}$ and RI average random consistency index should be calculated. A total of 500 sample matrices were randomly established, as follows: all the parts of the upper triangle of the sample matrix were randomly filled with the scale numbers and their reciprocals, all the values on the main diagonal were 1, and for the corresponding transposition item, the reciprocal of the random number at the corresponding position was applied. Finally, for each random sample matrix, its consistency index CI value was calculated and averaged to obtain the average random consistency index RI value. When $CR = \frac{CI}{RI} < 0.10$, the results of the AHP ranking will be considered to be satisfactorily consistent, that is, the distribution of the weight coefficients will be reasonable; otherwise, adjusting the value of the elements of the judgment matrix and redistributing the weight coefficients would be necessary.

FCE model. FCE is one of the comprehensive evaluation methods based on fuzzy mathematics. This comprehensive evaluation method changes qualitative evaluations into quantitative evaluations according to membership degree theory in fuzzy mathematics. FCE is characterized by clear results and strong systematicness, which can solve fuzzy problems and quantification difficulties effectively and is suitable for solving all types of uncertain problems. Through AHP calculation, FCE quantifies the fuzzy indices of the evaluated objects by establishing hierarchical fuzzy subsets (to determine the membership degree), then uses the principle of fuzzy transformation to synthesize the indices. In this study, first, the factor domain of the evaluation objects was determined, with $v = \{v_1, v_2, \ldots\ldots, v_p\}$ as the level set. Each level corresponded to a fuzzy subset. After the hierarchical fuzzy subsets were constructed, the evaluated objects were quantified from each factor $u_i (i = 1, 2, \ldots\ldots, p)$ one by one to determine the membership degree $(R \mid u_i)$ of the evaluated objects to the hierarchical fuzzy subsets from a single factor and obtain the fuzzy relation matrix, as shown in Formula (2).

$$R = \begin{bmatrix} R \mid u_1 \\ R \mid u_2 \\ \cdots \\ R \mid u_p \end{bmatrix} = \begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1m} \\ r_{21} & r_{22} & \cdots & r_{2m} \\ \cdots & \cdots & \cdots & \cdots \\ r_{p1} & r_{p2} & \cdots & r_{pm} \end{bmatrix}_{p.m}, \tag{2}$$

where r_{ij} in row i and column j of matrix R indicates the membership degree of an evaluated object to the hierarchical fuzzy subset v_j from factor u_i. The performance of an evaluated object from a certain factor u_i is described by a fuzzy vector $(R \mid u_i) = (r_{i1}, r_{i2}, \ldots\ldots, r_{im})$, but in other evaluation methods, it is mostly described by the actual value of an index. Therefore, from this perspective, FCE requires additional information. In the FCE, the weight vector $A = (a_1, a_2, \ldots\ldots, a_p)$ of the evaluation factors was determined, where a_i in the weight vector a_i is essentially the membership degree of factor u_i to the fuzzy subset (factors important to the evaluated objects). In this study, the relative importance order between the evaluation indices was

determined using AHP to determine and normalize the weight coefficients before synthesis, that is, $\sum_{i=1}^{p} a_i = 1$, $a_i \geq 0$, i = 1, 2, ..., n. Second, the vector of the FCE results was synthesized. Third, A was synthesized with the R of each evaluated object using an appropriate operator, thereby obtaining vector B of the FCE results of each evaluated object, as shown in Formula (3).

$$A \times R = (a_1, a_2, \cdots\cdots, a_p) \begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1m} \\ r_{21} & r_{22} & \cdots & r_{2m} \\ \cdots & \cdots & \cdots & \cdots \\ r_{p1} & r_{p2} & \cdots & r_{pm} \end{bmatrix} = (b_1, b_2, \cdots\cdots, b_m) = B, \quad (3)$$

where b_1, which was obtained by the operation in the first column of A and R, indicates the membership degree of the evaluated objects to the hierarchical fuzzy subsets as a whole. Fourth, the result vector of the FCE was given. In practice, the maximum membership degree is the most widely used principle, but occasionally, reluctance to use the principle is expressed, which may lose a considerable amount of information and yield unreasonable evaluation results. In this study, a weighted average method was proposed to calculate the membership degree, and several evaluated objects could be arranged according to their degree position. In the AHP-FCE, the evaluated objects processed the fuzzy quantities through digitally accurate quantities, which could deal with complex and diverse fuzzy information reasonably and scientifically and perform quantitative evaluations that were close to the reality. The evaluation result was a vector rather than a point value, which was rich in information and content and could respond to the evaluated objects accurately. After the data processing, increased reference information could be obtained.

3.2 Evaluation indices

The scientificity of the online course teaching quality evaluation results was closely related to the evaluation index system. Therefore, constructing an online learning process for the whole chain before, during, and after class, accepting the supervision of colleges and universities, teachers, and multiple evaluation subjects, composed of students, and developing a multidimensional online teaching learning effect evaluation system in terms of learning attitudes, methods, abilities, and teacher–student interaction, can improve teachers' "teaching" effect and students' "learning" effect during online teaching and solve the problems of online teaching learning effect evaluations. Based on a large number of existing documents, an online course teaching quality evaluation index system was designed in this study, as shown in Table 1.

Table 1. Online course teaching quality evaluation index system

Teaching Link	Evaluation Index	Concrete Meaning	Variable No.
Before class	Platform operation	**1.** Online teaching platforms, software, and equipment are fully debugged and skillfully used, which can ensure the safety and tranquility of the teaching network environment.	X-1
		2. Students can skillfully use various online teaching platforms.	X-2
	Teaching preparation	**3.** A feasible teaching plan can be made according to the actual online teaching situation, followed by teaching based on the teaching plan, with complete teaching documents.	X-3
		4. According to the effect of online teaching, students' self-learning tasks are arranged before class.	X-4
In class	Teaching content	**5.** Teaching resources are checked, with sufficient teaching materials and reasonable capacity; PPT designs are fresh and simple; and resources are selected scientifically and appropriately, which can help solve the key and difficult points of teaching and are consistent with the current industry trends.	X-5
		6. Online resources are sorted to fully explore excellent network resources and appropriately increase self-built resources, in combination with teaching objectives.	X-6
		7. Teaching links are designed scientifically and reasonably, with close connections; their internal logic is strict; and the teaching content and teaching implementation are in line with the course objectives and learning effects.	X-7
		8. In the teaching process, the concept of curriculum ideology and politics is embodied, and the cultivation of students' professional ethics and abilities is highlighted.	X-8
	Teaching method	**9.** Various flexible and appropriate teaching techniques and methods are adopted, and platforms are fully utilized to implement a flipped classroom and other teaching methods.	X-9
		10. The teaching effect and learning effect can be detected through various means such as asking questions, taking tests, and brainstorming, providing quick responses, and completing homework.	X-10
	Teaching organization	**11.** Online classrooms are entered in advance, students are carefully organized to sign in, and high student attendance rates are ensured.	X-11
		12. Online classroom management is emphasized. Teachers appropriately guide and control student discussions in the classroom and stimulate students' enthusiasm for online learning by asking questions, discussing, and so on, with a wide classroom interaction coverage and satisfactory teaching order.	X-12
After class	Teaching evaluation	**13.** Combining the online teaching effect, students can actively perform self-learning evaluations.	X-13
		14. Students can actively evaluate one another's learning achievements.	X-14
		15. Teachers can actively evaluate students' learning achievements and give them feedback.	X-15
		16. Teachers publish homework after class in a timely manner to promote and consolidate students' learning achievements.	X-16

3.3 Evaluation objects

Henan Province, which is a populous province in China, issued the Guiding Opinions on Promoting the Classified Development of Ordinary Colleges and Universities, stating that during the 13th Five-Year Plan period, priority will be given to the development of application-oriented universities. The construction of application-oriented universities would be of considerable significance to further promote the integration of industry and education, that is, it is an important measure to accelerate the cultivation of applied talents and enhance the service ability of students in colleges and universities. Therefore, in this study, a total of 348 students majoring in broadcasting art and hosting in six colleges and universities in Henan Province, were surveyed using a questionnaire with a five-point Likert-type scale (1 – very bad, 2 – bad, 3 – ordinary, 4 – good, 5 – very good). The universities involved in this study were Zhengzhou University of Aeronautics, Zhongyuan University of Technology, Anyang Institute of Technology, Zhengzhou Technology and Business University, Zhoukou Normal University, and Xuchang University.

4 RESULTS ANALYSIS AND DISCUSSION

4.1 AHP results

The index weights were calculated using the AHP method, and a consistency test was conducted. The weight of each index was described one by one. In this study, AHP was performed through the sum-product method, and the results are listed in Table 2.

Table 2. AHP results

Index	Eigenvector	Weight Value	Maximum Characteristic Value	CI Value	Total Weight
X-1	0.806	20.152%	4.14	0.047	0.0672
X-2	1.291	32.273%			0.1076
X-3	1.309	32.727%			0.1091
X-4	0.594	14.848%			0.0495
X-5	0.912	11.399%	8.57	0.081	0.0380
X-6	0.769	9.615%			0.0321
X-7	0.852	10.644%			0.0355
X-8	1.089	13.607%			0.0454
X-9	1.159	14.485%			0.0483
X-10	1.272	15.902%			0.0530
X-11	0.879	10.986%			0.0366
X-12	1.069	13.363%			0.0445
X-13	0.965	24.134%	4.243	0.081	0.0804
X-14	0.831	20.768%			0.0692
X-15	0.707	17.663%			0.0589
X-16	1.497	37.435%			0.1248

Table 2 reveals that X-16, X-2, and X-3 had substantial weight, indicating that the three factors were relatively important, that is, the students could proficiently use various online teaching platforms, feasible teaching plans could be made based on online teaching practices, and with complete teaching documents, teachers were able to publish after-school assignments in a timely manner to enhance and consolidate the students' learning achievements. This conclusion inspired the researchers to pay attention to the pre-class and after-class links of online teaching. Although the in-class link was relatively time consuming, the students watched their teachers' lectures through videos. Therefore, teachers should pay attention to pre-class and after-class links, in addition to teaching organization, in online teaching.

Table 3. Summary of consistency test results

Maximum Characteristic Root	CI Value	RI Value	CR Value	Consistency Test Result
4.14	0.047	0.89	0.052	Passed
8.57	0.081	1.41	0.058	Passed
4.243	0.081	0.89	0.091	Passed

It can be seen from Table 3 that the smaller the CR value, the better the consistency of the judgment matrix. Generally, if the CR value is less than 0.1, then the judgment matrix can meet the consistency test requirements. If the CR value is greater than 0.1, then inconsistency will be reflected, and the judgment matrix should be adjusted appropriately for the analysis. In this study, the CR value of the three links, that is, before class, in class, and after class, was less than 0.1, meaning that the judgment matrix in this study passed the consistency test, and the calculated weights were consistent.

4.2 FCE results

Based on the survey results of the 348 students majoring in broadcasting art and hosting in the six universities in Henan Province, the number of times all the students commented on the teaching quality of online courses in five aspects of the 16 indices was calculated, and the percentage of the specific five-level comments was obtained, as reported in Table 4.

Table 4. Original data of FEC calculation

Index	Index Weight	Student Comments				
		Very Bad	Bad	Ordinary	Good	Very Good
X-1	0.0672	0.0054	0.0245	0.1114	0.5217	0.3370
X-2	0.1076	0.0000	0.0245	0.1658	0.4755	0.3342
X-3	0.1091	0.0109	0.0326	0.1984	0.4647	0.2935
X-4	0.0495	0.0027	0.0163	0.1712	0.4538	0.3560
X-5	0.0380	0.0217	0.0353	0.1033	0.4565	0.3832
X-6	0.0321	0.0272	0.0707	0.1957	0.3859	0.3207

(Continued)

Table 4. Original data of FEC calculation *(Continued)*

Index	Index Weight	Student Comments				
		Very Bad	Bad	Ordinary	Good	Very Good
X-7	0.0355	0.0190	0.0761	0.1114	0.4239	0.3696
X-8	0.0454	0.0163	0.0652	0.1332	0.4293	0.3560
X-9	0.0483	0.0272	0.0462	0.1332	0.4728	0.3207
X-10	0.0530	0.0109	0.0842	0.2065	0.3913	0.3071
X-11	0.0366	0.0163	0.0842	0.1929	0.3967	0.3098
X-12	0.0445	0.0163	0.0652	0.1957	0.3967	0.3261
X-13	0.0804	0.0136	0.0462	0.1549	0.4212	0.3641
X-14	0.0692	0.0109	0.0353	0.1359	0.4728	0.3451
X-15	0.0589	0.0109	0.0245	0.1576	0.4375	0.3696
X-16	0.1248	0.0136	0.0435	0.1359	0.4701	0.3370

With MATLAB 2017b, the comment weights of the teaching quality of the online broadcasting art and hosting courses in the six universities in Henan Province, under four different operators, were obtained.

Table 5. Comment weights under different operators

Operator Type	Comment Weights				
	Very Bad	Bad	Ordinary	Good	Very Good
M(., +)	0.012	0.044	0.157	0.45	0.337
M(Λ, +)	0.117	0.06	0.275	0.275	0.275
M(., V)	0.042	0.013	0.167	0.453	0.325
M(Λ, V)	0.152	0.059	0.263	0.263	0.263

As seen in Table 5, the comment weights obtained under the four different operators were the same, so the overall online teaching quality evaluation score was calculated continuously using the four operators, as shown in Table 6.

Table 6. Overall online teaching quality evaluation score

Operator Type	Overall Online Teaching Quality Evaluation Score
M(., +)	4.056
M(Λ, +)	3.537
M(., V)	4.006
M(Λ, V)	3.426
Average score	3.756

Table 6 reveals differences in the overall online teaching quality evaluation score under the four different operators. The overall online teaching quality average score of the broadcasting art and hosting courses in the six universities in Henan Province, was 3.756, with a –24.88% room for improvement compared with the full score of 5. Thus, persistence in improving the quality of online education

is necessary. A possible reason for this outcome is the time separation between teachers' evaluations and students' evaluations under the current online course teaching quality system. Students' evaluations often lag behind teachers' evaluations, and the latter is based on students' performance. However, the learning styles for different classes differ, so the conclusions drawn by traditional evaluation methods are inapplicable to other classes. Traditional classroom evaluation methods fail to give timely and effective feedback to teachers or facilitate their adjustment of teaching methods, with students as the main body in the teaching process. The failure of current quality feedback methods to timely guide the teaching process can be effectively solved by the real-time online course teaching quality evaluation scores given by students in three dimensions: before class, in class, and after class. In the later stage, consideration should be given to data analysis based on online teaching. Driven by big data and artificial intelligence technology, timely and efficient two-way evaluation systems and methods should be established to evaluate the teaching process in a two-way manner to promote the development of artificial intelligence, big data, and other technologies in the field of education. Moreover, an interdisciplinary online course teaching quality evaluation method can be formed by processing audio and video data and analyzing teachers' and students' emotions from the perspective of the involvement of teachers and students and their emotional changes.

4.3 Discussion

Since the outbreak of COVID-19, the development of the online teaching mode has accelerated, and online courses have emerged. Various online teaching platforms gradually attracted the attention of teaching circles. From the perspective of evaluation, online evaluations aim to encourage students' autonomous learning and cooperative learning. Meanwhile, diversified, formative, and developmental evaluations can be realized through the development of educational informatization, which has become the new direction in the reform of online teaching evaluation in the current stage. With the advent of the artificial intelligence era, traditional teaching evaluation methods can no longer meet the requirements of the current online teaching mode. In this study, an online course teaching quality evaluation technology combining AHP and FCE is proposed, and 16 observation points in three links, that is, before class, in class, and after class, is evaluated. The evaluation system proposed in this study is suitable for the evaluation of not only online course teaching quality but also offline course teaching quality. The differences between the two modes are manifested mainly in the data analysis type, relevant indices, and evaluation models. Owing to the subjectivity of online course teaching quality evaluations, understanding the cognition of teachers and students in such evaluations and selecting the statistical indices and process indices for students to evaluate their teachers' dynamic behaviors during their online course teaching to achieve the effective and comprehensive evaluation of online course teaching quality are important. The findings of this study reveal that many factors can be improved in the online course teaching behaviors of teachers in application-oriented universities. For example, problems exist in teaching progress control, attention to students' needs, teacher–student interactions, and assignments and feedback. Teachers must adapt as soon as possible to the changes in teaching methods, triggered by online teaching, and student assessment and evaluation methods are in urgent need of reform and innovation. Teachers' information literacy, online teaching design level, and abilities remain to be further improved for effective online teaching practice.

5 CONCLUSION

Driven by Internet technology, mobile application technologies have infiltrated the field of education, achieving deep integration, and online teaching has met the conditions for full development. "Internet + Education" accelerated the construction and popularization of a large number of online teaching platforms, and the comprehensive popularization of online teaching platforms posed an important task to teaching staff on how to strengthen the scientific and accurate evaluation of online course teaching quality. In this study, an AHP-FCE evaluation technology is proposed, index weights are determined based on AHP, and an FCE model is established for evaluating the online course teaching quality in six application-oriented universities in Henan Province, China. The main conclusions are as follows: (1) the observation points of the online course teaching effect evaluation are relatively scientific and reasonable, and among the indices of the observation points, X-16, X-2, and X-3 exhibit relatively substantial weight; (2) the overall online course teaching quality average score of the case study subjects is 3.756, which has a –24.88% room for improvement compared with the full score of 5; (3) the method can effectively evaluate the teaching quality of online courses scientifically and accurately. In the future, in-depth study should be conducted on the improvement of current and future online classroom teaching and learning behaviors using the evaluation results, organic combination of process evaluations and result evaluations, and reform practice of online course teaching quality evaluations, characterized by informatization.

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