

PAPER

Fuzzy Comprehensive Evaluation of Students' Classroom Experience in Online Teaching

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ABSTRACT

Under the COVID-19 outbreak, the traditional teaching mode in universities is limited, and online teaching is in full swing. However, various factors that affect students' online classroom experience in teaching have characteristics of fuzziness and uncertainty. Therefore, using the course of human resource management as an example, this paper employs the fuzzy comprehensive evaluation (FCE) method to conduct a comprehensive evaluation of the classroom experience of online teaching students. This paper aims to minimize the impact of human or subjective factors by developing a scientific, rational, and practical multi-level fuzzy comprehensive evaluation model for assessing students' classroom experience in online teaching courses.

KEYWORDS

online teaching, classroom experience, multi-level fuzzy comprehensive evaluation, human resource management course

1 INTRODUCTION

With rapid technological progress, the arrival of online learning is inevitable. Online learning, also known as e-learning, originated in the United States and is a form of teaching that utilizes the internet as a medium. Specifically, it is guided by a variety of learning theories, needs to adapt to complex and diverse learners, has different types of learning objectives, aims at creating a learner-centered environment, and takes advantage of the rich learning resources available on the network data platform. This approach aims to achieve the ideal teaching effect. The *Horizon Report 2020: Teaching and Learning Edition*, released in March 2020, pointed out that online education is an effective way to sustain higher education, even in the face of unique challenges such as climate factors. It meets students' needs for affordable and flexible education. The outbreak of COVID-19 at the beginning of 2020 has disrupted traditional offline teaching methods, leading primary and secondary schools to implement online teaching. "Online teaching can not only serve as an emergency

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measure during the epidemic but also represents a learning revolution in the field of education and teaching that Chinese colleges and universities have been promoting in recent years.” Under the current epidemic prevention and control measures, college students are primarily engaging in online learning through platforms such as Tencent conferences, Chinese University MOOCs, Superstar, and others. Similarly, college teachers are also conducting real-time classroom teaching from their respective locations. Compared to traditional offline learning, where professors and students are in the same time and space, what is the classroom experience of students in online teaching? Obviously, students’ classroom experience is not only an important basis for self-teaching effectiveness feedback but also an effective guarantee for monitoring and assessing teaching quality in colleges and universities. It is also an important means to improve the overall teaching quality of college teachers.

Human resource management is a discipline that studies how to adopt measures and strategies such as planning, organizing, commanding, supervising, motivating, coordinating, and controlling to fully develop and utilize human resources in the organizational system. The goal is to improve work efficiency and achieve organizational goals. It is a mandatory course for students studying economic management in colleges and universities. It plays a crucial role in helping students understand the complete picture of enterprise human resource management and master fundamental theories. To this end, various colleges and universities across the country have established human resources courses and placed great importance on their teaching effectiveness. They have also conducted extensive research to enhance the quality of their teaching.

However, evaluating the classroom experience of online teaching students is a complex and comprehensive problem that involves multiple criteria and factors. There are many factors that affect students’ classroom experience, most of which are characterized by uncertainty and ambiguity. It is challenging to accurately describe the evaluation indicators using quantitative methods. Therefore, this paper adopts a multi-level fuzzy comprehensive evaluation and uses the online teaching course “Human Resource Management” for college students as an example to conduct a comprehensive evaluation of students’ classroom experience.

2 LITERATURE REVIEW

2.1 Online teaching

Online education represents a resurgence in the fundamental nature of education and a reevaluation of its positioning. The essence of education is to educate individuals. As a teaching method, online teaching has transformed the relationship between teaching and learning, altered the teaching process, changed the methods and environment of knowledge transmission, and introduced a new form of education (Fu, 2020) [1]. Affected by the COVID-19 pandemic, colleges and universities have implemented emergency measures for online teaching to ensure the safety of teachers and students. This also demonstrates the effectiveness of “Internet + education” in practice. At the same time, studying the online teaching behavior of “suspending classes without stopping” is beneficial for enhancing efficiency and ensuring the quality of online teaching (Jiang, 2020) [2]. It has been concluded that there are five basic models for online teaching in colleges and universities during the epidemic (Zhu et al., 2016) [3]. One form of teaching is live instruction, where teachers deliver their lessons through live audio or video broadcasts and students participate

in real-time online. The other is SPOC teaching, where students learn from MOOC course resources on Chinese University MOOC, Chaoxing, Wisdom Tree, and other platforms before class. They then discuss and clarify difficult points online in groups. The third is an online seminar. Teachers provide PPT, audio and video materials, homework assignments, and thought-provoking questions for students to access through the course platform before class. They also facilitate online discussions, answer questions, and encourage various forms of interaction among students. The fourth is recording and broadcasting teaching. Before class, students learn through videos recorded by the teacher. They also engage in group discussions and receive online explanations for difficult points and exercises. Fifth, students study independently. Teachers send learning materials through email and other channels in advance, emphasizing self-study for students. This is supplemented by email and other forms of discussion for answering questions. Although there are the five basic modes of online teaching mentioned above, the form of development is not limited to just one. When conducting online teaching, teachers will adopt a combination of various forms according to the actual needs of the course. These may include live broadcasts with seminars, recordings with homework assignments, MOOCs with seminars, online teaching, and a combination of seminar teaching with student self-learning. However, the online and offline teaching modes in university classrooms also have certain problems. Taking art and design courses as an example, the hybrid teaching method, which combines online and offline components, faces difficulties such as limited interaction and inconvenient hands-on operation (Shen, 2016) [4]. Under the influence of the COVID-19 pandemic, colleges and universities have implemented online teaching. We need to determine the format of online courses, online course platforms, courses, teachers, and course progress. Additionally, we need to ensure network technology, teacher training, and student engagement. At the same time, the evaluation of the impact of online teaching during epidemics reveals deficiencies in the standardization of online courses, campus network infrastructure, teacher training for online teachers, and monitoring of its effectiveness (Jianf, 2020) [5].

In research on influencing factors, academic self-efficacy directly affects the level of participation in online open courses and indirectly impacts the level of persistence in online open courses. The presence of teachers can enhance learner engagement and directly affect learners' persistence in learning, thereby increasing their desire to complete the course. The perceived usefulness of online open course platforms greatly affects learners' engagement with the course. However, it does not directly impact the persistence of online open-course learning. Instead, it has a mediating effect on learning persistence through learner engagement. The convenient online open course platform does not have a significant impact on learner participation, but it does directly affect the persistence of improvement. Therefore, when designing online open courses, teachers should make specific plans to meet the needs of learners and encourage them to actively participate in online open courses, thereby improving course completion (Jung and Lee, 2018) [6]. There are four motivations for learners to enroll in online open courses: a desire to learn new knowledge or expand existing knowledge, curiosity about online open courses, a personal challenge, and a goal to collect as many certificates of completion as possible. However, students' lack of motivation, inability to comprehend learning materials, uncertainty about where to seek assistance, and competing priorities are the primary factors contributing to the high dropout rate. Therefore, improving the teaching quality of online open courses in a timely manner and evaluating students' performance reasonably are the two major problems that need to be urgently addressed in the future (Hew and Cheung, 2014) [7].

2.2 Online teaching: Student classroom experience degree

Regarding the practice of the flipped classroom, a class satisfaction survey was conducted with the students involved. The impact of three factors—teaching effect, teaching process, and teaching equipment—on the satisfaction of the flipped classroom was analyzed. Information technology, teacher-student positioning, resource design, and corresponding improvement strategies are provided in five aspects of the course feedback and evaluation system (Chi, 2015) [8]. To assess the learning experience of typical undergraduate college students in MOOC courses, we can begin by examining their basic information, motivation to participate, course experience, learning effectiveness, learning challenges, and subjective perceptions (Li, 2017) [9]. The variables that influence student satisfaction in blended learning can be defined as 18. The specific idea is to utilize the structural model to transform the outcomes of each factor relationship into a coherent relationship. A hierarchical model of factors influencing students' satisfaction with learning in a blended learning environment is constructed. In addition, the study examines the impact of variables on satisfaction and proposes measures to enhance students' learning satisfaction (LI et al., 2016) [10]. An online course quality assurance system should include six elements: course design, instructional design, page design, explanation and tutoring, learning experience, and course presentation (Chao et al., 2006) [11]. Moreover, the online learning environment should include six sub-environments: the teaching environment, the situational environment, constructivism, the support environment, the cooperation environment, and the evaluation environment (Sarah, 2006).

Based on the above research, it has been found that the majority of previous studies on online teaching have focused on the perspective of teachers. From the perspective of curriculum teaching, it is about the reform of teaching methods and the transformation of teacher education formats, and some of them are examined from the standpoint of students [12, 13]. The influencing factors of online teaching classrooms are investigated and analyzed. By reviewing and analyzing the existing literature, this paper thoroughly examines the learners and other relevant factors to evaluate the new online teaching mode, which differs from traditional teaching [14]. Having experienced the most intuitive online teaching classroom experience, the impact of new teaching methods can be observed based on the learners' classroom experience [15, 16]. From the learner's perspective, this paper investigates and examines four key aspects of teaching: facilities, learners, teachers, and curriculum design. It analyzes the current state of students' experiences in online classrooms and identifies various issues and causes related to online teaching. And provide corresponding strategies for improving students' classroom experiences in order to achieve better teaching outcomes.

3 METHODS

Fuzzy comprehensive evaluation (FCE) is based on fuzzy mathematics (Gu et al., 2006). It is a method for conducting comprehensive analysis and evaluation of things that are difficult to clearly define, quantify, and describe precisely using mathematics. This method applies the principle of fuzzy relationship synthesis to quantify and analyze these things. This paper utilizes the FCE method to develop an evaluation model for students' classroom experience. The specific steps are as follows:

1. Develop a multi-level comprehensive evaluation factor set

Set U represents the comprehensive evaluation factor set, which consists of all evaluation indicators that impact the evaluation object. Considering that students' evaluation of the classroom experience is subjective, qualitative, and vague, this paper fully integrates the teaching and professional characteristics of the "Human Resource Management" course. Through the review of materials, student feedback, and collective discussions among experts and teachers, the paper identified several factors that influence the evaluation. Ultimately, it was determined that the primary evaluation index for students' classroom experience in online teaching is their perception of the teaching facilities, fellow learners, teachers, and curriculum design. The hierarchical modules are divided based on the characteristics of the factors, and each factor can be composed of the next-level factor. Therefore, we can further extract secondary indicators and then develop a secondary fuzzy evaluation model for assessing the classroom experience of online teaching students. Results are reported in Table 1.

Table 1. A secondary fuzzy evaluation model of online teaching students' classroom experience

First-Level Indicator	Weight	Second-Level Indicator	Weight
Teaching facilities factor (u_1)	0.20	Network lag factor (u_{11})	0.55
		Ease of using the software (u_{12})	0.45
Learner factor (u_2)	0.35	Preview before class (u_{21})	0.40
		Classroom engagement (u_{22})	0.60
Teacher factor (u_3)	0.30	Teaching content (u_{31})	0.50
		Teaching feedback (u_{32})	0.50
Course design factor (u_4)	0.15	Course schedule (u_{41})	0.40
		Content interest factor (u_{42})	0.35
		Course design arrangement (u_{43})	0.25

The factor set U is divided into K subsets according to the type of attributes, and the corresponding factor sets are divided into two layers, specifically:

The first layer is:

$$U = (u_1, u_2, u_3, u_k), k = 4 \tag{1}$$

The second layer is:

$$\begin{cases} u_1 = (u_{11}, u_{12}) \\ u_2 = (u_{21}, u_{22}) \\ u_3 = (u_{31}, u_{32}) \\ u_4 = (u_{41}, u_{42}, u_{43}) \end{cases} \tag{2}$$

2. Build a weight set

In order to reflect the importance of each factor, a corresponding weight "ai" is assigned to each factor "U," and the corresponding weight set is "A." In order to ensure a reasonable weight distribution, it was determined using the expert review method. The results are shown in the weight section of Table 1.

The weight set for the first-level indicators is:

$$A = (0.20, 0.35, 0.30, 0.15) \tag{3}$$

The weight set for the second-level indicators is:

$$\begin{cases} a_1 = (0.55 & 0.45) \\ a_2 = (0.40 & 0.60) \\ a_3 = (0.50 & 0.50) \\ a_4 = (0.40 & 0.35 & 0.25) \end{cases} \quad (4)$$

3. Build an evaluation set

Combined with the various qualitative evaluation results that students may provide on their teaching and classroom experience, the evaluation is divided into four grades: “dissatisfied,” “general,” “satisfied,” and “very satisfied,” each assigned a specific value. The evaluation set is composed as follows:

$$V = (v_1, v_2, v_3, v_4) = (1, 2, 3, 4) \quad (5)$$

4. Build a fuzzy evaluation matrix.

Starting from a single factor alone, we determine the degree of membership of the sample students to the evaluation set V to form a fuzzy set.

$$R_i = (r_{i1}, r_{i2} \dots r_{in}) \quad (6)$$

After conducting a univariate evaluation of all factors, the resulting matrix is as follows:

$$R = \begin{bmatrix} R_1 \\ R_2 \\ R_3 \\ R_4 \end{bmatrix} \quad (7)$$

5. Calculate the result vector of fuzzy evaluation.

On the basis of the evaluation matrix R and using the weight vector A and we calculate the fuzzy set of the comprehensive evaluation result, which is recorded as:

$$B_i = A_i * R_i \quad (8)$$

6. Rank of the evaluation result vector

Therefore, we can calculate the final score of the fuzzy evaluation, namely:

$$F_i = V * B_i \quad (9)$$

Comparing the final score F of the comprehensive evaluation with the evaluation set V, we can determine the level of students’ evaluation of the online teaching classroom experience.

4 RESULTS

Taking the online course “Human Resource Management” as an example, the questionnaire is designed in conjunction with the indicator system and evaluation criteria. A total of 130 questionnaires were distributed, and 116 valid questionnaires were recovered, resulting in a recovery rate of 89.23%.

4.1 Single-factor low-level fuzzy evaluation

The importance of each index is reflected in the assigned weights. The number of people who score at different levels for each index is then combined, and the proportions are selected to create the membership matrix for the comment level. Among them, the membership matrix of the reliability index "Teaching facilities factor (u_1)" is:

$$r_1 = \begin{bmatrix} 0.017 & 0.207 & 0.741 & 0.034 \\ 0.172 & 0.509 & 0.310 & 0.009 \end{bmatrix} \quad (10)$$

The weight matrix of the reliability index "Teaching facilities factor (u_1)" is:

$$a_1 = (0.55 \quad 0.45) \quad (11)$$

Therefore, according to equation 8, the fuzzy comprehensive evaluation matrix of the reliability index "Teaching facilities factor (u_1)" is as follows:

$$B_1 = a_1 * r_1 = (0.087 \quad 0.343 \quad 0.547 \quad 0.023) \quad (12)$$

And according to equation 9, the evaluation value of reliability index "Teaching facilities factor (u_1)" is:

$$F_1 = V * R_1 = (1 \quad 2 \quad 3 \quad 4) * \begin{pmatrix} 0.087 \\ 0.343 \\ 0.547 \\ 0.023 \end{pmatrix} = 2.506 \quad (13)$$

Similarly, we can obtain the fuzzy comprehensive evaluation matrix for other indicators. That is:

$$\begin{cases} B_2 = a_2 * r_2 = (0.100 & 0.329 & 0.452 & 0.119) \\ B_3 = a_3 * r_3 = (0.155 & 0.397 & 0.414 & 0.034) \\ B_4 = a_4 * r_4 = (0.117 & 0.444 & 0.378 & 0.062) \end{cases} \quad (14)$$

According to the survey statistics on membership status, we found the following: Firstly, the indicators of "teaching facilities factor," "learner factor," and "teacher factor" are all in a "satisfied state," accounting for 54.7%, 45.2%, and 41.4%, respectively. These ratios are relatively high. However, the first-level indicator "course design factor" is in the "general" state, accounting for 44.44%. On the other hand, when comparing the four first-level indicators, the "learner factor" has the highest proportion of "very satisfied" responses, accounting for 11.9%. Conversely, the "teacher factor" has the highest proportion of "dissatisfaction" responses, accounting for 15.5%.

Similarly, we also can get the fuzzy comprehensive evaluation value of other indicators. That is:

$$\begin{cases} F_2 = V * R_2 = 2.590 \\ F_3 = V * R_3 = 2.328 \\ F_4 = V * R_4 = 2.384 \end{cases} \quad (15)$$

According to the fuzzy comprehensive evaluation value of the four first-level indicators, the rank order is “F2 > F1 > F4 > F3,” and the level status is the same for all, which is “general.” Of course, the evaluation result of classroom experience for the four dimensions is 2.452, which is in the “general” state.

4.2 Multi-factor high-level fuzzy evaluation

According to equation 7, we summarize the fuzzy comprehensive evaluation matrix of all reliability indexes as follows:

$$R = \begin{bmatrix} 0.087 & 0.343 & 0.547 & 0.023 \\ 0.100 & 0.329 & 0.452 & 0.119 \\ 0.155 & 0.397 & 0.414 & 0.034 \\ 0.117 & 0.444 & 0.378 & 0.062 \end{bmatrix} \quad (16)$$

According to equations 3 and 8, we calculate the fuzzy set of the comprehensive evaluation result.

$$B = A * R = (0.116 \quad 0.369 \quad 0.448 \quad 0.066) \quad (17)$$

This shows that when it comes to evaluating their classroom experience, 11.6% of the students express “dissatisfaction,” 36.9% of the students are “neutral,” 44.8% of the students are “satisfied,” which is the highest proportion, and 6.6% of the students were “very satisfied,” which occupying the lowest proportion.

According to equation 9, we can also obtain the fuzzy comprehensive evaluation value for all indicators. That is:

$$F = V * B = 1 \times 0.116 + 2 \times 0.369 + 3 \times 0.448 + 4 \times 0.066 = 2.464 \quad (18)$$

This indicates that students’ overall assessment of their classroom experience is between “general” and “satisfied” levels.

5 CONCLUSION

According to the evaluation of the classroom experience in human resource management courses, this paper draws the following conclusions: The evaluation of students’ classroom experience in online teaching is a complex process that involves multiple factors, objectives, and levels. This paper utilizes the fuzzy comprehensive evaluation model method to establish a curriculum experience evaluation system based on four aspects: teaching facilities, learners, teachers, and curriculum design. Using the “Human Resource Management” course as an example, conducting an empirical analysis can comprehensively consider various factors at multiple levels. This analysis can help objectively evaluate students’ classroom experience in the online teaching process, reduce human interference, and make the results more objective and reasonable. It provides a basis for teachers to control online teaching and also lays the foundation for the development and implementation of a student classroom experience evaluation system.

In light of the current “overall” situation, enhancing the classroom experience can be approached from the following perspectives: First, as the key participants in online education, teachers should demonstrate strong adaptability, organization,

and coordination skills when confronted with significant changes in teaching methods and the learning environment. They should also utilize suitable teaching methods and software to facilitate effective teaching activities. Second, as the primary audience of online teaching, students should provide timely and specific feedback evaluations. Through teaching assistants or experienced teachers, the subjective experiences in the online teaching and learning process, such as a sense of achievement, pleasure, frustration, and pressure, can be evaluated and used to provide feedback to improve the effectiveness of online learning. Third, teachers should prioritize the training and enhancement of students' higher-order thinking skills, such as analysis, synthesis, evaluation, application, and creativity, when designing online teaching activities for students. Among them, the fundamental principle of designing teaching activities is to encourage students to actively engage in learning and prioritize hands-on experiences over rote memorization. At the same time, focus on the depth of learning, not just the breadth.

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