

*Original Research*

# Research on Satisfaction Evaluation and Influencing Factors of Online Teaching Mode under the Background of Green Sustainability

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## Abstract

Under the background of environmental pollution and energy depletion, online teaching is the key means to reduce the waste of resources and achieve the sustainable goal of education. This paper constructs a fuzzy comprehensive evaluation model to scientifically estimate the satisfaction of online teaching mode and introduces a multiple linear regression model and structural equation model respectively to empirically analyze the factors affecting satisfaction. The results show that: (1) Online teaching in colleges and universities has achieved remarkable results, and students' satisfaction is at a good level. According to the fuzzy comprehensive evaluation method, the comprehensive satisfaction scores for the dimensions of teacher questioning, flipped classroom, platform resources, student learning, and teacher engagement are in the range [80, 90]. (2) Teaching platform resources, student discussion and online skills are the key factors of online teaching satisfaction. According to the results of multiple linear regression analysis, the factors A11, B21, and C21 are significant at the 1% level in terms of significance level, with p-values of 0.008, 0.010, and 0.004, respectively. (3) The influence paths of teaching knowledge, teaching interaction and teaching platform on teaching satisfaction are different. According to the calculation results of structural equation model, teaching knowledge and teaching interaction have a positive impact on teaching satisfaction, and the regression coefficients for both are 0.123 and 0.930, respectively, while the regression coefficient of teaching platform on teaching satisfaction is -0.168, which has a negative impact. Finally, it is necessary for universities to build a three-dimensional element of a "teacher-student platform" to continuously optimize the path of online teaching satisfaction.

**Keywords:** green sustainable development, online teaching, fuzzy comprehensive evaluation method, hierarchical analysis, structural equation model

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## Introduction

Environmental pollution and energy depletion are serious challenges that need to be addressed by the world. Due to the excessive consumption of resources, energy depletion, ecological imbalance, serious carbon emissions and other contradictions, the development of green and sustainable production and living mode has become the inevitable choice of Chinese society. In 2020, General Secretary Xi Jinping proposed that China's carbon emissions should "peak by 2030 and become carbon neutral by 2060". During the 14<sup>th</sup> Five-Year Plan Period, green and sustainable development has become the key direction of economic development. The digital economy with digital technology as the core has become a new field of low-carbon development and green innovation, which helps to save energy, reduce emissions and protect the environment.

Digital economy is mainly characterized by computer technology, integrating advanced technologies such as big data, artificial intelligence, Internet of Things, mobile clients, etc., and enabling networking and intelligence of production, life and work through green technology. Since the outbreak of the novel coronavirus, the cross integration of digital technology and modern education has promoted the explosive growth of online teaching methods. Online teaching mode relies on digital technology to realize real-time visual learning for large-scale personnel, which has the characteristics of convenience, low cost and green sustainability. Online teaching mode has become a new, green and sustainable teaching mode.

The research on the satisfaction of online teaching mode at home and abroad is still in its infancy, and some scholars have carried out research on this problem from the theoretical and practical levels. By combing the existing literature, the results related to this paper focus on the following four aspects:

(1) Online teaching satisfaction theory-related research. The satisfaction theory comes from the field of management. In 1802, Bentham first proposed this problem. In 1965, Cardozo elaborated on marketing. Fornell (1989) first proposed the Fornell logic model [1]. After that, the satisfaction theory gradually expanded to the fields of economics, sociology, medicine and education. For example, the salary level, working environment and personnel system are the key factors of employees' individual salary satisfaction [2]. Teaching skills, teaching input and self-cognition will have an impact on education satisfaction [3]. Cognitive social capital and social trust have a positive impact on the life satisfaction of the elderly [4]. Increasing salary, creating a safe and comfortable environment, and strengthening the care of medical staff can help to improve nurses' job satisfaction [5].

(2) Research on online teaching satisfaction evaluation index system. The framework or index system of online teaching satisfaction evaluation has attracted the attention of many scholars. Due to different

research topics, the index system constructed has certain differences. Chun and Xian (2022) proposed an evaluation index system for curriculum design, learning, participation, feedback and achievements based on the "goal-activity-evaluation" paradigm [6]. Long and Ye (2021) focused on the cognition, behavior, attitude and results of learning and proposed standardized evaluation indicators [7]. Wang et al. (2022) proposed a teaching evaluation index system from the three dimensions of the effectiveness of teaching design, teaching orientation and student recognition. The results of the empirical evidence found that the effectiveness of online teaching was rated no less than offline teaching empirical results [8]. In terms of teacher recruitment, the University of California has set up indicators such as scientific research ability, work commitment, and concept fit [9]. Xiang and Lu (2021) constructed an evaluation index system of translation technology teaching from four aspects: evaluation content, method, subject and tool [10]. Bai (2021) built an evaluation system of ideological and political teaching courses around four aspects: teaching objectives, activities, ability and feedback [11]. Although the above research objects are different, they basically cover three aspects: teaching content, process and results.

(3) Research on online teaching satisfaction evaluation methods. From the technical level, Delphi method, Hierarchical analysis, Markov chain method and other methods are commonly used. Qiu et al. (2016) constructed a scale for classroom teaching evaluation from the aspects of classroom teaching, performance and effect evaluation, and calculated the weights of different indicators using Hierarchical analysis [12]. Considering the deficiency of traditional psychometric methods in dynamic assessment, the dynamic model based on the fusion of process and result established by Markov chain model is reliable [13]. In order to improve the teaching effect for clinical medical students, the goal can be effectively achieved by introducing the high simulation teaching method, and the CIPP model can form a decision-making-oriented evaluation method [14-16]. With the iteration of web technologies, the use of Citespace tools, based on bibliometric methods, helps to scientifically analyze cutting-edge directions in teaching evaluation [17]. Due to the adverse impact of the novel coronavirus, 13997 teachers were investigated by online questionnaire survey. The results show that teacher-student interaction and teaching mode have a significant impact on the teaching effect [18].

(4) Research on the influencing factors of online education satisfaction. Most scholars use empirical research methods to explore the main factors affecting online teaching from multiple perspectives. Based on the background of epidemic prevention and control, it is empirically found from two aspects of teaching and learning that classroom interaction, teaching attitude, teaching resources and student investment have a significant impact on teaching effect [19]. The empirical study based on IS continuous use theory shows that task difficulty and network conditions are the key

influencing factors [20]. In order to investigate students' satisfaction with foreign language online courses, an analysis model of satisfaction factors is built based on the theory of learning conditions and the theory of teaching system elements. Combined with the survey data, it can be seen that teaching quality, content, resources and learning driving forces have a direct and significant impact on teaching satisfaction [21]. Using scale evaluation, structured interviews and other methods to analyze the mixed experimental teaching, the research shows that learning interest, motivation and experimental operation skills have a significant impact [22]. Using interpretative structural model, we found that motivation, communication and environment have a direct impact on teaching satisfaction [23]. Teaching cognition and social inspiration have a direct effect on learning effect [24]. The above research analyzes the multidimensional factors that affect teaching satisfaction from multiple perspectives, and provides an important reference for the construction of online teaching satisfaction influencing factor system.

According to the above research, online teaching satisfaction theory, index design, evaluation methods and influencing factors are important topics with important theoretical and practical value. Foreign scholars have made fruitful achievements in satisfaction theory, learning theory, participation theory, community theory and so on. According to the characteristics of online teaching, domestic scholars have used Hierarchical analysis, Markov chain method and questionnaire survey method to focus on mining the effect of online teaching from the practical level, which has improved the key factors and feasible paths. However, the above research still has the limitations of weak systematicness, and further research is necessary. Based on the existing research, this paper uses fuzzy comprehensive evaluation method, multiple linear regression model and structural equation model to evaluate the satisfaction of online teaching and analyze the related impact. This study is conducive to enrich and expand the teaching satisfaction evaluation from the theoretical and practical levels, and is conducive to put forward specific paths and countermeasures to improve the effect of teaching evaluation.

## Material and Methods

### Construction of Online Teaching Mode Satisfaction Evaluation Model Based on Fuzzy Comprehensive Evaluation Method

Due to the rapid development of online teaching mode after the spread of the novel coronavirus, the academic community has not yet formed a standard index system for online teaching satisfaction evaluation. Because the evaluation object has fuzzy attributes, the fuzzy comprehensive evaluation method is introduced. Fully drawing on the relevant practices at home and

abroad, the fuzzy comprehensive evaluation method is mainly based on the idea of fuzzy transformation and membership function to comprehensively compare the size of different factors affecting the target value. In addition, due to the complexity of the estimated objects, fuzzy comprehensive evaluation methods mainly include a single-level method and multi-level evaluation methods. Considering the complexity of students, course content, teaching time and teaching form involved in the online teaching mode, this paper mainly considers the method of multi-level fuzzy comprehensive evaluation.

The main modeling steps of the fuzzy comprehensive evaluation method are as follows [25]:

#### Step 1: Determine the evaluation objectives.

According to the research subject and object, the main research goal of this paper is to evaluate the satisfaction of online teaching mode.

#### Step 2: Determine the domain of factors.

The  $n$  factors that affect online teaching satisfaction are accurately divided into different subsets from a systematic and hierarchical perspective  $E = (E_1, E_2, \dots, E_n)$ .

#### Step 3: First-level evaluation.

AHP is used to estimate the subset  $E_i (i = 1, 2, \dots, n)$  of influencing factors of satisfaction. Specific ideas: Assume that the weight vector of different factor subsets is  $\lambda_i (i = 1, 2, \dots, n)$ . Firstly, a judgment matrix is established according to the importance of different influencing factors. The judgment matrix can be determined through multiple rounds of Delphi survey. Since the satisfaction evaluation of online survey is mainly obtained through a questionnaire survey and Likert five subscale method, the grade set of different elements is  $U = (U_1, U_2, U_3, U_4, U_5) = \{\text{Very satisfied, Relatively satisfied, Be satisfied, General satisfaction, Not satisfied}\}$ . The judgment matrix  $T_i$  set can be constructed by using the grade set  $U$ . Therefore, using the above relationship, we can get the diversity of the first-level indicators  $T_i \times \lambda_i^T = G_i = (G_{i1}, G_{i2}, \dots, G_{in})$ , where  $i = 1, 2, \dots, n$ .

#### Step 4: Secondary evaluation.

In order to determine the final score, the weight matrix vector  $\lambda_i (i = 1, 2, \dots, n)$  is solved. Refer to the practice of relevant scholars [26] and introduce Hierarchical analysis.

The basic approach is as follows:

- (1) Build a judgment matrix. Based on the Saaty 1-9 scaling method.
- (2) Solve eigenvectors. The summation method was used to calculate the feature vectors and weights of different factors.
- (3) Consistency inspection. It is mainly based on the

value of  $C.R. = \frac{C.I.}{R.I.}$ . If  $C.R. < 0.1$ , it indicates that the

judgment matrix has passed the relevant test.

According to the weight matrix vector  $T_i$  and matrix  $T_i$ , the final set  $G_i$  can be obtained.  $T_i$  is mainly obtained through  $G_i = (G_{i1}, G_{i2}, \dots, G_{in})$ .

Wherein, the judgment matrix  $G$  of a single factor obtained by using the evaluation results of different elements is as follows:

$$G = \begin{bmatrix} G_1 \\ G_2 \\ \dots \\ G_n \end{bmatrix} = \begin{bmatrix} G_{11} & G_{12} & \dots & G_{1n} \\ G_{21} & G_{22} & \dots & G_{2n} \\ \dots & \dots & \dots & \dots \\ G_{n1} & G_{n2} & \dots & G_{nn} \end{bmatrix}$$

Finally, the final score of different evaluation subjects is  $Q = G \times \lambda_i^T$ . The value  $Q$  can reflect satisfaction.

### Analysis of Influencing Factors of Online Teaching Mode Satisfaction Based on Multiple Linear Regression Model

Based on the analysis results of fuzzy comprehensive evaluation, a multiple linear regression model is constructed to analyze the effects of different factors on satisfaction, which can effectively measure the deviation of key independent variables from dependent variables [27].

Basic ideas of multiple linear regression analysis [28-29]. Through the observation of a large number of samples, the data of explanatory variables and explained variables are obtained, and then several regression analysis models are constructed through the sample distribution. At the same time, correlation analysis, variance analysis, least squares estimation and other techniques are used to test the relationship between the two, and then the optimal variables are selected to build a linear regression model. Statistically, if there are at least two explanatory variables that have a linear correlation with the explained variables, the model is called multiple linear regression estimation.

The basic assumptions, principles and model expressions of the multiple linear regression model are as follows [30]. It is assumed that there is an explained variable  $Y$  and several explanatory variables  $X_1, X_2, \dots, X_n$ . If there is a linear relationship in the explanatory variables between  $(K - 1)$  variables and  $Y$ , there can be the following relationship:

$$Y = \lambda_0 + \lambda_1 X_1 + \lambda_2 X_2 + \dots + \lambda_{k-1} X_{k-1} + \delta$$

In the above formula,  $(X_1, X_2, \dots, X_{k-1})$  represents the explanatory variable,  $Y$  represents the explained variable, and  $\delta$  represents the random error term,  $\delta: N(0, \sigma^2)$ . If  $M$  groups of samples are obtained through multiple observations, they can be expressed as:

$$\begin{cases} Y_1 = \lambda_0 + \lambda_1 X_{11} + \lambda_2 X_{12} + \dots + \lambda_{k-1} X_{1k-1} + \delta_1 \\ Y_2 = \lambda_0 + \lambda_2 X_{21} + \lambda_{22} X_{22} + \dots + \lambda_{k-1} X_{2k-1} + \delta_2 \\ \vdots \\ Y_M = \lambda_0 + \lambda_1 X_{M1} + \lambda_{M2} X_{M2} + \dots + \lambda_{k-1} X_{Mk-1} + \delta_M \end{cases}$$

In the above formula,  $\delta_1, \delta_2, \dots, \delta_M$  are independent of each other, and  $\delta: N(0, \sigma^2)$ .

$$\text{If assumed } Y = \begin{pmatrix} Y_1 \\ Y_2 \\ \vdots \\ Y_M \end{pmatrix}_{M \times 1}, X = \begin{pmatrix} 1 & X_{11} & X_{12} & \dots & X_{1k-1} \\ 1 & X_{21} & X_{22} & \dots & X_{2k-1} \\ \vdots & \vdots & \vdots & \vdots & \vdots \\ 1 & X_{M1} & X_{M2} & \dots & X_{Mk-1} \end{pmatrix}_{M \times K}$$

$$\lambda = \begin{pmatrix} \lambda_1 \\ \lambda_2 \\ \vdots \\ \lambda_{M-1} \end{pmatrix}_{M \times 1}, \delta = \begin{pmatrix} \delta_1 \\ \delta_2 \\ \vdots \\ \delta_k \end{pmatrix}_{k \times 1}$$

Therefore, the matrix expression of the model is as follows:

$$\begin{cases} Y = X\lambda + \delta \\ \delta: N(1, \sigma^2 I_K) \end{cases}$$

In this study, online teaching satisfaction is the explained variable  $Y$ . The satisfaction evaluation of educational objects on online teaching can be obtained by using questionnaires and other methods. According to the index system of fuzzy comprehensive evaluation model, several explanatory variables affecting satisfaction can be obtained  $(X_1, X_2, \dots, X_{k-1})$ , and then through the data empirical test.

### Analysis of Influencing Factors and Mechanism of Online Teaching Mode Satisfaction Based on Structural Equation Model

In order to further explore the mechanism between different independent variables and dependent variables, this paper intends to introduce structural equation model to express these relationships more intuitively.

The structural equation model (SEM) was proposed in the 1960s. It can effectively evaluate the relationship between the explicit variables and dependent variables of the model, and can also analyze the latent variables that cannot be observed directly. In statistics, there is an effective analysis model to evaluate the relationship between variables. In the structural equation model, Maximum Likelihood Estimation and PLS have commonly used parameter estimation methods [31]. This paper mainly studies online teaching satisfaction and its key influencing factors as well as the relationship between potential variables. Because the sample data is carried out by random sampling and the satisfaction survey is processed by Likert scale, the data does not conform to the normal distribution completely, and the structural equation model based on Maximum Likelihood Estimation is more in line with the requirements.

The solution of structural equation model mainly includes two steps:

**Step 1: Build a measurement model.**

Assuming that the latent variables of online teaching satisfaction are  $\psi$  and  $\theta$ , and the apparent variable of influencing factors is  $X$ . Therefore, the relationship between  $\psi$ ,  $\theta$  and  $X$ ,  $Y$  can be effectively constructed through the measurement model [32].

$$Y = \alpha_y \theta + \mu$$

$$X = \beta_x \psi + \phi$$

Where, the vector  $Y$  represents the explained variable; Vector  $X$  represents exogenous explanatory variables; And  $\psi$  and  $\theta$  represent exogenous and endogenous latent variables respectively.  $\alpha_y$  and  $\beta_x$  are the factor load matrix of endogenous and exogenous observation variables to endogenous potential variables,  $\mu$ ,  $\phi$  represent the residual term respectively.

**Step 2: Build a structural model.**

In order to obtain the parameter values of the latent and explicit variables of online teaching satisfaction, it is necessary to construct further structural models to estimate the coefficients of  $\psi$  and  $\theta$ . Referring to relevant practices at home and abroad [33], the general form of structural model is as follows:

$$\theta = \rho\theta + \omega\psi + \varepsilon$$

Where  $\rho$  and  $\omega$  respectively represent the coefficient matrix of endogenous and exogenous latent variables, and  $\varepsilon$  represents the residual vector of endogenous latent variables. In addition, the common Least squares estimation method is used to obtain the parameter values of explicit and latent variables [34]. The strong and weak relationship between latent variables and explicit variables can fully reflect the path of multiple pairs of online teaching satisfaction.

### Selection of Variables

At present, the academic community has not yet formed a unified standard for the research of this paper. Combining relevant domestic and foreign research and the specific reality of online course teaching, with reference to relevant studies [35, 36], this paper forms an index system from four dimensions of teaching knowledge, interaction, platform and effect based on constructivism theory and learning theory. See Table 1 for details:

This paper mainly uses the method of questionnaire to obtain the research data, and uses the methods of fuzzy comprehensive evaluation, multiple linear regression model and interpretative structural equation model to construct the satisfaction evaluation of online teaching mode and the relationship between influencing factors. This paper uses the questionnaire survey method to obtain first-hand data. In order to obtain

enough effective variables of the model, this paper conducted a questionnaire survey on students majoring in transportation engineering, UAV system engineering, electronic information, civil engineering, logistics management, business administration, financial management, accounting, law, foreign languages and other majors in a university in Tianjin by random sampling. In order to improve the efficiency, the study sent questionnaires to 500 students who taught by 10 teachers through the course groups.

According to the statistical results, 351 questionnaires were collected, accounting for 70.2% of the sample, which was greater than 60%. The Cronbach  $\alpha$  coefficient of the questionnaire is 0.969, which is greater than 0.95 and has a high reliability. At the same time, the KMO value of different variables with high validity is 0.945. According to the distribution of the respondents, there are 208 boys, accounting for 59.26% of the total, and 143 girls, accounting for 40.74% of the total. In terms of grade distribution, there are 136 freshmen, accounting for 38.75%; 134 sophomores, accounting for 38.18%; 77 juniors, accounting for 21.94%; and 4 seniors, accounting for 1.14%. According to the results, freshmen and sophomores are the main body, with a total of 76.85%. Due to fewer courses and participation, seniors are in line with the actual situation of teaching. In terms of professional distribution, there are 220 engineering students, accounting for 62.68%, 115 economic management students, accounting for 32.76%, and 16 other categories, accounting for 4.56%. From the perspective of teaching methods, Wisdom Tree, Superstar, Bilibili, Tencent conference, DingTalk and QQ are common online course platforms.

## Results and Discussion

### Satisfaction Evaluation Results of Online Teaching Mode Based on Fuzzy Comprehensive Evaluation Method

According to the relevant ideas of AHP, in order to obtain the weights of different indicators of the influencing factors of teaching satisfaction in school, this paper selected 10 teachers with the titles of associate professor and professor in a university in Tianjin as experts through the Delphi method. These experts have more than 5 years of teaching experience, and actively carry out online teaching. Through multiple rounds of consultation and repeated evaluation, the expert comprehensive judgment matrix is formed. According to the calculation results, the index weight system of influencing factors of online teaching satisfaction is finally determined.

Based on the indicators, a questionnaire was prepared to obtain data. Finally, the relevant data were obtained by using Likert scale analysis, and the results in Fig. 1 were obtained through statistical analysis of relevant data. The above results reflect the actual

Table 1. Online teaching satisfaction evaluation index system.

Primary indicator	Secondary index	Tertiary indicators
Teaching knowledge	Platform resources	A11: The platform course is rich in content and information.
		A12: Clear and reasonable platform pictures and animations
		A13: Good resource retrieval, navigation, record, etc
	Student learning	A21: Students' listening concentration
		A22: Students' serious thinking in class
		A23: Students' focus on classroom tasks
	Teacher input	A31: Teachers' online learning guidance and feedback
		A32: Satisfaction with teaching design and activity organization
		A33: Cutting edge and enlightening situation of course content
Teaching interaction	Teacher questions	B11: Students' active response to questions
		B12: Students' questioning of teaching content
		B13: Students are willing to discuss the situation with teachers.
	Student discussion	B21: Students listen carefully to others' statements.
		B22: Students listen carefully to the discussion between classmates .
		B23: Inspired by the discussion among students
	Flipped Classroom	B31: Interested in the current classroom model
		B32: How much students like flipped classroom
		B33: Students' harvest in online classroom mode
Teaching platform	Platform conditions	C11: The impact of network speed of teaching platform on teaching tasks
		C12: The appeal of teaching video
		C13: Update speed of teaching platform content
	Online skills	C21: Interactive frequency of teaching communication
		C22: Abundance of online platform resources
		C23: Learning atmosphere of online teaching
	Teaching feedback	C31: Teaching platform discussion area function
		C32: Comment on online teaching through Wechat, microblog, etc
		C33: Feedback on online teaching problems
Teaching effectiveness	Content effect	D11: Satisfaction with the course content of online teaching
		D12: Satisfaction with the interface and function of the teaching platform
		D13: Very satisfied with the richness of teaching resources
	Enlightening effect	D21: Online teaching mode improves problem solving ability
		D22: Difficulty in communicating with classmates in online teaching
		D23: Online teaching increases the frequency of teacher-student interaction
	Experience effect	D31: Online teaching helps improve innovation ability
		D32: Online teaching is beneficial to broaden knowledge and ability
		D33: Online teaching contributes to career development
Teaching satisfaction	Satisfaction score	E11: Overall satisfaction with online teaching mode
		E12: Full of confidence in the development prospect of online teaching
		E13: Encourage more students to participate in online learning

Sources of research data

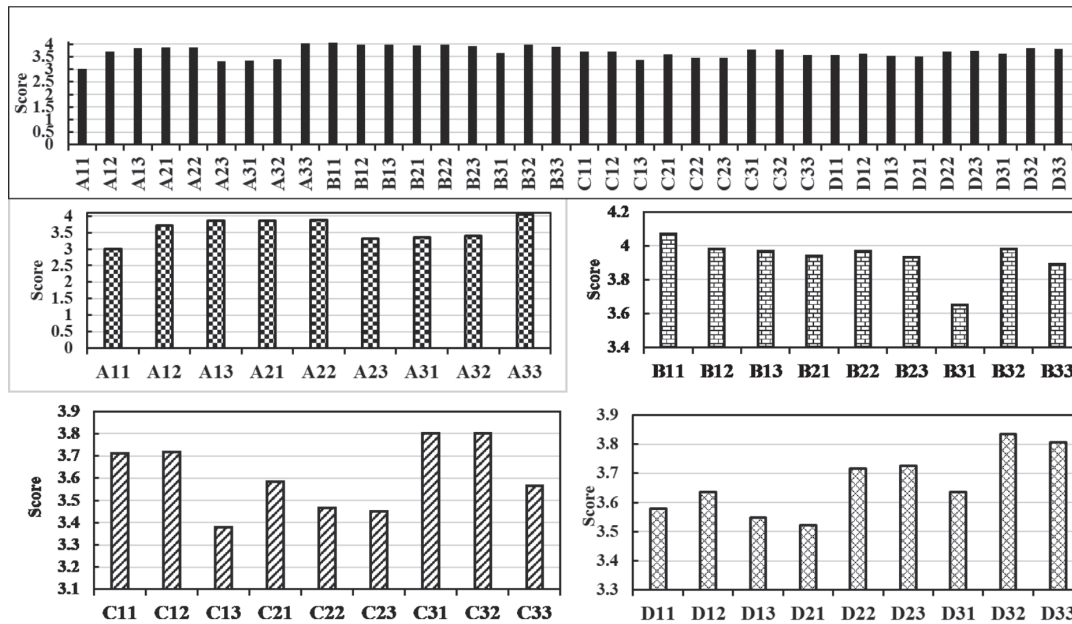


Fig. 1. Students' scores on different indicators.

situation of students' online teaching courses in their colleges and universities, which are typical, and can fully reflect the practical problems of online teaching mode in colleges and universities. From the results, "Students' active response to questions", "cutting-edge and enlightening course content", "students' enjoyment of flipped classroom" and "students' willingness to discuss with teachers" scored the highest, which are 4.07, 4.04, 3.98 and 3.97 respectively. This shows that in carrying out online teaching courses, colleges and universities pay attention to teacher-student interaction, heuristic teaching and participatory discussion, and students are more satisfied with online teaching.

At the same time, "the update speed of teaching platform content", "teachers' online learning guidance and feedback", "students' concentration on classroom tasks" and "rich content and large amount of information of platform courses" scored the lowest, which are 3.40, 3.38, 3.36, 3.32 and 3.01 respectively. This exposed the problems of the current online teaching courses, such as insufficient platform content updates, lack of teaching feedback, students' attention to be improved and platform resources to be enriched.

In order to further obtain the fuzzy comprehensive scores of different criteria level indicators, the final scores of different secondary indicators were obtained according to the fuzzy comprehensive evaluation indicators, weights, and combined with the students' survey scores of different indicators. According to the research of relevant domestic scholars, the final

scores are converted into a 100-point system, and the final criteria for evaluation is shown in Table 2. The scores are divided into four blocks in total: excellent (90-100), good (80-90), common (70-80) and weak (below 70).

According to the fuzzy comprehensive evaluation method, the satisfaction scores of different indicators are finally obtained. See Table 3 for details. The comprehensive satisfaction scores of teachers' questions, flipped classroom and experience effect are greater than 90, which are evaluated as excellent; The comprehensive scores of satisfaction of platform resources, student learning, teacher input and other nine

Table 2. Fuzzy comprehensive evaluation criteria.

Excellent	Good	Common	Weak
Above 90	80-90	70-80	Below 70

Table 3. satisfaction scores of different indicator dimensions.

Criterion layer	Evaluating indicator	Comprehensive score of satisfaction
Teaching knowledge	Platform resources	80.52
	Student learning	88.64
	Teacher input	80.98
Teaching interaction	Teacher questions	90.11
	Student discussion	88.94
	Flipped Classroom	91.83
Teaching platform	Platform conditions	82.06
	Online skills	80.01
	Teaching feedback	84.43
Teaching effectiveness	Content effect	81.74
	Enlightening effect	88.09
	Experience effect	90.18

Table 5. Results of multiple regression analysis.

Project	Regression coefficient	T value	P value	Vif
Constant	-0.03	-0.11	0.913	
Degree of concentration in completing classroom tasks	0.16	2.16	0.032*	1.11
Very satisfied with the teaching design, activity organization, etc	0.22	2.74	0.007**	2.20
Increase the frequency of interactive communication in online teaching	0.46	5.49	0.000**	2.31
The course content is close to the forefront and enlightening	-0.01	-0.09	0.929	1.98
Sample size	351			
R <sup>2</sup>	0.906			
Adjust R <sup>2</sup>	0.897			
F	F (4339) =37.287, p = 0.000			

\*P<0.05 \*\* p<0.01

indicator dimensions are in the range [80,90], which are evaluated as good. It can be seen from the above results that at present, the university has outstanding performance in teacher-student interaction, flipped classroom and paying attention to student experience. The effect of online course teaching is good, and online teaching is conducive to students' acquisition of knowledge, enlightenment and improvement of professional skills.

#### Online Teaching Satisfaction Evaluation Results Based on Multiple Linear Regression Model

Since there are many factors affecting online teaching satisfaction, if all the factors are included in the multiple linear regression model test, the explanatory power of the relevant results may be insufficient. Therefore, this paper first selects five factors as independent variables, "satisfaction with the online teaching mode", "focus on completing classroom tasks", "satisfaction with teaching design and activity organization", "increasing the frequency of interactive communication in online teaching", "grasping the forefront of the course content and enlightening", and "online teaching satisfaction score" as the dependent variables. A multiple linear regression model is constructed. Further analysis shows that according to Table 5, the regression coefficient of "the degree of concentration on completing classroom tasks" is 0.16, which is significant at the 5% level, indicating that the degree of concentration on the course has a significant impact on students' performance. The regression coefficients of "very satisfied with the teaching design and activity organization" and "increasing the frequency of interactive communication in online teaching" to the dependent variables are 0.22 and 0.46 respectively, and the corresponding p-values are 0.007 and 0.000 respectively.

In order to further analyze the role of different factors in online teaching satisfaction, A11, A21, B11, B21, C11, C21, D11, D21 were selected as independent variables, and the relevant results are shown in Table 6.

According to the statistical results, the eight factors A11, A21, B11, B21, C11, C21, D11 and D21 have a positive impact on online teaching satisfaction, and the regression coefficients of the model are 0.100, 0.267, 0.104, 0.220, 0.116, 0.018, 0.067 and 0.229, which are all greater than 0.000. From the significance level, A11, B21, C21 are significant at 1% level with p-values of 0.008, 0.010, 0.004 respectively; A21, C11, D11, D21 are significant at the level of 5% with p-values of 0.043, 0.015, 0.035, 0.022 respectively. Therefore, it can be seen that platform resources, student discussions, and online skills have the highest impact on online teaching satisfaction. The richness of online platform resources, positive student interaction, and proficient classroom skills of teachers and students help to improve the effectiveness of online teaching and increase students' satisfaction. The possible reason for the low impact of students' active response to questions on students' satisfaction is that based on the online teaching scenario, some students prefer to obtain knowledge from teachers, but the meaning of active participation is low. Therefore, mobilizing classroom enthusiasm can improve students' sense of participation. The impact of students' listening concentration situation, internet speed of teaching platform on teaching tasks, satisfaction with the course content of online teaching, and online teaching mode to improve problem-solving ability also have a significant impact. By improving students' concentration, optimizing the online class environment, such as internet speed, improving course content and teaching mode with competence development will significantly increase students' access and satisfaction.



Table 6. Linear regression analysis results (n = 351).

	Denormalization coefficient		Standardization coefficient	T	P	VIF
	B	Standard error	Beta			
Constant	-0.333	0.309	-	-1.077	0.282	-
A11	0.018	0.075	0.012	0.243	0.008**	1.361
A21	0.1	0.068	0.081	1.467	0.043*	1.618
B11	0.067	0.056	0.062	1.196	0.233	1.415
B21	0.267	0.103	0.215	2.591	0.010**	3.678
C11	0.229	0.094	0.189	2.446	0.015*	3.192
C21	0.104	0.08	0.08	1.302	0.004**	2.007
D11	0.116	0.089	0.093	1.297	0.035*	2.751
D21	0.22	0.096	0.1	2.296	0.022*	1.013
R <sup>2</sup>	0.359					
Adjust R <sup>2</sup>	0.344					
F	F(8342) = 23.922, p = 0.000					
D-W value	2.081					

Dependent variable: satisfaction with online teaching mode; \* p<0.05 \*\* p<0.01

### Evaluation Results of Teaching Satisfaction Based on Structural Equation Model

#### Construction Results of Structural Equation Model

In order to further investigate the relationship between different factors affecting online satisfaction, and according to the principle of structural equation model, relevant results were obtained, as shown in Fig. 2.

According to the results, teaching knowledge and teaching interaction have a positive impact on the dependent variables, and the regression coefficients are

0.123 and 0.930 respectively. The regression coefficient of the teaching platform on teaching satisfaction is -0.168, which has a negative impact, indicating that the current teaching platform still has many shortcomings and needs to be improved, such as platform interface design, platform resource richness, platform operation speed, etc.

#### Test Results of the Model

In order to further verify the effectiveness of the structural equation model, the fitting index can fully

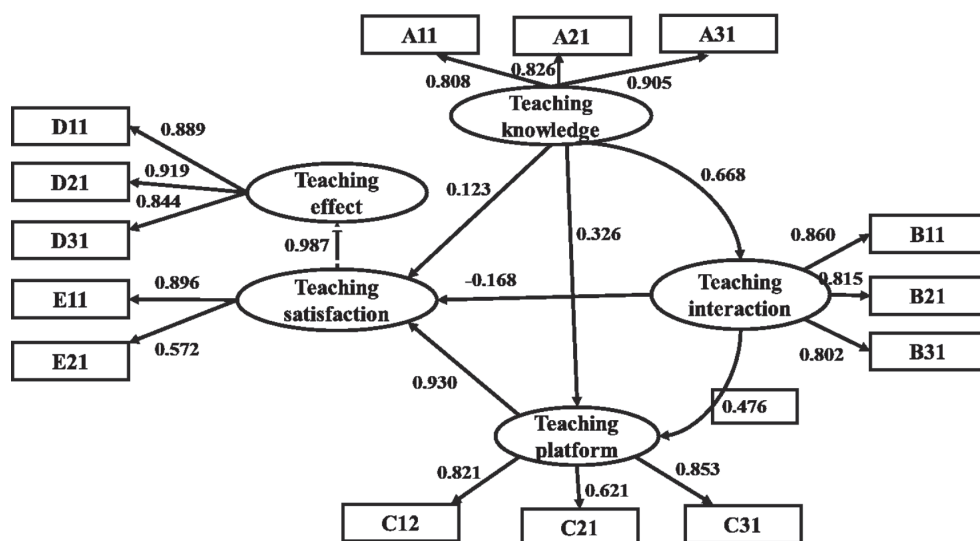


Fig. 2. Structural equation model results.

Table 7. Model fitting index.

Common indicators	$\chi^2$	DF	P	Chi-square degree of freedom ratio $\chi^2/df$	GFI	RMSEA	RMR	CFI	NFI	Nnfi
Judgment criteria			>0.05	<3	>0.9	<0.10	<0.05	>0.9	>0.9	>0.9
value	183.496	70	0.000	2.621	0.93	0.068	0.03	0.969	0.951	0.959
Other indicators	TLI	AGFI	IFI	Pgfi	Pnfi	SRMR	RMSEA 90% Ci			
Judgment criteria	>0.9	>0.9	>0.9	>0.9	>0.9	<0.1				
Value	0.959	0.896	0.969	0.62	0.731	0.043	0.056 ~0.080			

Default model:  $\chi^2(91) = 3718.361, p = 1.000$

reflect. As shown in Table 7, the  $\chi^2$  value of the model is 183.496, df is 70, and the p-value is 0.000, which fully showed that the model fits well.

### Conclusions

Under the background of the “double carbon” goal, green sustainable development has become the key development direction in the fields of economy, politics, education and so on. Online teaching is a new model of green technology empowerment education, which is conducive to energy conservation and environmental protection. In order to explore the evaluation of students’ satisfaction with online teaching, and analyze the relationship between different influencing factors, this paper uses the fuzzy comprehensive evaluation method, multiple linear regression model and structural equation model system analysis. According to the theoretical and empirical research, the following conclusions are drawn:

First, online teaching in colleges and universities has achieved remarkable results, and students’ satisfaction is at a good level. Through the fuzzy comprehensive evaluation method, the comprehensive scores of satisfaction with teachers’ questions, flipped classroom and experience effect are greater than 90, which are evaluated as excellent; The comprehensive scores of satisfaction of platform resources, student learning, teacher input and other nine indicator dimensions are in the range [80, 90], which are evaluated as good. Online teaching is conducive to students’ acquisition of knowledge, enlightenment and improvement of professional skills.

Second, teaching platform resources, student discussion and online skills are the key factors of online teaching satisfaction. According to the results of multiple linear regression analysis, A11, B21, and C21 are significant at 1% level, and P values are 0.008, 0.010, and 0.004 respectively. At the same time, the rich resources of the online platform, positive student

interaction and proficient teaching skills of teachers and students help to improve the effectiveness of online teaching and students’ satisfaction.

Third, the influence path of teaching knowledge, teaching interaction and teaching platform on teaching satisfaction is different. According to the results of structural equation model, teaching knowledge and teaching interaction have a positive impact on satisfaction, and the regression coefficients are 0.123 and 0.930, respectively. The regression coefficient of teaching platform on teaching satisfaction is -0.168, which has a negative impact, indicating that the current teaching platform in school still has many shortcomings and needs to be improved, such as platform interface design, platform resource richness, platform operation speed, etc.

Therefore, it is necessary for colleges and universities to continuously optimize the resources of online teaching from the three-dimensional element level of the “teacher-student platform”, create a good external environment for online teaching, continuously improve students’ sense of knowledge acquisition, and enhance students’ satisfaction.

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### Conflict of Interest

The authors declare no conflict of interest.

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