

*Original Research*

# Comprehensive Evaluation of Online Foreign Language Teaching Satisfaction under the Green and Sustainable Background

Haixia Guo<sup>1\*</sup>, Gang Zeng<sup>2\*\*</sup>

<sup>1</sup>School of Foreign Languages, Tianjin University, Tianjin 300350

<sup>2</sup>School of Economics and Management, Civil Aviation University of China, Tianjin 300300

*Received: 8 March 2023*

*Accepted: 3 June 2023*

## Abstract

Due to the increasingly serious problems of environmental pollution and resource waste, promoting the green and low-carbon transformation of education has become a new trend. Online foreign language education is a new mode of green transformation development relying on digital technology. Based on the new background of green technology, this paper focuses on the evaluation of online foreign language teaching satisfaction and the key influencing factors. The entropy weight method was used to construct the evaluation index of online foreign language teaching satisfaction, the multiple linear regression model and confirmatory factor analysis model were used to systematically analyze the main factors affecting the satisfaction, and the questionnaire was used to investigate the data of online foreign language courses such as American Literature, American Culture, College English, Comprehensive English, and History of Foreign Literature. The results show that: (1) college students have a high degree of satisfaction with online foreign language teaching, and the satisfaction index based on entropy weight method is above level 2. (2) Through the multiple linear regression model, the four dimensions of teaching involvement, teaching communication, teaching skills and teaching effect all have a significant impact on the satisfaction of online foreign language teaching. (3) Based on the confirmatory factor model, online foreign language teaching satisfaction is affected by multiple latent and explicit variables, and the effect direction is generally positive. Finally, the paper puts forward specific strategies to improve the effect of green and low-carbon digital technology on foreign language education.

**Keywords:** green and low-carbon development, digital technology, online foreign language teaching, entropy weight method, confirmatory factor analysis

---

\*email: haixia.guo@tju.edu.cn

\*\*email: gzeng666@foxmail.com

## Introduction

Serious environmental pollution has been caused by energy consumption and resource waste. In the past 40 years, China's economy has achieved rapid growth relying on high resource input. However, the development model represented by fossil energy and traditional technology has destroyed the ecological environment and hindered sustainable development. In order to deal with these problems, it has become an inevitable choice for Chinese society to develop green technology and to promote the innovation of energy conservation and environmental protection industry. In September 2020, the Chinese government clearly put forward the ambitious goals of "2030 carbon peak" and "2060 carbon neutrality".

Relying on big data, cloud platform and artificial intelligence, digital technology has the specific characteristics of energy saving, low carbon and green, and has profoundly changed the operation mode of production, life and education [1]. Online foreign language teaching mode is a typical representative of digital technology enabled education, which can effectively save teaching resources and help improve the quality of foreign language courses such as American Literature, College English, Integrated English, and History of Foreign Literature. Especially in the case of the spread of new corona-virus, it can effectively reduce personnel flow and improve teaching efficiency. Online foreign language teaching mode can help students enhance their understanding of foreign literature, enhance national self-confidence and national identity, and improve students' English skills. Online foreign language teaching mode has become a new paradigm in the field of digital education.

Green and low-carbon development is an important proposition to achieve sustainable social development. Online foreign language education model is an important content of digital technology to promote the low-carbon transformation of educational activities. By using the online foreign language education model, teachers and students can carry out teaching interaction conveniently. For example, online education can reduce the occupation of traditional meeting space by means of virtual conference rooms, effectively saving social resources. Online foreign language education can effectively reduce traffic, paper waste and other links, promote the exchange and dissemination of knowledge. Online foreign language teaching driven by digital technology has become an important way of social green transformation.

There is no systematic research on the satisfaction evaluation of online foreign language teaching at home and abroad. The related research mainly includes: learning theory, satisfaction theory, satisfaction evaluation model, etc. The following mainly combs the theoretical and empirical results of the above topics:

Learning theory first emphasized the individual behavior of "stimulus response". Since 1980,

cognitivism has become popular, with special emphasis on the individual psychological process. After 1990, constructivist learning theory gradually became the mainstream [2, 3]. Constructivism originated in the field of psychology. Piaget, the founder of the Geneva School, believes that children's cognition is generated through communication with the external environment, and constantly promotes the improvement of individual cognitive structure [4]. In constructivism, cooperation, situation, communication and meaning are the main elements of learning [5, 6]. With the development of theory, many scholars believe that learning support strategies can be divided into three types [7-9]. With the popularization and development of computer technology, the influence of constructivism has become increasingly powerful, mainly because the learning environment advocated by constructivism can be realized through online courses and other network platforms [10, 11].

Satisfaction theory originated from the field of management. From 1970 to 1980, Philip Kotler, a famous American scholar, first proposed the concept of customer satisfaction. He defined it as the feeling formed by the comparison between the perceived effect of customers on the products or services provided by an organization and the expected value [12]. With the development of this theory, many valuable measurement models have been formed, such as Difference analysis model [13], Service quality measurement model [14], Perceived performance service quality measurement model [15], etc. At the specific application level, customer satisfaction theory has been extended to the fields of commerce, public governance and education. Yan et al. (2021) established a satisfaction measurement model from the perspective of emotional superposition and conducted a numerical simulation [16]. Luan and Zhang (2020) established a user reading satisfaction model based on user perceived quality and value [17].

As for satisfaction evaluation, most scholars use the method of parameter estimation. Common models include OLS regression, PLS structural equation, Fuzzy comprehensive evaluation method, Probit model, and Analytic hierarchy process, etc. Kim et al. (2022) used machine learning method to study the relationship between interior space design and residential satisfaction [18]. Coelho et al., (2021) used the QASSAB questionnaire to evaluate the satisfaction of oral health services [19]. Farra & Hodgson (2021) used the student satisfaction scale to simulate disaster teaching skills [20]. Oh et al., (2022) used the Likert scale to estimate patients' satisfaction with rheumatic telemedicine [21]. Liu et al. (2021) used the improved entropy weight TOPSIS to analyze residents' satisfaction with heating [22]. Wang (2020) used AHP method to analyze the satisfaction index of poverty alleviation [23]. Song et al. (2021) used the discrete regression model to analyze the satisfaction of e-commerce farmers [24]. Zhao et al. (2020) used Kano model to estimate the satisfaction of online comment users [25]. Ma et al. (2021) used IPA

method to compare the satisfaction index of tourism public service [26].

On the issue of online foreign language teaching, most scholars use the method of qualitative analysis to carry out their research. Zhong (2021) proposed specific directions and strategies for improving smart foreign language teaching reform [27]. Zhang and Zhao (2021) analyzed the differences between online and offline oral teaching experience [28]. Liu and Guo (2021) believe that cognitive and emotional support have a significant impact on teachers' and students' teaching-learning pleasure [29]. Zhu et al. (2021) believe that online courses can improve the learning ability of academic English [30]. Zhao proposed to strengthen the computer application skills of foreign language majors [31]. Feng and Shi (2022) analyzed the impact of online collaborative learning on foreign language teaching and the ways to improve it [32]. Hui and Wang (2022) believe that students' engagement in online foreign language learning is at the upper middle level [33].

To sum up, foreign scholars have carried out many groundbreaking studies around learning theory and satisfaction theory, and domestic scholars have formed a series of valuable achievements focusing on specific issues such as satisfaction evaluation and the improvement of online foreign language teaching quality. These become the important theoretical and practical basis of this study. However, empirical research on online foreign language teaching satisfaction evaluation is relatively scarce. At present, digital technology empowering modern education has become a new trend, and the "student-centered" education model needs to be integrated into online foreign language teaching. How to build an effective online foreign language teaching evaluation index system and scientific model is a practical problem worthy of further study, which has an important impact on the quality of online foreign language teaching. This paper will mainly solve this problem and broaden the theoretical boundary of the existing research.

The possible innovation points of this paper include: first, the construction of an effective method system of online foreign language teaching satisfaction evaluation. This paper intends to combine entropy weight method, multiple linear regression method and confirmatory factor analysis method to enrich the theory of satisfaction evaluation, and expand the application range of the theory by introducing comprehensive evaluation method. Secondly, empirical research is adopted to scientifically and accurately diagnose the satisfaction level of online foreign language teaching. Through the questionnaire survey to obtain the latest data, combined with the method of empirical research, it is found that teaching involvement, teaching communication, teaching skills, teaching effect have a significant impact on teaching satisfaction. Thirdly, based on the theoretical and empirical research results, this paper proposes effective countermeasures to improve the satisfaction level of online foreign language teaching,

such as increasing teaching input and enhancing teacher-student interaction.

## Material and Methods

### Construction of Online Foreign Language Teaching Satisfaction Index Model Based on Entropy Weight Method

There are two main methods to evaluate the satisfaction of online foreign language teaching: subjective evaluation method and comprehensive evaluation method. Through the questionnaire survey method, the score can be directly evaluated by the evaluated person, and the satisfaction score can be obtained. However, this result has obvious individual subjective bias, which is not conducive to directly reflecting the online foreign language teaching level and actual satisfaction. Entropy weight method is a kind of technology that uses a variety of information of multiple evaluation indexes to determine the weight, which is conducive to overcoming the defects of the simple subjective targeting method.

Considering the characteristics of the problem studied in this paper, the entropy weight comprehensive index method is used to get the score of online foreign language teaching satisfaction, which is conducive to obtaining scientific and reasonable evaluation results. Referring to the research of relevant scholars at home and abroad, the construction idea of entropy weight comprehensive index method is as follows [34]:

**Step 1:** To determine the indicator system. Referring to the research results at home and abroad, according to the learning theory, participation theory, satisfaction theory, etc., at the same time, according to the expert evaluation method, either or method, comprehensive comparison method, etc., the online foreign language teaching satisfaction evaluation index system is constructed. Suppose there are  $i$  secondary index and  $j$  tertiary index, then  $g_{ij}$  represents the  $i$  index of the  $j$  dimension.

**Step 2:** To standardize the indicators. Due to the different dimensions of different indicators, if the original data is used for estimation, the results may be distorted due to the dimensional deviation. Therefore, it is necessary to standardize the indicator data. According to the rules of entropy weight method, Min-Max standardization method is adopted. Suppose  $g_j^{\max} = \max_i g_{ij}$ ,  $g_j^{\min} = \min_i g_{ij}$  represents the maximum and minimum in  $h_j$ , respectively. The index after standardization is assumed to be  $h_j$ , then the following expression is given:

Standardization of negative indicators:

$$h_{ij} = \frac{g_{ij} - g_j^{\min}}{\max_i g_{ij} - \min_i g_{ij}}$$

Standardization of positive indicators:

$$h_{ij} = \frac{g_{ij} - g^{\min}_j}{\max_i g_{ij} - \min_i g_{ij}}$$

**Step 3:** To determine the entropy value  $\eta_i$

$$\eta_i = -(ln(k))^{-1} \sum_{i=1}^k (\theta_{ij})$$

$$\theta_{ij} = \frac{h_{ij}}{\sum_{i=1}^k h_{ij}}$$

Of which,

**Step 4:** To determine the degree of variation  $R_i$ .  $R_i = 1 - \eta_i$ , Where,  $R_i$  represents the variability of index  $j$ .

**Step 5:** To determine the weight of the indicator  $\omega_j$ .

$$\omega_j = \frac{R_i}{\sum_{j=1}^n R_i}$$

**Step 6:** To determine the comprehensive score of online foreign language teaching satisfaction evaluation  $Q_j$

$$Q_j = \sum_j \omega_j h_{ij}$$

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

Using entropy weight method to get satisfaction index is an effective evaluation method of foreign language teaching level. However, the simple satisfaction index is still difficult to explain the key factors affecting the satisfaction level. In order to further explore this problem, it is necessary to introduce multiple linear regression model. This model is a reliable method to study the factors affected by the explained variables, revealing the complex mechanism of multiple factors by constructing the functional relationship between independent variables and dependent variables [35].

Multiple linear regression model is a classical model of mathematical statistics theory. Referring to relevant studies, the basic idea of the multiple linear regression model is as follows: it is assumed that the sample size is  $q$ , the number of independent variables and dependent variables is  $a, b$  respectively, and the number of constraints is  $t$ . Hence, we can get the coefficient matrix of the model  $\theta_{(a+1) \times b}$ , where  $a \leq q$ ,  $b \leq q$ . At the same time,

suppose  $E_{q \times b} = (E_{(1)}, E_{(2)}, \dots, E_{(q)})^T$  is a  $b$ -dimensional error vector, where  $E_{(1)}, E_{(2)}, \dots, E_{(q)} : i.i.d.N_b(0, z)$  and  $A_{t \times (a+1)}$  are constraint matrices, and there is  $A_{t \times (a+1)} \theta_{(a+1) \times b} = D_{t \times b}$  and this expression has a non-unique solution. When  $Rank(A) = b < a+1$ , there is the following expression [36]:

$$\begin{cases} y_{q \times b} = x_{q \times (a+1)} \theta_{(a+1) \times b} + E_{q \times b} \\ A_{t \times (a+1)} \theta_{(a+1) \times b} = D_{t \times b} \\ E_{q \times b} = (E_{(1)}, E_{(2)}, \dots, E_{(q)})^T \\ E_{(1)}, E_{(2)}, \dots, E_{(q)} : i.i.d.N_b(0, z) \\ z = (\sigma_{ij})_{b \times b} \text{ or } E : N_{q \times b}(0, z \otimes I_q) \end{cases}$$

In the above equation,  $y_{q \times b}, x_{q \times (a+1)}, A_{t \times (a+1)}$  represents a known matrix and  $x, y$  represents a matrix composed of observed values.

Using the above formula, we can construct a multiple linear regression model with online foreign language teaching satisfaction as the dependent variable and multiple indicators affecting satisfaction as the independent variable. The model can effectively reflect the effect of different variables on satisfaction and determine the key elements and direction of improving satisfaction through significance.

### Analysis of Influencing Factors of Online Foreign Language Teaching Satisfaction Based on Confirmatory Factor Analysis Model

Since there are many influencing factors of online foreign language teaching satisfaction, it is needed to further analyze the model by using the confirmatory factor, to study the role of explicit and potential variables that affect satisfaction. Confirmatory factor analysis is an effective conceptual model, suitable for the analysis of subjective dependent variables such as satisfaction.

Confirmatory factor analysis model is a special form of structural equation model. Therefore, the idea of referring to the structural equation model (SEM model) can effectively analyze the role of multiple factors in online foreign language teaching satisfaction. Referring to relevant studies, SEM models generally include two models [37]:

(1) Measurement model:

$$x = \lambda_x \psi + \mu, y = \lambda_y \omega + \xi$$

(2) Structural model:  $\omega = \rho \omega + \beta \theta + \sigma$

In the above model,  $x$  represents exogenous explicit variable and  $y$  represents endogenous dependent variable.  $\psi$  represents exogenous latent variable, and  $\lambda_x$  represents the factor load matrix corresponding to  $x$ .  $\omega$  represents the endogenous latent variable, and  $\lambda_y$  represents the factor load matrix corresponding to  $y$ .  $\mu$  and  $\xi$  represent the error terms of  $x, y$ , respectively. Similarly, in the structural model,  $\rho$  and  $\beta$  respectively represent the path coefficients of endogenous and

exogenous latent variables, and  $\sigma$  represents the error term of the structural model. In this paper, the above model can be used to construct a confirmatory factor analysis model with online foreign language teaching satisfaction as the endogenous dependent variable, considering the influence of multiple latent and explicit variables on the dependent variable.

### Variables and Descriptive Statistical Analysis

#### Selection of Variables

The selection of online foreign language teaching satisfaction indicators is mainly based on constructivist learning theory, which explores the relationship between learners and the environment [38, 39] (Piccoli & Ives, 2001; Alavi & Leidner, 2001). By constructing the model, the main factors affecting the learning effect can be summarized as: knowledge, information, interaction, effect, etc. Because online foreign language teaching satisfaction involves multi-dimensional factors such as curriculum platform, teachers' quality, students' input, network technology and so on. In the process of learning, information sharing, cooperation between teachers and students and cognitive processing of information are indispensable. Therefore, based on the theories of constructivism, synergism and cognitive information, the index system of this paper can be formed. With reference to relevant domestic studies [40], we can get

the theoretical basis and basic ideas for the construction of the index system (see Fig. 1).

Teaching satisfaction is affected by knowledge construction, teaching interaction and information processing. These three factors work together and synergistically to affect teaching satisfaction. After that, teaching satisfaction will directly affect the teaching effect. At the same time, according to the relevant results of online teaching evaluation in China, the online foreign language teaching satisfaction index system of this paper has been formed, as shown in Table 1. According to the construction theory, combined with the characteristics of online teaching, the satisfaction evaluation is divided into four dimensions: teaching input, teaching communication, teaching skills and teaching effect. Three factors and nine specific indicators are selected for each dimension. For example, in measuring teaching input, three aspects are considered: resource input, student input and teacher input. In terms of specific indicators, to measure resource input, "A11: resource richness of online foreign language teaching platform", "A12: resource update rate of online foreign language teaching platform" and "A13: failure rate of online foreign language teaching platform" are selected as indicators. Finally, the indicators of learning satisfaction only consider the sense of teaching acquisition, and take "E12: the sense of acquisition of online foreign language teaching to improve ability", "E13: the sense of acquisition of online

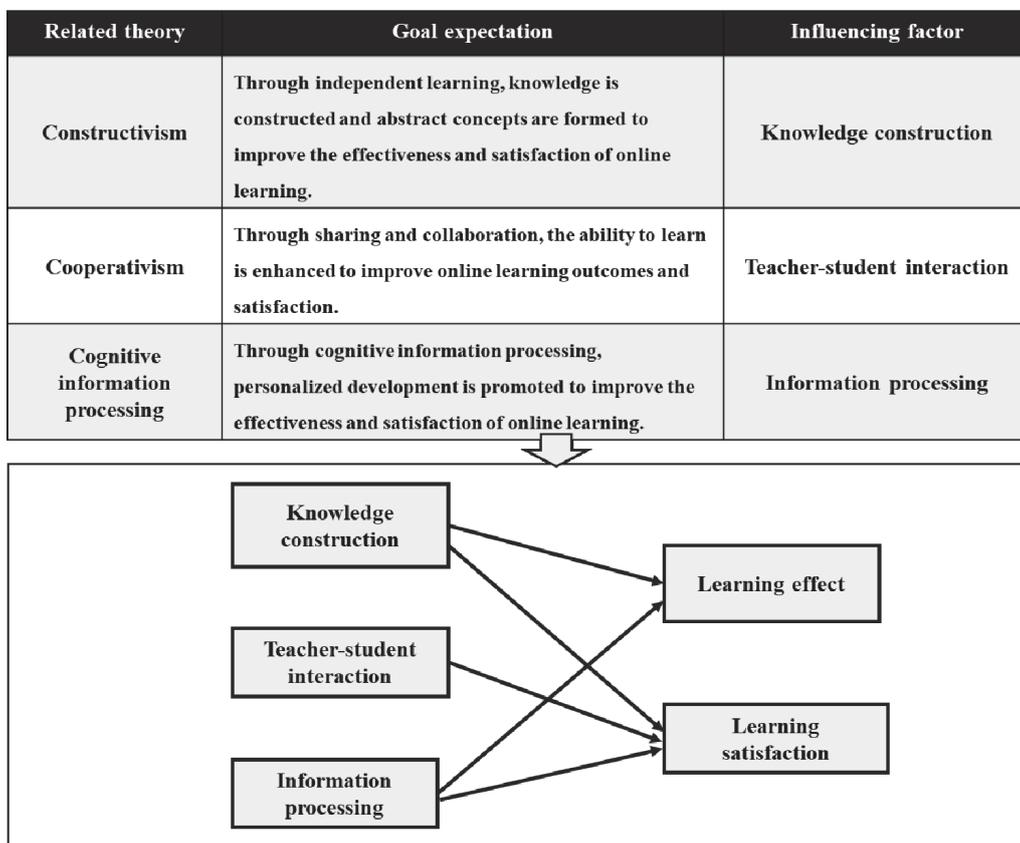


Fig. 1 Logical thinking of index construction.

Table 1. Index System of influencing factors of online foreign language teaching satisfaction evaluation level.

| Dimension              | Factor                        | Specific indicators  |
|------------------------|-------------------------------|--|
| Teaching investment    | Resource input                | A11: resource richness of online foreign language teaching platform                              |
|                        |                               | A12: resource update rate of online foreign language teaching platform                           |
|                        |                               | A13: failure rate of online foreign language teaching platform                                   |
|                        | Student engagement            | A21: interest in online foreign language courses   |
|                        |                               | A22: motivation for online foreign language courses  |
|                        |                               | A23: time investment in online foreign language courses  |
|                        | Teacher input                 | A31: teachers' language expression in online foreign language teaching                           |
|                        |                               | A32: teachers' emotional input in online foreign language teaching                               |
|                        |                               | A33: teachers' attitudes towards online foreign language teaching                                |
| Teaching exchange      | Teacher student communication | B11: teachers' feedback on classroom assignments in online foreign language teaching             |
|                        |                               | B12: Teachers' encouragement of students' participation in online foreign language teaching      |
|                        |                               | B13: media role of online foreign language teaching environment                                  |
|                        | Student exchange              | B21: increasing students' speaking in online foreign language teaching                           |
|                        |                               | B22: increasing group discussion in online foreign language teaching                             |
|                        |                               | B23: online foreign language teaching increases students' question answering                     |
|                        | Flipped Classroom             | B31: interactive situation of flipped classroom  |
|                        |                               | B32: support of flipped classroom  |
|                        |                               | B33: adaptability of flipped classroom   |
| Teaching skills        | Platform properties           | C11: interface design of online platform   |
|                        |                               | C12: real time performance of online platform  |
|                        |                               | C13: convenience of online platform  |
|                        | Student operation             | C21: pre adaptation to online foreign language teaching platform                                 |
|                        |                               | C22: operation of online foreign language teaching system  |
|                        |                               | C23: proficiency in online foreign language teaching system                                      |
|                        | Instructional design          | C31: discussion and evaluation mechanism of online foreign language teaching.                    |
|                        |                               | C32: solutions of the teachers' Association to the problems of the online communication platform |
|                        |                               | C33: teachers' reminders of the progress of online foreign language teaching                     |
| Teaching effectiveness | Course quality                | D11: learning atmosphere of online foreign language teaching mode                                |
|                        |                               | D12: content explanation of online foreign language teaching mode                                |
|                        |                               | D13 rich teaching forms in the course  |
|                        | Course efficiency             | D21: improvement of learning efficiency by online foreign language teaching                      |
|                        |                               | D22: knowledge presentation of online foreign language teaching platform                         |
|                        |                               | D23: the efficiency of online foreign language teaching  |
|                        | Course harvest                | D31: the improvement of online foreign language teaching on academic performance                 |
|                        |                               | D32: satisfaction of online foreign language teaching to learning needs                          |
|                        |                               | D33: improvement of personal ability by online foreign language teaching                         |
| Learning satisfaction  | Sense of teaching acquisition | E11: increasing the sense of knowledge acquisition in online foreign language teaching           |
|                        |                               | E12: the acquisition of online foreign language teaching for improving ability                   |
|                        |                               | E13: the acquisition of interest in online foreign language teaching                             |
|                        |                               | E14: satisfaction of online foreign language teaching with the practicality of the platform      |
|                        |                               | E15: satisfaction of online foreign language teaching with professional cognition                |
|                        |                               | E16: satisfaction of online foreign language teaching on career development                      |

foreign language teaching to stimulate interest”, “E14: the satisfaction of online foreign language teaching to the practical platform”, “E15: the satisfaction of online foreign language teaching to professional cognition”, “E16: the satisfaction of online foreign language teaching to career development” as specific indicators.

#### *Data Sources and Descriptive Statistics*

This paper mainly selects students from a university in Tianjin as the research object, and the research include: American Literature, College English, Integrated English, and History of Foreign Literature. Through the random survey, 500 students majoring in Engineering, Humanities and Social Sciences, Economics and Management were selected as the total sample, and questionnaires were issued. Finally, 381 questionnaires were collected, with a recovery rate of 76.2%. From the perspective of sample distribution, there are 23 people in Humanities and Social Sciences, accounting for 6.04%; 124 in Economic Management, accounting for 32.55%; 201 students in Engineering, accounting for 52.76%, including financial management, business administration, law, traffic engineering, automation and other majors. From the perspective of gender distribution, there are 205 boys, accounting for 53.81%, and 46.19% girls. According to the specific grade, there are 193 freshmen, accounting for 50.66%, the highest proportion, and 117 sophomores, accounting for 30.71, the two accounting for 81.36% in total, which is consistent with the situation of college foreign language teaching. Therefore, this survey can better reflect the situation of online foreign language teaching.

### **Results and Discussion**

#### **Result Analysis of Online Foreign Language Teaching Satisfaction Evaluation**

According to the entropy weight method, we can get the following weight of the six satisfaction indicators: “E11: online foreign language teaching’s sense of acquiring knowledge”, “E12: online foreign language teaching’s sense of acquiring ability”, “E13:

online foreign language teaching’s sense of acquiring interest”, “E14: online foreign language teaching’s sense of satisfaction with the practical platform”, “E15: online foreign language teaching’s sense of satisfaction with professional cognition” and “E16: satisfaction of online foreign language teaching with career development” is the weight of the six satisfaction indicators.

Table 2 is a descriptive statistics of the evaluation scores of the six indicators. From the results, the mean values of E11, E12, E13, E14, E15 and E16 are 3.52, 3.47, 3.5, 3.52, 3.55 and 3.55, respectively. The scores are in the range [3.47, 3.55] and the standard deviation is in the range [0.81, 0.88]. This shows that the evaluation objects’ evaluation on these six indicators is relatively similar, which is more consistent with the actual situation. Due to the subjectivity of online satisfaction, the evaluation objects tend to have the same preference for different indicators of online foreign language courses.

Table 3 shows the information entropy of the six indicators of satisfaction estimated by using the entropy weight method. According to the statistical results, the information entropy of E11, E12, E13, E14, E15 and E16 are 0.9935, 0.9938, 0.9936, 0.9933, 0.9927 and 0.9938 respectively. The corresponding information utility is 0.0065, 0.0062, 0.0064, 0.0067, 0.0073 and 0.0062, respectively. Generally speaking, the greater the entropy, the worse the effectiveness of the data, and the lower the utility value. In terms of weight, the weights of E11, E12, E13, E14, E15 and E16 are 16.55%, 15.72%, 16.24%, 17.08%, 18.61% and 15.79% respectively. The weight of „E12: online foreign language teaching’s sense of acquisition for improving ability” is the lowest, and the weight of „E15: online foreign language teaching’s satisfaction with professional cognition” is the highest, which shows that the ability improvement is difficult to measure in the short term, so the weight is low, and the teaching object has a stronger practical demand for professional cognition.

Since there is no benchmark for online satisfaction evaluation at home and abroad, according to relevant practices at home and abroad, the satisfaction evaluation results are considered to be divided into five levels: the standardized score range of [0.9-1.0] is rated as level 1; the score range of [0.8-0.9] is rated as level 2; the score range of [0.7-0.8] is rated as level 3; the score range

Table 2. Descriptive statistics of satisfaction evaluation indicators.

| Term  | Sample size | Average value | Standard deviation |
|---|-------------|---------------|--------------------|
| E11: increasing the sense of knowledge acquisition in online foreign language teaching      | 381         | 3.52          | 0.835              |
| E12: the acquisition of online foreign language teaching for improving ability              | 381         | 3.47          | 0.81               |
| E13: the acquisition of interest in online foreign language teaching                        | 381         | 3.5           | 0.835              |
| E14: satisfaction of online foreign language teaching with the practicality of the platform | 381         | 3.52          | 0.847              |
| E15: satisfaction of online foreign language teaching with professional cognition           | 381         | 3.55          | 0.88               |
| E16: satisfaction of online foreign language teaching on career development                 | 381         | 3.55          | 0.833              |

Table 3. index weight results based on entropy method.

| Term  | Information entropy e | Information utility value D | Weight coefficient w |
|---|-----------------------|-----------------------------|----------------------|
| E11: increasing the sense of knowledge acquisition in online foreign language teaching      | 0.9935                | 0.0065                      | 16.55%               |
| E12: the acquisition of online foreign language teaching for improving ability              | 0.9938                | 0.0062                      | 15.72%               |
| E13: the acquisition of interest in online foreign language teaching                        | 0.9936                | 0.0064                      | 16.24%               |
| E14: satisfaction of online foreign language teaching with the practicality of the platform | 0.9933                | 0.0067                      | 17.08%               |
| E15: satisfaction of online foreign language teaching with professional cognition           | 0.9927                | 0.0073                      | 18.61%               |
| E16: satisfaction of online foreign language teaching on career development                 | 0.9938                | 0.0062                      | 15.79%               |

Table 4. Online teaching satisfaction evaluation grade based on entropy weight method.

| Evaluation grade | Five levels | Level IV  | Level III | second level | Level I   |
|------------------|-------------|-----------|-----------|--------------|-----------|
| Interval         | [0-0.6)     | [0.6-0.7) | [0.7-0.8) | [0.8-0.9)    | [0.9-1.0) |

of [0.6-0.7) is rated as level 4, and the score range of [0-0.6) is rated as level 5. The higher the level, the lower the effect. See Table 4 for specific evaluation criteria.

The subjective evaluation method and entropy weight method are respectively used to obtain the satisfaction evaluation results of online foreign language teaching. See Fig. 2 for details. From the results, there are obvious differences between the two methods. Through the subjective evaluation method, the average scores of freshmen and sophomores were 0.911 and 0.901, respectively; according to the entropy weight comprehensive index method, the scores of freshmen and sophomores were 0.886 and 0.904 respectively, showing differences between the two methods. Using the subjective evaluation method, the scores of junior and senior students were 0.865 and 0.920 respectively; according to the entropy weight comprehensive index method, the scores of junior and senior students were 0.952 and 0.951 respectively, showing the same significant difference. The reason for the above results

may be that the subjective evaluation method mainly relies on the subjective feelings of the evaluation object, which is prone to obvious individual bias and error. The entropy weight comprehensive index method estimates the satisfaction of the evaluation object to the online course through multiple indicators and levels. At the same time, the index weight is obtained through objective weighting, and finally the comprehensive index is obtained. Therefore, the entropy weight comprehensive index method is more convincing in terms of the effectiveness of the evaluation.

### Multiple Linear Regression Analysis of Online Foreign Language Teaching Satisfaction

In order to further explore the relationship between online foreign language teaching satisfaction and its influencing factors, this paper constructs a multiple linear regression model with entropy weight satisfaction as the dependent variable and teaching input, teaching

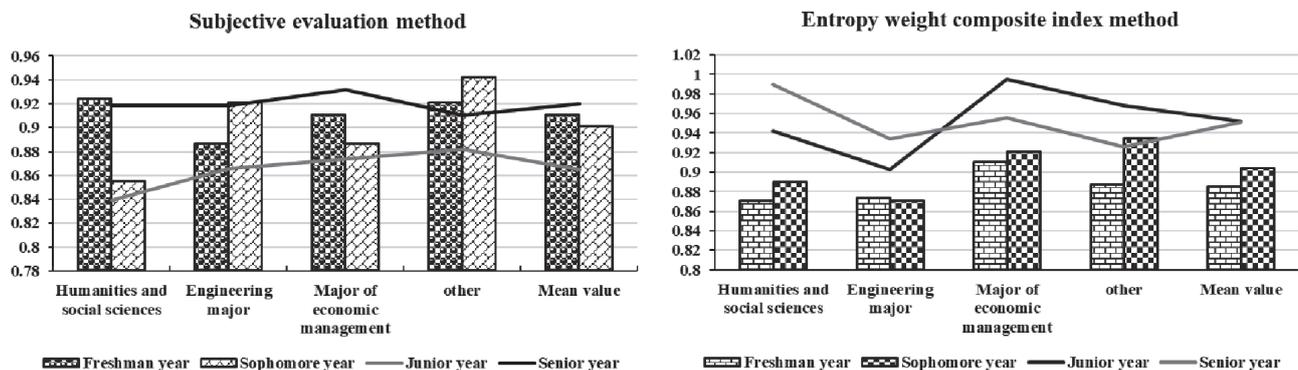


Fig. 2. Comparison of satisfaction evaluation results of different methods.

communication, teaching skills, teaching effect and other dimensions as independent variables. Because the multiple linear regression model can accurately explain the linear relationship between independent variables and dependent variables, it has the advantage of easy operation. Since there are many specific indicators affecting teaching satisfaction constructed in this paper, taking all indicators as independent variables will lead to the problem of poor fitting effect of the model. Therefore, this paper selects some typical indicators as independent variables, and uses SPSS20.0 statistical software to calculate the results, as shown in Table 8.

As shown in Table 5, eight indicators such as “I have a strong motivation to learn online English Courses”, “I can use the online English learning system without much help”, “the learning support provided by the online foreign language platform will affect my learning satisfaction” were selected as independent variables, and the entropy weight satisfaction score was used as independent variables for regression analysis. The adjusted goodness of fit of the model was 0.652, D-W value was 2.042, F test value was 89.859, P value was 0.000, which showed that the model had good explanatory power. In addition, the maximum VIF value of all independent variables is 4.066, and the minimum is 1.565, which are less than 10, indicating that there is

no multicollinearity between independent variables, and the multiple linear regression model is suitable.

According to the regression results, “I have a strong motivation to learn online English Courses” and “the timely update of online foreign language platform resources will affect my learning satisfaction” as independent variables have a significant negative impact on the dependent variables, and the standardization coefficients are -0.018 and -0.042 respectively, which are significant at the level of 1%. This shows that the teaching objects’ motivation for online foreign language teaching is not strong, and the timeliness of platform resource update directly affects teaching satisfaction. “The learning support provided by the online foreign language platform will affect my learning satisfaction”, “I am satisfied with the learning results of online foreign language teaching”, “online foreign language teaching can meet my learning needs” as independent variables have significant positive effects on the dependent variables, and the regression coefficients are 0.048, 0.402, 0.237, which all pass the significance test of 1%. This shows that the platform support, learning effect and learning needs directly affect teaching satisfaction. Fig. 3 shows the relationship between independent and dependent variables.

Table 5. Linear regression analysis results of online foreign language teaching satisfaction (n = 381).

|  | Denormalization coefficient |                | Standardization coefficient | T      | P       | Vif   |
|--|-----------------------------|----------------|-----------------------------|--------|---------|-------|
|  | B                           | Standard error | Beta                        |        |         |       |
| Constant   | 0.201                       | 0.146          | -                           | 1.374  | 0.17    | -     |
| I have a strong motivation to learn online English courses   | -0.018                      | 0.04           | -0.018                      | -0.437 | 0.662   | 1.807 |
| Without much help, I can use the online English learning system smoothly                                   | 0.116                       | 0.037          | 0.119                       | 3.142  | 0.002** | 1.565 |
| The learning support provided by the online foreign language platform will affect my learning satisfaction | 0.051                       | 0.056          | 0.048                       | 2.915  | 0.003** | 2.962 |
| Timely update of online foreign language platform resources will affect my learning satisfaction           | -0.043                      | 0.054          | -0.042                      | 2.998  | 0.000** | 3.074 |
| Online foreign language teaching can increase the opportunities of communication between me and teachers   | 0.119                       | 0.05           | 0.118                       | 2.377  | 0.018*  | 2.697 |
| The online foreign language teaching environment is a very good communication medium                       | 0.073                       | 0.053          | 0.07                        | 1.378  | 0.039*  | 2.817 |
| I am satisfied with the learning results of online foreign language teaching                               | 0.419                       | 0.064          | 0.402                       | 6.585  | 0.000** | 4.066 |
| Online foreign language teaching can meet my learning needs  | 0.236                       | 0.056          | 0.237                       | 4.176  | 0.000** | 3.528 |
| R <sup>2</sup>   | 0.659                       |                |                             |        |         |       |
| Adjust R 2   | 0.652                       |                |                             |        |         |       |
| F  | F(8372) = 89.859, p = 0.000 |                |                             |        |         |       |
| D-W value  | 2.042                       |                |                             |        |         |       |

Dependent variable: online teaching satisfaction evaluation score based on entropy weight method  
 \* p<0.05 \*\* p<0.01

### Confirmatory Factor Analysis of Online Foreign Language Teaching Satisfaction

According to the previous theoretical analysis, a confirmatory factor analysis model is constructed based on the indicators of four dimensions that affect the satisfaction of online foreign language teaching. Load factor is an index reflecting the weight relationship and importance of different variables, which can accurately reflect the influence of different factors. Using SPSSAU platform, we can calculate the standardized load coefficient that affects the satisfaction of online foreign language teaching and learning, as shown in Table 6.

According to the statistical results, the load factor of all potential variables and explicit variables is greater than 0.71, the maximum value is 0.929, and the minimum value is 0.710. From the perspective of the effectiveness of the estimation, most of the P values are 0.000, which is significant at the level of 1%, indicating that the estimation effect is good, and there is a good

measurement relationship between the latent variable and the apparent variable.

Factor covariance further reflects the relationship between factors. First, the data is standardized and the standard estimation coefficient is used to reflect the relationship between factors. As shown in Table 7, the standard estimated coefficients of all factors are greater than 0.000, and the P values are all 0.000. Therefore, it can be considered that there is a significant relationship between all factors, and this relationship is positive.

Finally, the structural relationship among teaching input, teaching communication, teaching skills, teaching effect and teaching satisfaction is drawn. As shown in Fig. 3, the coefficient of effect of teaching skills on teaching satisfaction is 0.326, the coefficient of effect of teaching investment on teaching effect is 0.786, the coefficient of effect of teaching communication on teaching satisfaction is 0.892, and the coefficient of effect of teaching satisfaction on teaching effect is 0.930, showing a positive relationship. At the same time,

Table 6. Factor load factor.

| Factor (latent variable) | Measurement item (explicit variable)  | Nonstandard load factor (coef.) | STD. error | Z (CR value) | P     | STD. estimate |
|--------------------------|---|---------------------------------|------------|--------------|-------|---------------|
| Teaching investment      | I quickly accepted and adapted to the online foreign language teaching model                                  | 1.000                           | -          | -            | -     | 0.757         |
| Teaching investment      | I have a strong motivation for learning English courses in online universities                                | 0.975                           | 0.075      | 12.944       | 0.000 | 0.710         |
| Teaching investment      | I can use the online foreign language learning system without much help                                       | 1.016                           | 0.076      | 13.342       | 0.000 | 0.733         |
| Teaching exchange        | Online foreign language teaching has increased the opportunities for me to communicate with teachers          | 1.000                           | -          | -            | -     | 0.850         |
| Teaching exchange        | Using online foreign language teaching can deepen my understanding of classroom content                       | 0.957                           | 0.045      | 21.312       | 0.000 | 0.867         |
| Teaching exchange        | Online foreign language teaching can increase the opportunities of communication between me and my classmates | 0.997                           | 0.051      | 19.574       | 0.000 | 0.821         |
| Teaching skills          | Online foreign language teaching and learning support will affect my satisfaction                             | 1.000                           | -          | -            | -     | 0.843         |
| Teaching skills          | The real-time nature of the online foreign language teaching platform will affect my satisfaction             | 0.913                           | 0.060      | 15.25        | 0.000 | 0.73          |
| Teaching skills          | The presentation of online foreign language teaching platform resources will affect my satisfaction           | 1.079                           | 0.060      | 17.949       | 0.000 | 0.867         |
| Teaching effectiveness   | Under the online foreign language teaching mode, the learning atmosphere is very good                         | 1.000                           | -          | -            | -     | 0.804         |
| Teaching effectiveness   | Online foreign language teaching mode can meet my learning needs  | 1.154                           | 0.056      | 20.757       | 0.000 | 0.875         |
| Teaching effectiveness   | I am satisfied with the learning efficiency of online foreign language teaching                               | 1.177                           | 0.052      | 22.701       | 0.000 | 0.926         |
| Learning satisfaction    | How satisfied are you with the online foreign language teaching mode  | 1.000                           | -          | -            | -     | 0.851         |
| Learning satisfaction    | I am willing to participate more in online foreign language teaching in the future                            | 1.016                           | 0.047      | 21.856       | 0.000 | 0.850         |
| Learning satisfaction    | I am satisfied with the learning results of online foreign language teaching                                  | 1.047                           | 0.04       | 25.947       | 0.000 | 0.929         |

Table 7. Factor covariance.

| Factor                 | Factor                 | Nonstandard estimation coefficient (coef.) | STD. error | Z      | P     | STD. estimate |
|------------------------|------------------------|--|------------|--------|-------|---------------|
| Teaching investment    | Teaching exchange      | 0.387                                      | 0.041      | 9.513  | 0.000 | 0.794         |
| Teaching investment    | Teaching skills        | 0.259                                      | 0.034      | 7.606  | 0.000 | 0.568         |
| Teaching investment    | Teaching effectiveness | 0.346                                      | 0.037      | 9.354  | 0.000 | 0.786         |
| Teaching investment    | Teaching satisfaction  | 0.397                                      | 0.041      | 9.692  | 0.000 | 0.809         |
| Teaching exchange      | Teaching skills        | 0.278                                      | 0.036      | 7.808  | 0.000 | 0.534         |
| Teaching exchange      | Teaching effectiveness | 0.454                                      | 0.042      | 10.76  | 0.000 | 0.899         |
| Teaching exchange      | Teaching satisfaction  | 0.502                                      | 0.046      | 11.004 | 0.000 | 0.892         |
| Teaching skills        | Teaching effectiveness | 0.27                                       | 0.033      | 8.193  | 0.000 | 0.574         |
| Teaching skills        | Teaching satisfaction  | 0.283                                      | 0.036      | 7.958  | 0.000 | 0.538         |
| Teaching effectiveness | Teaching satisfaction  | 0.513                                      | 0.045      | 11.374 | 0.000 | 1.008         |

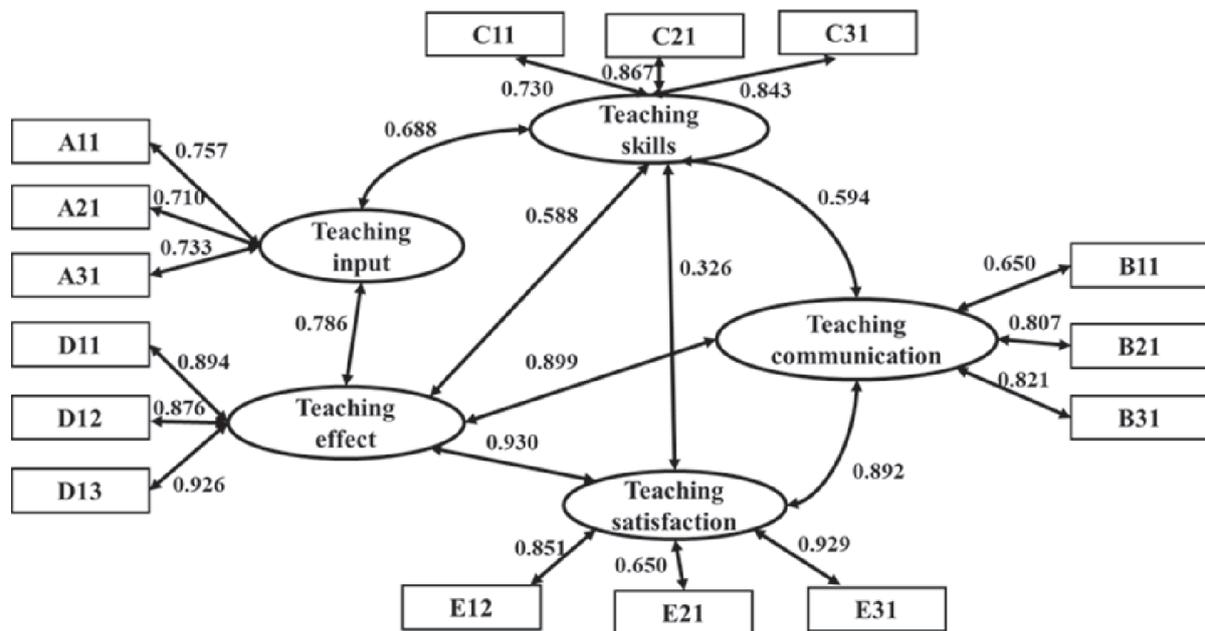


Fig. 3. Confirmatory factor analysis diagram.

Table 8. MI values among measurement items.

| Measurement item 1   | Relationship | Measurement item 2  | MI value | Par Change |
|--|--------------|---|----------|------------|
| I'm very motivated by online foreign language courses                              | ↔            | I quickly adapted to online foreign language teaching                           | 17.174   | -0.117     |
| I can use the online foreign language learning platform smoothly                   | ↔            | I quickly adapted to online foreign language teaching                           | 13.187   | 0.14       |
| I would like to participate more in online foreign language teaching in the future | ↔            | I quickly adapted to online foreign language teaching                           | 16.557   | 0.067      |
| I am satisfied with the results of online foreign language teaching                | ↔            | I am satisfied with the learning efficiency of online foreign language teaching | 13.962   | 0.032      |
| I would like to participate more in online foreign language teaching in the future | ↔            | How satisfied are you with the online foreign language learning model           | 13.662   | 0.076      |

Note: MI in the table is greater than 10

teaching investment, teaching communication, teaching skills, teaching effect and teaching satisfaction are also affected by multiple factors. For example, teaching input is affected by three factors, A11, A21 and A31, with coefficients of 0.757, 0.710 and 0.733 respectively, and the effect is positive.

#### A Discussion on Health Test of Online Foreign Language Teaching Satisfaction Based on Confirmatory Factor Analysis

In order to test the effect of confirmatory factor analysis above, MI index between latent variable and explicit variable was used to measure. Generally speaking, if the value of MI is greater than 20, the correlation between the two variables needs to be considered, and the measurement item needs to be removed and verified again. Based on this, MI values of all explicit variables are obtained, as shown in Table 8. It can be seen from Table 8 that MI values among all variables are greater than 10 and less than 20. Therefore, it can be considered that there is no significant correlation between the factors of the model established above and it can be used for confirmatory factor analysis without adjustment of indicators. Therefore, it can be considered that the confirmatory factor analysis model in this paper is good.

### Conclusions

Based on the new background of green technology, this paper focuses on the evaluation of online foreign language teaching satisfaction and the key influencing factors. By using the entropy weight method to construct the satisfaction index of online foreign language teaching, scientifically measure the satisfaction level, and comprehensively apply the multiple linear regression model and confirmatory factor analysis model to systematically analyze the main factors affecting satisfaction. Through the survey of 500 students in a university in Tianjin, 381 valid questionnaires were obtained. The following conclusions were obtained through empirical analysis and test:

(1) College students' satisfaction with online foreign language teaching is quite high, and the satisfaction index based on entropy weight method is above level 2. The satisfaction scores of freshmen, sophomores, juniors and seniors were 0.886, 0.904, 0.952 and 0.951, respectively. Compared with the subjective evaluation method, the entropy weight comprehensive index method estimates the satisfaction of the evaluation object to the online course through multiple indicators and multiple levels. At the same time, the index weight is obtained through the objective weighting method. Finally, the comprehensive index is obtained, which improves the persuasiveness of the evaluation results.

(2) The four dimensions-teaching investment, teaching communication, teaching skills and teaching effect-have a significant impact on online foreign language teaching satisfaction. By constructing a multiple linear regression model, the adjusted goodness of fit of the model was 0.652, D-W value was 2.042, F test value was 89.859, P value was 0.000, which showed that the model had good explanatory power. In addition, the maximum and minimum VIF values of all independent variables are 4.066 and 1.565, which are less than 10, indicating that there is no auto-correlation of variables. Further, according to the regression results, the coefficients of all independent variables passed the significance test at the 5% level.

(3) Online foreign language teaching satisfaction is affected by multiple latent and explicit variables, and the overall direction is positive. By constructing the confirmatory factor analysis model, the load factor of all potential variables and explicit variables is greater than 0.71, the maximum value is 0.929, and the minimum value is 0.710. From the perspective of the effectiveness of the estimation, most of the P values are 0.000, which is significant at the level of 1%, indicating that the estimation effect is good, and there is a good measurement relationship between the latent variable and the apparent variable. According to the structural relationship model, the coefficient of effect of teaching skills on teaching satisfaction is 0.326, the coefficient of effect of teaching investment on teaching effect is 0.786, the coefficient of effect of teaching communication on teaching satisfaction is 0.892, and the coefficient of effect of teaching satisfaction on teaching effect is 0.930, showing a positive relationship.

Finally, in order to further improve the teaching quality of foreign language courses such as American Literature, College English, Integrated English, and History of English Literature, to improve students' understanding of foreign literature, to deepen national cultural identity and to improve English learning ability, according to the conclusions of the above empirical research, some strategies are put forward to improve the satisfaction of online foreign language teaching from the following aspects:

- (1) To increase teaching investment and continuously improve the quality of teaching content;
- (2) To enhance the interaction between teachers and students to meet the practical needs of students' question answering and doubt solving;
- (3) To improve teaching skills, and teachers and students cooperate to master online platform skills.
- (4) To pay attention to teaching effect and form a goal oriented curriculum system.

Of course, there are some limitations in this study. For example, the research sample can be further expanded, which becomes the direction of the follow-up research of this paper.

## Acknowledgments

This research was funded by National Social Science Foundation project, named a study on the spatial writing of Chinese American literature and the construction of national identity (19CWW019).

## Conflict of Interest

The authors declare no conflict of interest.

## References

1. WANG F.Z., LIU X.L., ZHANG L. Does digitalization promote green technology innovation in resource-based enterprises? *Scientific research*. 332, **2022**.
2. DUFFY M.C. Constructivism: implications for the design and delivery of instruction, *Handbook of research for Educational Communications & Technology*, **1996**.
3. HE K.H. New Constructivism Theory – critical absorption and innovative development of Western constructivism by Chinese scholars , *China Education Science*. 14, **2021**.
4. SPIRO R.J., FRLTOVICH P.J., JACOBSON M.J. Cognitive flexibility, constructivism, and hypertext. PP.random access instruction for advanced knowledge acquisition in ill structured domains, *Educational technology*, **1992**.
5. JONASSEN D., DAVIDSON M., COLLINS M. Constructivism and computer mediated communication in distance education, *American Journal of distance education*. PP. 9 (2), **1995**.
6. WILSON B.G. Metaphones for instruction: why we talk about learning environments, *Educational technology*. 25, **1995**.
7. GARCIA L.L.The new Constructivism in international relations theory, *International affairs*. 5, **2022**.
8. MOHAJAN D., MOHAJAN H. Constructive grounded theory: new research approach in social science, *MPR paper*, **2022**.
9. TROFIMOVA I. Analytical background in the neuroscience of the potential project “Hippocrates”, *Brain sciences*. 5, **2022**.
10. DOUGLAS K.A., JOHNSTON A.C., MARTIN J.P. How engineering engineers supported students during emergency remote instruction. case comparison, *Computer applications in engineering education*. 30, **2022**.
11. KAMTHAN P. The experience of tests during the covid-19 pandemically induced emergency remote teaching, *International Journal of software engineering and knowledge engineering*. 32, **2022**.
12. KOTHEP P. Reconceptualizing marketing. PP.an interview with Philip kotler, *European Management Journal*. 353, **1994**.
13. PARASURAMAN A., ZEITHAML V.A., BERRY I.L. A conceptual model of service quality and its implications for future research, *Journal of marketing*. PP.49 (4), **1985**.
14. PARASURAMAN A.V., ZEITHAML V.A., BERRY L.L. Servqual a multiple item scale for measuring consumer perceptions of service quality, *Journal of retailing*. 64, **1988**.
15. Taylor s a Measuring service quality: reexamination and extension, *Journal of marketing research*. 55, **1992**.
16. YAN Z.H., LI Q., LIU L. Measurement and improvement of customer satisfaction based on two factor theory, *Computer integrated manufacturing system*. 3365, **2021**.
17. LUAN B., ZHANG W.D. Research on user satisfaction of mobile audio reading platform based on perception theory, *Library science research*. 81, **2020**.
18. KIM J., KENT M., KRAL K. Seemo: a new tool for early design window view satisfaction evaluation in residential buildings, *Building and environment*, 108909, **2022**.
19. COELHO C., PEDROSA F.R., ZINA L. Evaluation of satisfaction of adults treated by dental students, *Pesquisa Brasileira EM odontopediatria e Cl í Nica integrada*, **21 (3), 2021**.
20. FARRA S.L., HODGSON E. Evaluation of two simulation methods for teaching a disaster skill, *BMJ simulation and technology enhanced learning*. 92, **2021**.
21. OH Y., HENNESSEY A., YOUNG L. Evaluation of patient satisfaction for telehealth (telephone and video) in meteorology outpatients during Covid-19 pandemic, *Internal medicine journal*. 559, **2022**.
22. LIU X., QIN B., WU Y. Study on rural residents’ satisfaction with the clean energy heating program in northern China - a case study of Shandong province, *Sustainability*. 13, **2021**.
23. WANG W.H. Construction of satisfaction evaluation index system for targeted poverty alleviation based on AHP theory, *Statistics and decision making*. 60, **2020**.
24. SONG Y., CAI F.F., ZHANG C. Research on the satisfaction of farmers’ participation in agricultural products e-commerce under the background of Rural Revitalization Strategy – Based on the dual perspective of purpose and process, *Chongqing Social Sciences*. 104, **2021**.
25. ZHAO Y.Q., RUAN P.N., LIU X.Y. Research on user satisfaction evaluation based on online reviews, *Management review*. 179, **2020**.
26. MA H.Q., LIU Y.X., YAN M.Q. Research on tourist satisfaction of tourism public service based on SEM and IPA model , *Resources and environment in arid areas*. 192, **2021**.
27. ZHONG F.Q. Research on the path and system construction of smart foreign language teaching reform, *Foreign language audio visual teaching*. 85, **2021**.
28. ZHANG J., ZHAO K. Research on learners’ experience in online oral English task , *Foreign languages and foreign language teaching*. 68, **2021**.
29. LIU X.H., GUO J.D. The relationship between teacher support and students’ interactive engagement and learning pleasure in foreign language online teaching , *Journal of the PLA Foreign Languages Institute*. 34, **2021**.
30. ZHU L., XU Y., HAN J. L. Research on the path of deep integration of foreign language teaching and information technology – Academic English teaching reform and practice , *Foreign language circles*. 46, **2021**.
31. ZAHO Y. Research on the application ability of information technology and online teaching satisfaction of foreign language majors in Colleges and universities, *Modern distance education* **02, 45, 2021**.
32. FENG R.L., SHI X.H. Exploration of internationalization of foreign language education based on Transnational Online Collaborative Teaching Learning Research Mode, *Foreign language circles*. 34, **2022**.
33. HUI L.H., WANG B.R. Research on the impact of College Students’ digital Aboriginal characteristics on online English learning engagement, *Foreign language circles*. 83 **2022**.

34. CHA J.P., ZHOU X., ZHOU Y.X. Comprehensive evaluation and analysis of agricultural green development level in the Yellow River Basin, *Agricultural resources and Regionalization in China*. 18, **2022**.
35. TANG C.Y., FENG Z.X. Research on the construction of enterprise credit default rate measurement model based on multiple linear regression, *Economic science*. 100, **2005**.
36. LI X.S., WANG S.L. Parameter estimation of multivariate linear regression model with linear constraints , *Statistical research*. 85, **2016**.
37. REN J., KONG R. Research on Farmers' income quality based on confirmatory factor analysis, *Journal of Chongqing University (SOCIAL SCIENCE EDITION)*. 54, **2016**.
38. PICCOLI G., IVES A.B. Web based environmental learning environments: research framework and a preliminary assessment of effectiveness in basic IT skills training, *MIS quarterly*. 401, **2001**.
39. ALAVI M., LEIDER D.E. Research comment: technology mediated learning - a call for greater depth and breadth of research, *Information systems research*. 1, **2001**.
40. SHEN Z.H., WU D.G. Research on Influencing Factors of online learning effectiveness and satisfaction of College Students – An Empirical Analysis Based on structural equation model, *Research on education development*. 25, **2020**.