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# Evaluation method of service quality of college students' innovation and entrepreneurship education based on AHP-DEA method

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**Abstract:** In order to overcome the problems of time-consuming and low accuracy of quality evaluation methods, this paper proposes a service quality evaluation method of college students' innovation and entrepreneurship education based on Analytic Hierarchy Process-Data Envelopment Analysis (AHP-DEA). Firstly, the evaluation system of education service quality is constructed, and the service quality evaluation data is collected by using multi-thread new application programming interface (NAPI). Secondly, meaningless evaluation data is removed by time constraint. Then, the judgement matrix is constructed, the quality evaluation function is constructed with data envelopment analysis (DEA) method, the total ranking weight is calculated, and the evaluation value is solved by linear weighting method to realise the service quality evaluation. Experimental results show that the average time of this method is 52.8 ms, the weight calculation error rate is 2.2%, the average evaluation accuracy rate is 96.4%, and the practical application effect is good.

**Keywords:** AHP-DEA; college students; innovation and entrepreneurship education; service quality evaluation; multi-threaded NAPI.

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**Biographical notes:** Qingqin Chen is now an Associate Professor of the School of Art and Design of Jiangxi University of Science and Technology. He graduated from Nanchang Aviation University with a Master's degree in computer technology in 2017. His research direction is ideological and political education.

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## 1 Introduction

As the main places for innovation and entrepreneurship education, colleges and universities have continuously increased their emphasis on innovation and entrepreneurship with the support of the state. By opening relevant innovation and entrepreneurship courses, they instill relevant knowledge of innovation and

entrepreneurship to students, so that more college students can invest in the wave of innovation and entrepreneurship. Solve the problem of difficult employment of college students at this stage, and promote the improvement of the level of social and economic development (Li, 2021). The service quality of innovation and entrepreneurship education for college students will have an important impact on the future employment of students. Therefore, it is necessary to evaluate the service quality of innovation and entrepreneurship education (Yz and Hz, 2022). According to the evaluation results, find out the deficiencies in the process of innovation and entrepreneurship education for college students. In order to optimise the innovation and entrepreneurship education program in colleges and universities, it is of great significance to study the service quality evaluation method of college students' innovation and entrepreneurship education.

Aiming at the important research topic of service quality evaluation of college students' innovation and entrepreneurship education (Xu, 2020) proposes a method for evaluating service quality of college students' innovation and entrepreneurship education based on fuzzy mathematics. Through expert interviews and questionnaires and other methods to obtain evaluation index data, and through multiple rounds of expert evaluation to screen indicators, in order to build a service quality evaluation system for college students' innovation and entrepreneurship education, the system consists of 4 first-level indicators and 25 second-level indicators. Based on the construction of high-level indicators, combined with the questionnaire survey results, the membership degree of college students' innovation and entrepreneurship education service quality evaluation was obtained, and the index weights were calculated. However, in practice, it is found that this method has the problem that the data collection of the evaluation index data of innovation and entrepreneurship education service quality of college students takes a long time. Tian (2022) proposes a service quality evaluation method based on system control theory for college students' innovation and entrepreneurship education. Use the web crawler technology to collect the evaluation index data of college students' innovation and entrepreneurship education service quality, establish the relevant evaluation index system, optimise the evaluation system by using the system control theory, and construct the BP neural network model combined with the calculation results of the index weight. However, this method has the problem of a high error rate in the calculation of the weight of the evaluation index of the service quality of innovation and entrepreneurship education for college students. Li (2020) proposes a service quality evaluation method for college students' innovation and entrepreneurship education based on entropy weight matter-element extension theory. Collect the evaluation index data of college students' innovation and entrepreneurship education service quality, build a related evaluation index system, use the entropy weight method to weight the evaluation index, and obtain the calculation result of the evaluation index weight. The evaluation model was constructed by using matter-element extension theory to evaluate the service quality of innovation and entrepreneurship education for college students.

To solve the problems of low evaluation accuracy and high weight calculation error rate in the above methods, this paper designs an AHP-DEA based service quality evaluation method for innovation and entrepreneurship education of college students. The overall scheme of this method is as follows:

- 1 Evaluation system construction and evaluation data collection. Build an education service quality evaluation system, and use multi-threaded NAPI to collect service quality evaluation data.

- 2 Filtering and processing of educational service quality evaluation data. The meaningless evaluation data is removed through time constraints, and the quality evaluation data processing is completed.
- 3 Evaluation of service quality of innovation and entrepreneurship education for college students. Construct a judgement matrix for entrepreneurship education service quality evaluation, combine DEA method to construct an educational service quality evaluation function, calculate and sort the total ranking weight of elements at each level, and use the linear weighting method to solve the value of service quality evaluation, so as to realise the service quality of college students' innovation and entrepreneurship education.
- 4 The time-consuming evaluation index data collection, the evaluation index weight calculation accuracy and the evaluation accuracy are used as experimental indicators to verify the practical application effect of the method.

## **2 Innovation and entrepreneurship education service quality evaluation data processing**

### *2.1 Constructing the service quality evaluation system of innovation and entrepreneurship education in colleges and universities*

One of the keys to improve the evaluation accuracy of innovation and entrepreneurship education service quality in colleges and universities is to take scientific evaluation as the basis, and the evaluation system, as the evaluation standard and scale, must reflect the evaluated object scientifically, reasonably, objectively and comprehensively as far as possible (Hong, 2021; Yao et al., 2022). The basic principles for building a service quality evaluation system are as follows:

- 1 *Systematic principle*. The basis system should be able to comprehensively reflect the comprehensive situation of the construction project, and find out the indicators of the main aspects, which can reflect both the direct effect and the indirect effect, so as to ensure the comprehensiveness and credibility of the comprehensive evaluation.
- 2 *Principle of measurability of indicators*. The meaning of indicators is clear, and the data required for calculating indicators are easy to collect, calculate and master.
- 3 *The principle of correlation between indicators and objectives*. Objectives are the requirements that the project is expected to achieve at the macro or high level, and indicators are often measurable or perceptible results at the operational level. Only the realisation of multiple indicators can achieve the overall objective of the project. Therefore, the indicators and objectives must have some degree of correlation, and the realisation of indicators must make substantial contributions to the realisation of the objectives.
- 4 *The principle of combining quantitative indicators with qualitative indicators*. With quantitative index calculation, the evaluation can be objective and easy to use mathematical methods; Combined with qualitative indicators, it can make up for the shortcomings of simple quantitative indicators to avoid bias.

- 5 *The principle of combining absolute indicators with relative indicators.* Absolute indicators reflect the total amount and scale, while relative indicators reflect the intensity or density of some aspects.

In this paper, under the guidance of the above principles (Cui, 2020; Hou, 2020), the evaluation index system of service quality of innovation and entrepreneurship education in colleges and universities is constructed by screening index data, as shown in Table 1.

**Table 1** Evaluation index system

| <i>First-level indicator</i> | <i>Secondary indicators</i>   |
|------------------------------|---|
| Curriculum 15                | Core Course Offering Rate 5<br>Interdisciplinary course offering rate 2<br>Hours of practical courses 3<br>The degree of penetration of innovation and entrepreneurship knowledge into existing courses 5   |
| Teaching method 15           | Number of Entrepreneurs Visiting Speeches 5<br>Number of on-campus innovation and entrepreneurship competitions 3<br>Number of study and practice bases on and off campus 5<br>Number of entrepreneurs serving as part-time mentors 3   |
| Faculty 15                   | Proportion of teachers with innovation and entrepreneurship experience 3<br>Percentage of teachers with training experience 4<br>Proportion of teachers with senior professional titles 5<br>Teacher's Paper Citations 2<br>The conversion rate of teachers' scientific research achievements 1   |
| Educational environment 15   | Coverage rate of students receiving funding for innovation and entrepreneurship activities 2<br>The school's attitude towards innovation and entrepreneurship 5<br>Number of school-enterprise cooperation projects 1<br>Entrepreneurship center or similar institution promoting entrepreneurship education 3<br>Open ratio of incubator-as-a-package services to students 5 |
| Student engagement 10        | Student participation rate in innovation and entrepreneurship courses 6<br>Attendance in Innovation and Entrepreneurship Courses 2<br>The percentage of students who participated in social surveys 1<br>The number of students received by the internship base 1<br>Student Participation Rate of Innovation and Entrepreneurship Practice Courses 1                         |

**Table 1** Evaluation index system (continued)

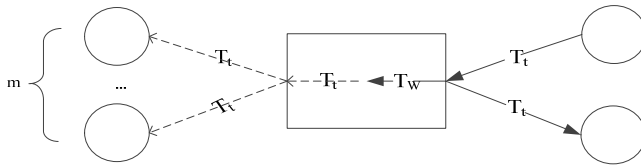
| <i>First-level indicator</i>               | <i>Secondary indicators</i>  |
|--|--|
| Career choice 15                           | Proportion of students who choose innovation and entrepreneurship as a career choice 8<br>Number of student innovation and entrepreneurial entities 5<br>Innovation and Entrepreneurship Ratio of Middle School Students in Innovation and Entrepreneurship Park 2 |
| Innovation and Entrepreneurship Ability 15 | The number of innovation and entrepreneurship societies on campus 3<br>Growth rate of student innovation and entrepreneurship achievements 3<br>Number of winners of off-campus innovation and entrepreneurship competitions 9                                     |

According to the above evaluation system, the evaluation data of innovation and entrepreneurship education service quality in colleges and universities is collected.

*2.2 Data collection for service quality evaluation of innovation and entrepreneurship education in colleges and universities*

In this paper, we use multi-threaded NAPI to collect the service quality evaluation data of innovation and entrepreneurship education from 5 colleges and universities, including Huazhong University of Science and Technology, Zhejiang University, Harbin University of Technology, Beijing University of Posts and Telecommunications and Chongqing University, in order to improve the accuracy and efficiency of index data collection. In multi-threaded NAPI, the write and read process of buffer unit (Zhang et al., 2022; Han et al., 2020) is shown in Figure 1.

**Figure 1** Write and read process of a buffer unit



In Figure 1,  $m$  represents the number of producers of the indicator data for the service quality evaluation of innovation and entrepreneurship education for college students. The indicator data provided by the producer is transmitted to the buffer unit time, read time and transmission time are all represented by  $T_r$ , and the data storage time is represented by  $T_w$ . Indicates that the data readout time is denoted by  $T_r$ .

The calculation formula of the reading and writing time ratio of the service quality evaluation data of innovation and entrepreneurship education for college students in the buffer unit (Gao et al., 2020; Fahim et al., 2020) is as follows:

$$\Psi = \frac{T_c}{T_p} \tag{1}$$

In order to ensure the mutual exclusivity of buffer unit producer and consumer access, access constraints need to be set, as follows:

$$2T_i + T_w \leq T_i + T_r \tag{2}$$

Assuming that the consumer read time is represented by  $m(T_i + T_r)$  (Samak and Samak, 2020), the data read and write time ratio is calculated by the following formula:

$$\Psi_{old} = \frac{m(T_i + T_r)}{2T_i + T_w} \tag{3}$$

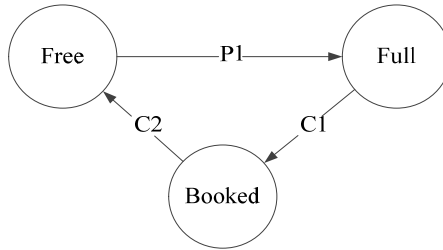
From the above formula, it can be known that  $\Psi_{old} \geq m$ .

In order to ensure the fluency of reading and writing data for college students' innovation and entrepreneurship education service quality evaluation, it is necessary to set when a buffer cannot be read at the same time, so as to optimise the data reading and writing time ratio. The specific calculation formula is as follows:

$$\Psi_{new} = \frac{T_r + T_i}{2T_i + T_w} \tag{4}$$

The finite state machine (Satriyo et al., 2021; Rosales and Paulitsch, 2021) is used to represent the unit state transition process under the buffer unit labelling algorithm, as shown in Figure 2:

**Figure 2** Unit state transition diagram



In Figure 2, Free, Full, and Booked indicate that the cell is empty, the cell is full, and the cell cannot be written or read. P1 represents the data writing process, C1 and C2 represent the data reservation and reading process respectively (Hong, 2021; Yao et al., 2022).

In order to improve the writing speed and reading speed of the evaluation data of innovation and entrepreneurship education service quality of college students, a new ring buffer needs to be set up, and the following formula is established:

$$V_{in} = \frac{dN_p}{dt} \tag{5}$$

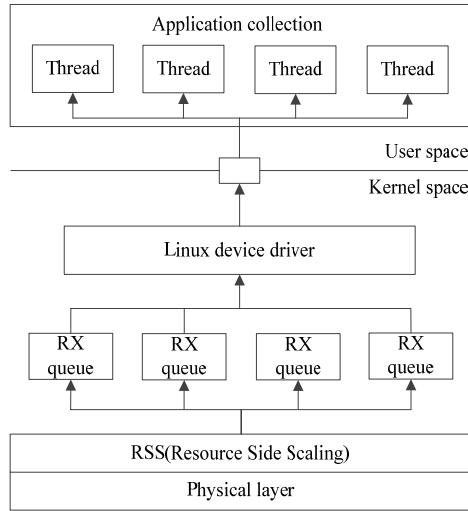
$$V_{out} = \frac{dN_c}{dt} \tag{6}$$

In the above formula,  $V_{in}$  and  $N_p$  respectively represent the speed of data writing into the ring buffer and the corresponding number of units, and  $V_{out}$  and  $N_c$  respectively represent the speed of data read out of the ring buffer and the corresponding number of units. At this time, the data of formulas (5) and (6) will be included in the data collection results of education service quality evaluation, and the data collection of innovation and entrepreneurship education service quality evaluation based on multi-threaded NAPI college students will be completed, and the next education services will be carried out according to the above results (Cui, 2020).

### 2.3 Educational service quality evaluation data filtering processing

The evaluation data collection structure of multi-threaded NAPI is analysed, and the collected data of college students' innovation and entrepreneurship education service quality are constrained, the meaningless college students' innovation and entrepreneurship education service quality evaluation data are effectively removed, and the data processing of education service quality evaluation data is completed (Hou, 2020). The evaluation data collection architecture based on multi-threaded NAPI is shown in Figure 3.

**Figure 3** Evaluation data collection architecture based on multi-threaded NAPI



Assuming that there is a time constraint  $(0, t]$  during the evaluation data collection process, at this time, it is necessary to write the recalculated data into the ring buffer unit number  $N_p$ , and the calculation formula is as follows:

$$N_p = \int_0^t V_p(\tau) d\tau, N_c = \int_0^t V_c(\tau) d\tau, \tag{7}$$

The calculation formula of the number of corresponding data reading ring buffer units  $N_c$  is updated as follows:

$$N_c = \sum_{i=1}^m N_{ci} \tag{8}$$

According to formulas (7) and (8), it can be concluded that:

$$N_c = \sum_{i=1}^m \int_0^t V_{ci}(\tau) d\tau = \int_0^t \sum_{i=1}^m V_{ci}(\tau) d\tau \tag{9}$$

At this time, by sorting out formulas (5) and formula (9), we can get:

$$\left\{ \begin{array}{l} V_{in} = \frac{d(\int_0^t V_{ci}(\tau) d\tau)}{dt} = V_p \\ V_{out} = \frac{d(\int_0^t \sum_{i=1}^m V_{ci}(\tau) d\tau)}{dt} = \sum_{i=1}^m V_{ci} \end{array} \right. \tag{10}$$

Then, the data that can evaluate the quality of educational services need to meet the following conditions:

$$\left\{ \begin{array}{l} N_p - N_c \geq 0 \\ N_p - N_c \leq tR \end{array} \right. \tag{11}$$

$$\left\{ \begin{array}{l} \int_0^t \left[ V_p(\tau) - \sum_{i=1}^m V_{ci}(\tau) \right] d\tau \geq \int_0^t 0 d\tau \\ \int_0^t \left[ V_p(\tau) - \sum_{i=1}^m V_{ci}(\tau) \right] d\tau \leq \int_0^t R d\tau \end{array} \right. \tag{12}$$

$$\left\{ \begin{array}{l} V_p(t) - \sum_{i=1}^m V_{ci}(t) \geq 0 \\ V_p(t) - \sum_{i=1}^m V_{ci}(t) \leq R \end{array} \right. \tag{13}$$

From formulas (11)–(13),  $0 \leq V_{in} - V_{out} \leq R$  can be obtained. According to the above constraints, the collected evaluation data are filtered to obtain the final evaluation data of innovation and entrepreneurship education service quality. According to the above data, the service quality evaluation of innovation and entrepreneurship education for college students is carried out.

### 3 Evaluation of service quality of college students' innovation and entrepreneurship education based on AHP-DEA

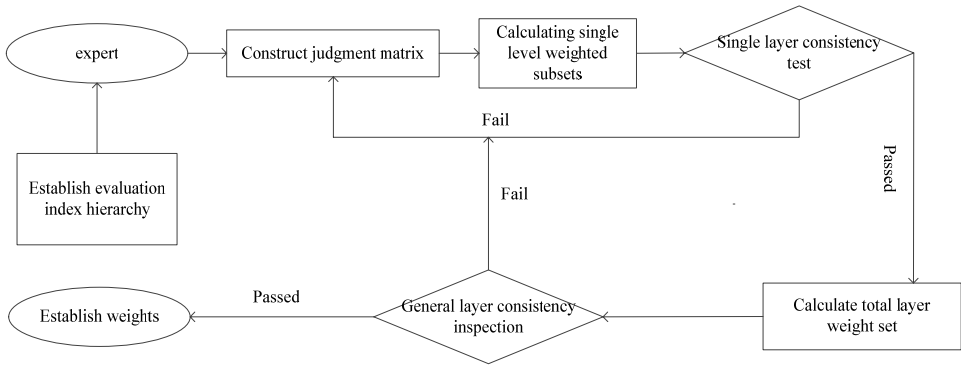
The analytic hierarchy process (AHP) is applied to the calculation of the weight of the evaluation index of college students' innovation and entrepreneurship education service quality.

First, establish the hierarchy of evaluation indicators; Secondly, the constructed judgement matrix is as follows:

$$AW = \begin{bmatrix} \frac{W_1}{W_1} & \frac{W_1}{W_2} & \dots & \frac{W_1}{W_n} \\ \frac{W_2}{W_1} & \frac{W_2}{W_2} & \dots & \frac{W_2}{W_n} \\ \vdots & \vdots & \dots & \vdots \\ \frac{W_n}{W_1} & \frac{W_n}{W_2} & \dots & \frac{W_n}{W_n} \end{bmatrix} \begin{bmatrix} W_1 \\ W_2 \\ \vdots \\ W_n \end{bmatrix} = \begin{bmatrix} nW_1 \\ nW_2 \\ \vdots \\ nW_n \end{bmatrix} = nW \quad (14)$$

Matrix  $AW$  is called positive and negative matrix, which satisfies  $C_{ij} > 0$ ,  $C_{ij} = 1/C_{ji}(i \neq j)$  and  $C_{ii} = 1(i, j = 1, 2, \dots, n)$ . Then, the hierarchical single ranking and consistency test are carried out. The evaluation process of education service quality based on analytic hierarchy process is shown in Figure 4.

**Figure 4** Calculation process of index weight based on AHP



The construction process of judgement matrix is:

Firstly, the judgement matrix and eigenvector are normalised, and the evaluation indicators of innovation and entrepreneurship education service quality of all college students are ranked in a hierarchical order.

Secondly, calculate the maximum characteristic root  $\lambda_{max}$  of the judgement matrix. The specific calculation is as formula (15).

$$\lambda_{max} = \sum_{i=1}^n \frac{(AW)_i}{nW_i} \quad (15)$$

Then, make consistency judgement. The judgement matrix judgement formula is as follows:

$$CI = \frac{\lambda_{max} - n}{n - 1} \quad (16)$$

When  $\lambda_{max} = n$  and  $CI = 0$ , the judgement matrix is completely consistent; When  $\lambda_{max}$  is slightly greater than  $n$ , it means that the judgement matrix has satisfactory consistency. The value of consistency index  $RI$  is shown in Table 2.

**Table 2** RI values

| Order | 1 | 2 | 3    | 4    | 5    | 6    | 7    | 8    | 9    |
|-------|---|---|------|------|------|------|------|------|------|
| RI    | 0 | 0 | 0.58 | 0.90 | 1.12 | 1.24 | 1.32 | 1.41 | 1.45 |

The ratio of CI to RI gives CR, and CR represents the random consistency ratio. When  $CR = \frac{CI}{RI} < 0.10$ , that is, through the consistency test, the judgement matrix is meaningful.

Finally, the ratio of 1 to 2 yields a random consistency ratio of 3,4. When  $1=5\pi$  passes the consistency test, and the judgement matrix is meaningful.

- 4 Total ranking and inspection of levels. Calculate the total ranking weight of each level of elements for each level, and rank them, so as to determine the importance of each element at the bottom for the overall goal. Finally, test it, so as to realise the weight calculation of the evaluation index of college students' innovation and entrepreneurship education service quality.

Data envelopment analysis (DEA) is an objective decision – making method based on relative efficiency. It is assumed that there are  $n$  decision units, which are composed of  $m$  input variables and  $S$  output variables. Assume  $X, Y_r$  are input and output vectors of dsu  $j$  respectively. Objective function of decision making unit is as follows:

$$\max V_p = \frac{u^T Y_r}{v^T X} \tag{17}$$

where  $u^T$  and  $v^T$  represent the input and output weights of the function respectively.

The constraint conditions of objective function of decision making unit are as follows:

$$\left\{ \begin{array}{l} s.t. \frac{u^T Y_R}{v^T X} \leq 1 \\ \frac{u^T Y_r}{v^T X} \leq 1 \\ u \geq 0, v \geq 0 \end{array} \right. \tag{18}$$

where  $u, v$  represents the weight of different evaluation indexes, whose purpose is to make the constraint established.

$$v = (v_1, v_2, \dots, v_m)^T \tag{19}$$

$$u = (u_1, u_2, \dots, u_s)^T \tag{20}$$

Suppose  $(\bar{u}, \bar{v})$  is the solution of equations (17) and (18), since  $Y_r \leq Y_R$ , and  $\frac{\bar{u}^T Y_r}{\bar{v}^T X} \leq 1$ . Get

$$\frac{\bar{u}^T}{\bar{v}^T} \leq \frac{X}{Y_R} \leq \frac{X}{Y_r} \tag{21}$$

$(\bar{u}, \bar{v})$  satisfies the following formula:

$$\frac{\bar{u}^T}{\bar{v}^T} \leq \frac{X}{Y_R} \tag{22}$$

The final target value can be calculated by the following formula:

$$h_k = \frac{\sum_{r=1}^q v_r y_{rk}}{\sum_{i=1}^p u_i x_{ik}} = \frac{\bar{u}^T Y_r X}{\bar{v}^T X Y_R} \cdot \frac{Y_r}{X} = \frac{Y_r}{Y_R}, k = 1, 2, \dots, n \tag{23}$$

Then the evaluation function of service quality of innovation and entrepreneurship education for college students is:

$$DMU_k = \begin{cases} \max \frac{\sum_{r=1}^q v_r y_{rk}}{\sum_{i=1}^p u_i x_{ik}} = h_k \\ \frac{\sum_{r=1}^q v_r y_{rj}}{\sum_{i=1}^p u_i x_{ij}} \leq 1, j = 1, 2, \dots, n \\ V = [v_1 v_2 \dots v_q]^T \geq 0 \\ U = [u_1 u_2 \dots u_p]^T \geq 0 \end{cases} \tag{24}$$

Use  $\theta_k$  to represent the efficiency evaluation index  $h_k$ , then the above formula expressed in matrix form is:

$$DMU_k = \begin{cases} \theta_k = \max \frac{V^T Y_k}{U^T X_k} \\ \frac{V^T Y_j}{U^T X_j} \leq 1, j = 1, 2, \dots, n \\ U \geq 0, V \geq 0 \end{cases} \tag{25}$$

In this paper, the linear weighting method is used to solve the value of the quality evaluation function, and the final evaluation result is:

$$Y = \alpha x + (1 - \alpha) DMU_k \tag{26}$$

where  $\alpha$  represents deviation coefficient, and  $x$  represents weight calculation result of evaluation index of innovation and entrepreneurship education service quality for college students.

At this point, the evaluation result obtained by formula (26) is the final evaluation result of the service quality of innovation and entrepreneurship education, thus completing the service quality evaluation of college students' innovation and entrepreneurship education based on AHP-DEA method.

## 4 Experimental

### 4.1 Experimental scheme

In order to further verify the practical application effect of evaluation method of service quality of college students' innovation and entrepreneurship education based on AHP-DEA method in this paper, relevant experimental tests are carried out. The overall test environment parameters are shown in Table 3.

#### 1 Test environmental parameters

The specific description of test environment parameter settings is shown in Table 3.

**Table 3** Test environment parameter settings

| <i>Project</i>             | <i>Specific parameters</i>   |
|----------------------------|------------------------------|
| Computer version and model | ASUS X550                    |
| Image net dataset version  | 3.0.3                        |
| CPU                        | Intel i7-9700K               |
| Memory                     | 1GB                          |
| Operating system           | Windows10                    |
| Hard disk capacity         | 120GB                        |
| Data sampling frequency    | Collect data every 2 seconds |
| Simulation software        | Matlab 7.2                   |

- 2 *Experimental data*: Take 5 universities as the research object, use the form of cooperation to obtain the relevant data of college students' innovation and entrepreneurship education, integrate and statistically process the data, and take the processed data as the experimental sample data. After statistics, the amount of experimental data obtained in this paper is 19.64G. On this basis, part of the experimental sample data is input into the simulation software, and the optimal operation parameters of the simulation software are obtained after many trial runs. This parameter is taken as the initial simulation parameter to ensure the authenticity and reliability of the simulation experiment results.
- 3 *Experimental indicators*: Taking Xu (2020) method, Tian (2022) method and method of this paper as experimental test methods, by comparing different methods of college students' innovation and entrepreneurship education quality evaluation index data collection time, college students' innovation and entrepreneurship education service quality evaluation index weight calculation error rate and college students' innovation and entrepreneurship education service quality evaluation accuracy rate as experimental indicators, in order to verify the practical application effect of different methods.

## 4.2 Experimental results

### 4.2.1 Data acquisition time

The time-consuming data collection of college students' innovation and entrepreneurship education quality evaluation indicators of the above three methods is compared, and the comparison results are shown in Table 4.

**Table 4** Time consuming for data collection of evaluation indicators of innovation and entrepreneurship education quality of college students

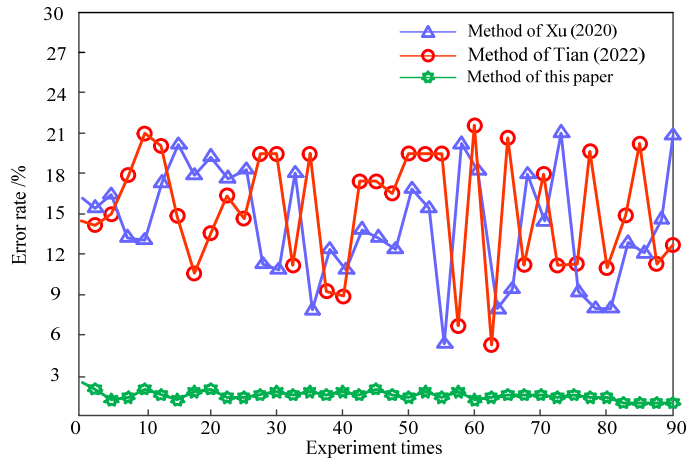
| Number of experiments/time | Acquisition time/ms |                    |                      |
|----------------------------|---------------------|--------------------|----------------------|
|                            | Xu (2020) method    | Tian (2022) method | Method of this paper |
| 10                         | 169.5               | 96.3               | 56.8                 |
| 20                         | 155.8               | 98.7               | 57.4                 |
| 30                         | 149.6               | 95.6               | 58.6                 |
| 40                         | 152.3               | 103.2              | 62.3                 |
| 50                         | 178.9               | 147.5              | 51.1                 |
| 60                         | 166.7               | 95.3               | 49.6                 |
| 70                         | 128.4               | 82.1               | 48.7                 |
| 80                         | 163.5               | 87.4               | 45.6                 |
| 90                         | 186.9               | 85.7               | 44.7                 |
| average value              | 161.3               | 99.1               | 52.8                 |

By analysing the data in Table 4, we can see that with the increase of the number of experiments, the time-consuming of data collection of college students' innovation and entrepreneurship education quality evaluation indicators of different methods shows a fluctuating trend. The average time-consuming of data collection of college students' innovation and entrepreneurship education quality evaluation indicators of Xu (2020) method is 161.3 ms, and the average time-consuming of data collection of college students' innovation and entrepreneurship education quality evaluation indicators of Tian (2022) method is 99.1 ms. The average time-consuming of data collection of college students' innovation and entrepreneurship education quality evaluation indicators of this method is 52.8 ms, which is lower than 108.5 ms and 46.3 ms in Xu (2020) method and Tian (2022) method respectively, indicating that the data collection of college students' innovation and entrepreneurship education quality evaluation indicators in this method takes less time and is more efficient. This is because this method uses multi-threaded NAPI to collect service quality evaluation data, removes meaningless evaluation data through time constraints, constructs education service quality evaluation function through DEA method, calculates the total ranking weight of elements at all levels, and uses linear weighting method to solve the value of service quality evaluation, effectively improving the efficiency of data collection.

#### 4.2.2 Error rate of index weight calculation

The error rate of the weight calculation of the service quality evaluation index of college students' innovation and entrepreneurship education based on the three methods is compared, and the results are shown in Figure 5.

**Figure 5** Comparison results of error rate of index weight calculation (see online version for colours)



By analysing the data in Figure 5, it can be seen that the maximum and minimum error rates of the weight calculation of the evaluation index of college students' innovation and entrepreneurship education service quality based on (Xu, 2020) method are 22.1% and 5.1%; According to Tian (2022) method, the maximum error rate of the weight calculation of the service quality evaluation index of college students' innovation and entrepreneurship education is 21.3%, and the minimum value is 5.3%; The maximum error rate of the weight calculation of the service quality evaluation index of college students' innovation and entrepreneurship education of this method is 2.2%, and the minimum is 1.1%. Compared with the experimental comparison method, the calculation error rate of the index weight in this method is lower. This is because this method removes meaningless evaluation data through time constraints, uses DEA method to build the evaluation function of education service quality, calculates the total ranking weight of elements at all levels, effectively reduces the calculation error rate of the index weight, and can lay a solid foundation for the subsequent evaluation of the service quality of innovation and entrepreneurship education for college students.

#### 4.2.3 Evaluation accuracy

The accuracy rate of the service quality evaluation of college students' innovation and entrepreneurship education by the above three methods is compared, and the comparison results are shown in Table 5.

**Table 5** Accuracy rate of service quality evaluation of innovation and entrepreneurship education for college students

| <i>Number of experiments/time</i> | <i>Accuracy rate of education service quality evaluation/%</i> |                           |                             |
|-----------------------------------|--|---------------------------|-----------------------------|
|                                   | <i>Xu (2020) method</i>  | <i>Tian (2022) method</i> | <i>Method of this paper</i> |
| 10                                | 86.1   | 79.8                      | 96.3                        |
| 20                                | 85.6   | 82.3                      | 98.7                        |
| 30                                | 84.7   | 86.4                      | 95.6                        |
| 40                                | 82.3   | 75.2                      | 94.8                        |
| 50                                | 84.5   | 78.6                      | 96.4                        |
| 60                                | 86.3   | 79.4                      | 94.6                        |
| 70                                | 85.9   | 81.3                      | 95.1                        |
| 80                                | 84.4   | 85.6                      | 98.6                        |
| 90                                | 85.9   | 84.7                      | 97.2                        |
| Average value                     | 85.1   | 81.5                      | 96.4                        |

By analysing the results in Table 3, it can be seen that the maximum accuracy rate of the service quality evaluation of college students' innovation and entrepreneurship education in Xu (2020) method is 86.3%, the minimum value is 82.3%, and the average value is 85.1%. The maximum accuracy rate of the service quality evaluation of college students' innovation and entrepreneurship education in Tian (2022) method is 86.4%, the minimum value is 75.2%, and the average value is 81.5%; The maximum accuracy rate of this method is 98.7%, the minimum is 94.8%, and the average is 96.4%. Overall, the average evaluation accuracy of this method is 11.3% and 14.9% higher than that of Xu (2020) method and Tian (2022) method respectively, indicating that this method can be used to accurately evaluate the service quality of innovation and entrepreneurship education for college students. This is because this method uses multithreaded NAPI to collect service quality evaluation data. Remove meaningless evaluation data through time constraints, construct an evaluation function of education service quality with DEA method, calculate the total ranking weight of elements at all levels, and effectively improve the accuracy of innovation and entrepreneurship education service quality evaluation.

## 5 Conclusion

This paper proposes an evaluation method of service quality of college students' innovation and entrepreneurship education based on AHP-DEA method. Build an evaluation system of education service quality, and collect service quality evaluation data using multi-threaded NAPI. The meaningless evaluation data are removed by time constraints, and the evaluation function of education service quality is constructed by combining DEA method. The total ranking weight of elements at all levels is calculated, and the value of service quality evaluation is solved by using linear weighting method, so as to realise the evaluation of service quality of innovation and entrepreneurship education for college students. The following conclusions are drawn through experiments: the evaluation index data collection time of this method is short, the calculation error rate of evaluation index weight is low, and the evaluation accuracy rate

is high, which shows that this method can improve the data collection efficiency, reduce the evaluation error of education service quality, and improve the evaluation effect of education service quality.

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