Perceived Quality Evaluation of Higher Education Service from the Students' Perspective Based on Weighting Method

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Abstract. As customers of higher education services, students are both producers and consumers in this process. With students’ subjective perception, the evaluation of perceived quality of higher education service from the students' perspective can more truly reflect the influence of objective conditions on students. According to the satisfaction index model, the paper designs the service quality evaluation index, uses questionnaire to obtain the language evaluation information of graduates and graduates about the service quality evaluation index, then constructs the evaluation matrix accordingly. The initial weight values of the indexes are determined based on factor analysis. Rasch model is introduced to calculate personal ability to revise the weight values, and the satisfaction value is calculated by combining weighting method with the quantitative value of the service quality evaluation index. Through the above methods, the evaluation of higher education satisfaction from the perspective of students is realized, which points out the follow-up direction for improving the quality of undergraduate education service.

Introduction

The teaching process of higher education is completed under the joint action of teachers and students. Students directly participate in the education and teaching process. They are not only producers but also consumers. The interaction between students and teachers directly affects the quality of education and teaching [1]. Therefore, the output of higher education is an education service. The quality of education service depends not only on the teaching methods and teaching level of teachers, but also on the subjective feelings of the students [2].

Students have multiple identities in the higher education service system, which are users, participants and co-producers of higher education services, as well as evaluators and supervisors of higher education quality. This makes the evaluation of the quality of higher education service from students’ perspectives particularly important.

Foreign countries attach great importance to the research on the quality evaluation methods and quality dimensions of higher education service. Paula took the students with two different cultural backgrounds of China Hong Kong and China mainland as the research object, and applied the revised SERVQUAL Model to evaluate the quality of higher education service [3]. Mohammad et al. believed that the quality dimensions of higher education service include service facilities, service capabilities, service attitudes, service content, service process and reliability etc. [4]; Paula and Brenda et al. applied factor analysis methods and obtained seven quality dimensions of higher education service, which are the content of the course, attention to students, teaching facilities, examinations, guidance, social activities, personnel, etc. Domestic scholars also reached similar conclusions. The quality of higher education service is the contrast between students' expectation and perceived quality of the service. The service quality affects customer satisfaction, customer loyalty and customer behavior willingness etc. [5-6]. Ma Wanmin [7] studied the gap analysis model. Liu Wu et al. [8] constructed a model of higher education customer satisfaction index, and conducted case analysis about some colleges and universities in Shenyang.
Through the comparison between domestic and international research, it is found that, in the past the research objects of higher education service quality evaluation are often college undergraduates, lacking the evaluation and opinions of graduates. At the same time, the evaluation of education service quality based on SERVQUAL Model ignores the impact of customers’ personal ability and test difficulty on the evaluation results. All of the above factors will lead to large deviation in their evaluation. Therefore, this paper takes graduates and undergraduates of a certain college as test objects, calculates the personal ability by the Rasch model which is based on education and psychometrics [9], and uses the weighting method to analyze the graduates and undergraduates’ quality evaluation level of higher education service, and thus improves the accuracy and rationality of the evaluation.

**Index Selection and Quantification**

There is no uniform standard for the quality evaluation of higher education service at home and abroad. Therefore, this paper uses the literature research method and obtains the customer satisfaction index model of higher education as shown in Fig. 1.

![Customer Satisfaction Index Model for Higher Education](image)

**Table 1 Satisfaction Scoring Criteria.**

| scoring interval | (4,5] | (3,4] | (2,3] | (1,2] | (0,1] |
|------------------|-------|-------|-------|-------|-------|
| satisfaction     | Very satisfied | Satisfied | Basically satisfied | Dissatisfied | Very dissatisfied |

**Index Weight Calculation**

**Calculation of the Initial Weight Value Based on Factor Analysis**

This paper designs 28 questions, collects 86 valid questionnaires from graduates and 71 valid questionnaires from undergraduates. Among them, there were 125 male students and 32 female students. After the credibility analysis, it can obtain that the coefficient $\alpha$ is 0.911 which is greater than 0.910, it indicates that the questionnaire’s credibility is very good. Through KMO test, KMO value is 0.673 which is greater than 0.5. Through Bartley Spherical test, the Bartley Sphere spherical test approximate $\chi^2$ value is 808.723, freedom degree is 378, and the significant
probability of approximate $\chi^2$ is less than 0.050, which means that there are common factors in the correlation matrix of the questions, and factor analysis is needed.

According to the common factor feature vector and factor variance contribution rate, this paper uses the Eq. 1 to calculate the weight coefficient.

$$\beta_i = \sum_{i=1}^{m} A_i F_i,$$  

(1)

Where $i$ - question number; $m$ - Common factor number; $\beta_i$ — $i$ th question weight coefficient; $A_i$ — The absolute value of the factor load of the $m$ th factor to the $i$ th question, which is obtained from the feature vector; $F_m$ — $m$ th factor variance contribution rate.

The initial weight $W_i$ of the $i$ th question can be calculated by the Eq. 2:

$$W_i = \beta_i \sum_{i=1}^{m} \beta_i.$$  

(2)

Calculation of Index Weight Value Based on Personal Abilities

Condition for the establishment of the Rasch model are as follows:

1) For any test question, a high-ability teste has a higher probability of correctly answering a question than a low-ability teste;

2) Any teste's performance on an easy question is better than a difficult one.

Let $P_{mi}$ and $P_m$ be the probability of teste $m$ and teste $n$ correctly answering question $i$. The probability of incorrectly answering question $i$ are $1-P_{mi}$ and $1-P_m$, which is used to compare the personal abilities of the two testes.

Similarly, when the teste tests question $j$, $m$ 's and $n$ 's ability comparison is $P_m(1-P_{nj})$. Because the personal ability of the teste remains unchanged, $P_m(1-P_{nj}) = P_m(1-P_n)$. Let the teste $n$ be a "standard" teste and the question $j$ is a "standard" question, that is, the personal ability of teste $n \theta_n$ is equal to the difficulty of question $j \delta_j$. Through calculating, $P_{nj} = 0.5$. Through equality transformation, it is obtained that $P_m(1-P_{nj}) = P_m(1-P_n)$. Therefore, the personal ability of the teste $m$ is defined as:

$$\theta_m = \ln \left( \frac{P_m}{1-P_{mi}} \right).$$  

(3)

The difficulty of the question $i$ is: $\delta_i = \ln \left( \frac{1-P_{mi}}{P_{mi}} \right)$, then $\ln \left( \frac{P_{mi}}{1-P_{mi}} \right) = \theta_m - \delta_i$.

That is:

$$P_{mi}(x_{mi}|\theta_m, \delta_i) = \frac{e^{(\theta_m - \delta_i)}}{1 + e^{(\theta_m - \delta_i)}},$$  

(4)

The Eq. 4 is the Rasch model. Where $x_{mi}$ - the score of teste $m$ to question $i$. If it is correct, it is marked as "1", otherwise it is marked as "0."

According to Likert's five-dimensional-scale form, the number of people who scored 5, 4, 3, 2, 1 for question $i$ is $a_{i1}, a_{i2}, a_{i3}, a_{i4}, a_{i5}$. Then the probability that question $i$ gets a full score is:

$$P_i = \frac{5a_{i1} + 4a_{i2} + 3a_{i3} + 2a_{i4} + a_{i5}}{5(a_{i1} + a_{i2} + a_{i3} + a_{i4} + a_{i5})}.$$  

(5)
Let the probability of getting the full score of question \( i \) be the probability of correctly answering the question \( i \). Let undergraduates and graduates’ probability of correctly answering the question \( i \) is \( P_{u,i}, P_{g,i} \). Because students’ perceptions of different dimensions of higher education services vary, they have different personal abilities for different questions. In addition, this paper focuses on the evaluation and scoring of each question by students, the difficulty of the question itself is not taken into accord.

According to Eq. 3, the personal abilities of undergraduates and graduates are calculated as \( \theta_{u,i}, \theta_{g;i} \). Calculate the difference between them \( \theta_{g;i} - \theta_{u;i} \), the positive or negative feature of the value is used to judge the ability of undergraduates and graduates to perceive problems.

Calculate the index coefficient \( \phi_{ki} \) of the \( k \)th class of students to the question \( i \) according to personal ability \( \theta_{u;i}, \theta_{g;i} \), \( 0 \leq \phi_{ki} \leq 1 \) and the bigger the better. For question \( i \), the best teste ability is \( \theta_{opt;i} \), that is, \( \phi_{opt;i} = 1 \). For the index which is the smaller the better, the index coefficient is \( \phi_{ki}^{/} = \theta_{u;i} / \theta_{opt;i} \). In this study, undergraduates are more sensitive to the quality evaluation of the higher education service than the graduates. Therefore, the ability of undergraduates \( \theta_{u;i} \) is chose as the best, that is, \( \phi_{opt;i} = 1 \). Graduates’ ability index coefficient is \( \phi_{ki} = \theta_{g;i} / \theta_{opt;i} \) . After getting \( \phi_{ki} \), normalize \( \phi_{ki} \). That is, the weight of the \( k \)th class of students to the question \( i \) is obtained.

\[
\lambda_{ki} = \frac{\phi_{ki}}{\phi_{ki} + \phi_{ki}^{/}}.
\]

(6)

Combine Table 1 to get the comprehensive weight of question \( i \), which is \( W_{ki} = W_{i}\phi_{ki} \). Then normalization is performed to obtain the final weight value.

\[
W_{ki} = \frac{\sum_{i=1}^{28} W_{ki} \phi_{ki}}{\sum_{i=1}^{28} W_{ki} \sum_{i=1}^{28} W_{ki} \phi_{ki}}.
\]

(7)

Quality Evaluation of Higher Education Service Based on Weighted Method

The Likert five-point scale is used to obtain the factor set \( F = \{ f_{1},...,f_{28} \} \) and assessment glossary \( E = \{ e_{1},e_{2},e_{3},e_{4},e_{5} \} = \{ 5,4,3,2,1 \} \). The single factor evaluation membership vector is determined:

\[
R_{i} = \left( r_{m;i} \right)_{1 \leq i \leq 28}, \sum_{i=1}^{28} r_{m;i} = 1 \text{ and membership matrix } R = \left( R_{1},...,R_{28} \right)^{T} \text{ is formed. According to this, the membership matrix of undergraduates and graduates } \left( R_{u} \right)_{28 \times 5}^{T} \text{ and } \left( R_{g} \right)_{28 \times 5}^{T} \text{ can be obtained.}
\]

Calculate the matrix according to \( S = W_{ki} R \) and the evaluation result is obtained. Then the satisfaction value is calculated by \( \mu = S \left( 5,4,3,2,1 \right)^{T} \). Compare it with Table 1 to determine the evaluation results of higher education service quality.

Examples

This study used the online questionnaire to obtain the students’ learning ability values \( \theta_{u;i}, \theta_{g;i} \), and draw the personal ability comparison chart and difference map. As shown in Fig. 2 and Fig. 3.

As can be seen from Fig. 2, graduates’ quality evaluations of the higher education service are better than the undergraduates. As can be seen from Fig. 3, there is a clear gap between the graduates and the undergraduates’ personal ability to question 1, 6, 19, 24, 25, and 26. These questions correspond to the accommodation environment, campus perimeter, class activities, school fees, and grant loans.
The principal component analysis method is used to calculate the feature values and feature vectors of 28 questions correlation matrices. According to the principle that the original feature value is greater than 1, 9 common factors are extracted, and their feature values are 3.281, 3.09, 2.375, 2.184, 2.114, 2.032, 2.011, 2.002, 1.916 respectively. The variance contribution degrees are 0.117, 0.110, 0.085, 0.078, 0.076, 0.073, 0.072, 0.072, 0.068 respectively and cumulative contribution rate reaches 75%. It shows that these 9 factors contain most of the information of 28 variables, which can reflect the content of the indexes and can effectively reflect the service quality of each institution. According to Eq.1 and Eq.2, the initial weights of 28 questions can be calculated. As shown in Table 2.

Table 2. Weights of Questions \( w_i \times 10^3 \) \((i = 1, 2, \ldots, 28)\).

| Question number | 1  | 2  | 3  | 4  | 5  | 6  | 7  | 8  | 9  | 10 | 11 | 12 | 13 | 14 |
|-----------------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| Weights         | 38 | 32 | 35 | 36 | 34 | 25 | 33 | 32 | 30 | 32 | 30 | 31 | 35 | 31 |
| Question number | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 |
| Weights         | 45 | 46 | 43 | 41 | 38 | 35 | 44 | 39 | 42 | 29 | 36 | 32 | 45 | 32 |

According to the student ability in Fig.2, calculate the students’ ability index coefficient and weight \( \lambda_{ki} \), comprehensive weight \( W_{ki} \), final weight \( W_{Fki} \) for question \( i \). Combine evaluation matrix \((R_{1})_{28 	imes 5}\) and \((R_{2})_{28 	imes 5}\), \( \mu_1 = 3.334 \) and \( \mu_2 = 3.512 \) are calculated by matrix calculation \( \mu = S(5,4,3,2,1)^T W_{ki} R (5,4,3,2,1)^T \). According to the satisfaction scoring criteria, students are satisfied with the higher education.

Conclusion

(1) Students are satisfied with the overall service quality provided by the university, and the attitude towards each index is between satisfaction and basic satisfaction.
(2) Undergraduates are more sensitive to higher education services than graduates. The indexes that differ greatly between graduates and undergraduates' satisfaction are the accommodation environment, campus surrounding, inter-class activities, school fees and subsidized loans. This indicates that it is important to improve students’ life service and needs in the service process.

(3) Campus surroundings, learning environment, canteen environment, medical services, responsiveness of faculty and staff to students’ issues, teaching facilities, cultural and recreational facilities, student union activities, social experiment activities and scholarship assessment mechanisms, the satisfaction scores of these indicators are low. It shows that the school's infrastructure construction and other social practices still need to be improved.

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References

[1] Yuan Ye. Research of Characteristics and Application of Higher Education Quality Evaluation under the Background of Higher Education Popularization. D. Shanxi University of Finance and Economics, (2012).

[2] Liu Junxue. The View of Service Quality in Higher Education, J. China higher education research, 07 (2002) 31-32.

[3] Paula, Y., K. Kwan and Paul W.K. Ng. Quality indicators in higher education-comparing Hong Kong and China’s students. J. Managerial Auditing Journal, 14 (1999) 20-27.

[4] Mohammad, S. Owlia, Elaine and M. Aspinwall. A framework for the dimensions of quality in higher education. J. Quality Assurance in Education, 4 (1996) 12-20.

[5] Hu Zixiang. Research on Evaluation Model of Higher Education Service Quality. J. Modern educational science, 2 (2006) 122.

[6] He Dayi and Liu Jiansheng. Assumption of Constructing China Customer Satisfaction Index (CCSI). J. World Standardization and Quality Management, 10 (2000) 7-10.

[7] Ma Wanmin. Evaluation Model of Higher Education Service Quality and Its Construction. J. Modern Education Management, 1 (2009) 62-64.

[8] Liu Wu and Yang Xue. Construction of Customer Satisfaction Index Model for Higher Education in China. Journal of Public Management, 1 (2007) 84-88.

[9] Yanzi. Objective Measurement in the Field of Psychological Science—Characteristics and Development Trend of Rasch Model. J. Advances in Psychological Science, 18 (2010) 1298-1305.