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The Investigation and Study on the Students' Satisfaction with the Quality of College Mathematics Teaching

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Abstract		Review Article

Based on the theory of customer satisfaction, this paper constructs the index system of students' satisfaction of university mathematics teaching quality, and constructs and issues the final questionnaire from five dimensions of teachers, personnel training, classroom effect, teaching management and teaching effect. Using exploratory factor analysis, comprehensive linear weighting method and satisfaction index model to calculate and analyze the survey data, and finally get the discussion about the students' satisfaction, and make a significant analysis on the influencing factors of the students' satisfaction index. Finally, combined with the results of data analysis, the methods and suggestions to improve students' satisfaction are given.

Keywords: college Mathematics Teaching;satisfaction index; exploratory factor analysis; significance test; comprehensive linear weighting.

INTRODUCTION

In the 1960s, based on the research of customer satisfaction, the concept of student satisfaction was put forward. In essence, student satisfaction is a kind of customer satisfaction, which is a term, produced after the introduction of customer satisfaction into higher education institutions. Compared with customer satisfaction, the level of student satisfaction refers to the feeling state formed by comparing the actual perceived quality of college education service with the expected value of college.

The theory of customer satisfaction has penetrated into the field of higher education earlier abroad. No matter in the definition of the connotation of student satisfaction, the construction and use of the model and index system, they have been repeatedly tested and used, and now they have become a more mature system. Laurie Schreiner and Stephanie J uillerant 1993 designed SSI to measure the expectation and satisfaction of students in all aspects of school. It is a more authoritative measurement standard in the United States. Tracking survey is adopted almost once a year. After the survey, a national report is formed and published in Education publications or magazines. The Institute of education of Indiana University in the United States focuses on measuring aspects of university life every year. This kind of analytical

research report has a large scale, wide coverage and great influence in American universities. The first survey on the satisfaction of university students was carried out in 1999 and developed to 2005 in the UK. The survey on the satisfaction of graduates has been carried out every year. In 2006, 157000 students participated in the British college students' satisfaction assessment, with a large number and a wide range of students.

The empirical research of student satisfaction evaluation in China began in 2001. The research objects are relatively unified. For college students, master's students or graduates, the focus of the research is mainly on the construction of the model and index system of student satisfaction, the factors affecting student satisfaction, the overall satisfaction of the students who provide services in a certain college or region, the satisfaction of teachers' teaching or courses, the learning experience or living environment of students The satisfaction of. With the coming of the popularization of higher education in China, the theory of customer satisfaction has been paid more and more attention by the scholars in the field of higher education and has been applied to this field. Compared with the research on the satisfaction of foreign college students, it pays more attention to the attraction of colleges and universities, the development of students' abilities, the

evaluation of higher education services or the overall colleges and universities, and the overall objectivity.

The evaluation method of student satisfaction is the application of customer satisfaction evaluation method in the field of education. The subjective evaluation of students on the evaluation object is quantified by numbers. Likert scale is often used to evaluate student satisfaction, which is easy to operate, convenient for later data analysis, and has good effect. In order to understand the situation of the undergraduate students' satisfaction with the college mathematics teaching quality compared with the students' expectation. This paper uses Likert scale to measure the students' satisfaction. Through the quantitative evaluation and the analysis of the students' satisfaction with the overall and various indicators of the university mathematics teaching process, we can find the problems in the university mathematics teaching process。We also can find the direction and methods to solve the problems, evaluate the effect of the teaching reform from multiple perspectives, and provide direction guidance for the teaching reform, so as to effectively improve the satisfaction of the university mathematics

teaching in our university High teaching quality and Realization of teaching objectives.

DESIGN RESEARCH
The survey object is undergraduates from B University. The questionnaire survey started in 2017 and has been carried out for 3 consecutive years. In order to ensure the validity and reliability of the questionnaire, 100 pre questionnaires were carried out before the formal issuance of the questionnaire. According to the feedback results, some indicators and their expressions were modified to form a formal questionnaire.

INDEX SYSTEM
College Mathematics elements mainly include: teachers, students, teaching objectives, teaching content, teaching methods, teaching conditions, etc. Through the reliability and validity analysis, on the basis of the previous index system, the questions with poor differentiation in the questionnaire were modified or deleted, and finally a satisfaction index system including 5 first level indexes and 38 second level indexes was formed, as shown in Table 1.

Table-1: Satisfaction Index System

First level indicators	Second level indicators	Third level indicators
Satisfaction index system of College Mathematics Curriculum	teaching staff B1	Professional ethics C11
		Discipline expertise C12
		Manners C13
		Teaching level C14
		Work enthusiasm C15
		Teaching content C16
		Teaching responsibility C17
		Coaching and answering C18
		Teaching methods C19
	personnel training B2	Improvement of practical operation abilityC21
		Guide students to treat learning correctly C22
		Mobilize students' enthusiasm and initiative in learning C23
		The improvement of theoretical learning ability C24
		Lay a foundation for the development of students C25
		Cultivate positive life values C26
		Understand extracurricular knowledge C27
		Teachers treat every student fairly in class C28
	Classroom effect B3	Forward looking course content C31
		Communicate with students in and out of class C32
		Classroom teaching atmosphere C33
		The choice of Teachers C34
		Course teaching progress C35
		Degree of integration with practice C36
		Class hours setting of theory course and experiment course C37
		Language expression C38
		Time allocation in classroom teaching C39
	Teaching resources B4	Other supplementary teaching materials C41
		Infrastructure conditions of teaching laboratory C42
		Teaching material C43
		Openness of network resources C44
		Communication channels of teaching management information C45

	Teaching management B5	The way to learn the curriculum of failing to pass C51
		The way to re-establish the existing failing courses C52
		The teacher gives the score Fair C53
		Course selection system C54
		Students can contact teachers in time C55
		Classroom management of Teachers C56
		Classroom management measures C57

Questionnaire Quality

The questionnaire was distributed to students through the website of questionnaire star. 1675 questionnaires were collected, 1675 valid questionnaires were collected, and the effective recovery rate was 100%.The questionnaire uses Likert scale, a 5-level sequential scale, "very satisfied", "satisfied", "basically satisfied", "dissatisfied" and "very satisfied" five options, which are recorded as 5, 4, 3, 2, 1 respectively. The higher the score, the higher the satisfaction. The main indicators of questionnaire quality testing are reliability, validity and differentiation.

Reliability is a measure of the reliability of the questionnaire.It is generally believed that the reliability coefficient of colonbach is 0.60-0.70 (the minimum acceptable value), 0.70-0.80 (quite good), 0.80-0.90 (very good).The reliability of this questionnaire is very high. The reliability of the five secondary indicators is shown in Table 2.The indicators in the scale have high internal consistency and pass the test of reliability.
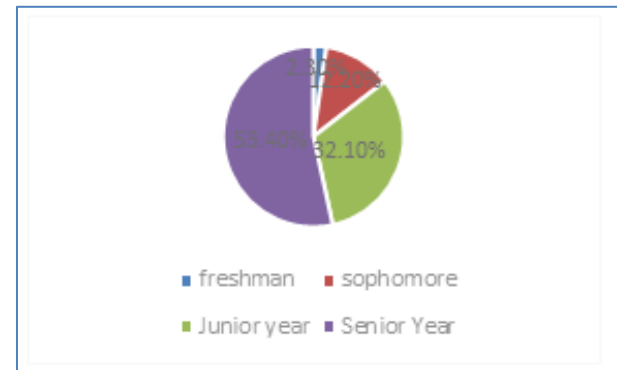
Table-2: Colonbach Reliability Coefficient of Each Secondary Index

Second level indicators	Number of indicators	Cronbach's Alpha α
Teaching staff B1	7	0.967
Personnel training B2	8	0.980
Classroom effect B3	9	0.973
Teaching resources B4	5	0.950
Teaching management B5	7	0.959

The discrimination degree mainly tests whether each item can identify the reaction degree of the subjects. The critical ratio value CR value method was used for the discrimination test, and the scores of each item were arranged in the order from high to low. The first 27% of the scores were high group, and the last 27% were low group. The independent sample t test was used to test the differences between the high score and low score groups of each item. The results show that the CR value of each item is less than the significance level of 0.05, indicating that each measure can distinguish the response degree of different subjects.
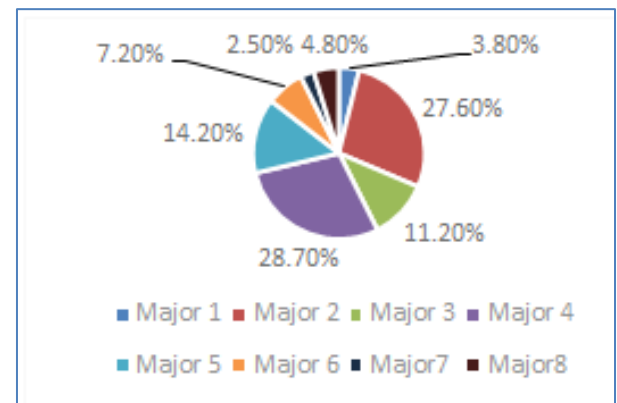
Validity is an index to measure the validity of a measurement item. It refers to the degree to which a measurement tool or means can accurately measure the things to be measured. Using KMO and Bartlett to test the correlation between measure terms. The kmo value of the questionnaire validity analysis is 0.989, which is more than 0.8.The validity of the questionnaire is good.

Evaluation and Analysis of students' satisfaction
Descriptive analysis of the questionnaire

In terms of sample composition, 1675 samples came from 8 majors, including 762 boys and 913 girls, basically consistent with the gender ratio of the school. From the perspective of student source, the proportion of rural students is 51.3%, and that of urban students is 48.7%. The proportion of rural students is higher than that of urban students. In terms of grade structure, there are 38 freshmen, 204 sophomores, 538 juniors and 895 seniors. Their distribution is shown in the figure.

Fig-1: Distribution of School Grade

Fig-2: Distribution of Students' majors

Table-3: Sample Composition of Questionnaire

variable	attribute	Number of people （person）	Percentage (%)
Gender	male	762	45.5
	female	913	54.5
grade	freshman	38	2.3
	sophomore	204	12.2
	Junior year	538	32.1
	Senior Year	895	53.4
Source of students	rural area	859	51.3
	city	816	48.7
Major	Major 1	63	3.8
	Major 2	462	27.6
	Major 3	188	11.2
	Major 4	481	28.7
	Major 5	238	14.2
	Major 6	121	7.2
	Major7	42	2.5
	Major8	80	4.8

The average score and variance statistics of the five secondary indicators are shown in Table 4.The results show that the scores of teachers and personnel training are high, which shows that students are satisfied with the quality of university mathematics teachers. The score of teaching resources is the lowest. This is consistent with the lack of online teaching resources in our school. Generally speaking, students are satisfied with the teaching of college mathematics.

Table-4: Average Score and Variance of Secondary Indicators

	B1	B2	B3	B4	B5
Mean	4.546	4.498	4.482	4.418	4.47
Standard deviation	0.68628	0.72514	0.72903	0.78453	0.72819

Analysis of Student Satisfaction Index

Customer satisfaction degree refers to the actual degree of comparison between the actual feeling value of students' acceptance of university mathematics teaching and their expectation value. It is a quantitative statistical index of satisfaction degree.The formula can be expressed as: CSD=user experience value / expectation value. The measurement of CS is essentially the problem of customer satisfaction (CSD).

Customer satisfaction index (CSI) is an important tool to measure customer satisfaction. This is an indicator to measure the degree of satisfaction from the perspective of students. It is the result of customer satisfaction measurement through a specific causal model.

In the evaluation of students' satisfaction, many methods can be used to calculate the satisfaction index. In this paper, the score measurement method is used to calculate the satisfaction of each three-level index, and then the objective summation method is used to weighted sum the satisfaction index of each index to obtain the overall satisfaction index CSI of students.

Finally, further analysis is made according to the satisfaction index of the two-level index.

Determine Index Weight

First, determine the weight of the second and third level indicators. The index system of student satisfaction reflects the level and characteristics of higher education service quality provided by colleges and universities, and the influence degree of each index change on the change of student satisfaction is different, and the important scale reflecting the influence degree is the weight. The objective factor analysis method is used to calculate the index weight.

SPSS is used to standardize the data, then the standardized data were analyzed by exploratory factor analysis, the main factors were extracted by principal component analysis, the rotation factor load matrix can be obtained by using the equal quantity maximum method to rotate the orthogonal matrix. A total of 5 factors were extracted and the cumulative contribution rate reached 84.77%. The effect was very good. The calculation results are shown in Table 5.

Table-5: Explanation of Total Variance

	Initial eigenvalue			Sum of squares of rotating loads	
Total	Variance percentage	Cumulative%	Total	Variance percentage	Cumulative%
29.067	76.492	76.492	6.749	17.76	17.76
1.394	3.667	80.159	6.537	17.201	34.961
0.75	1.975	82.134	6.479	17.051	52.012
0.547	1.439	83.573	6.404	16.852	68.864
0.456	1.201	84.774	6.046	15.91	84.774

From table 8, 38 indexes have higher factor load (greater than 0.787) on a corresponding factor. Through factor analysis, five factors can be obtained, and the corresponding sub variables have no difference, which also proves that the questionnaire has good structural validity. The matrix of factor score coefficient obtained by calculation is shown in Table 6.

Table-6: Factor Score Coefficient Matrix

Third level indicators	F_1	F_2	F_3	F_4	F_5	Third level indicators	F_1	F_2	F_3	F_4	F_5
C11	0.407	-0.09	-0.249	-0.03	0.026	C33	-0.155	-0.01	0.354	-0.096	-0.028
C12	0.354	-0.104	-0.188	0.035	-0.032	C34	-0.222	-0.214	0.373	-0.072	0.207
C13	0.295	-0.016	-0.159	-0.027	-0.027	C35	-0.073	-0.049	0.267	-0.072	-0.005
C14	0.295	-0.118	-0.135	0.061	-0.034	C36	-0.022	-0.013	0.257	-0.005	-0.155
C15	0.237	-0.06	-0.039	-0.021	-0.052	C37	-0.108	-0.034	0.28	0.018	-0.091
C16	0.24	-0.031	-0.098	0.006	-0.051	C38	0.038	-0.07	0.197	-0.061	-0.038
C17	0.171	-0.039	0.049	-0.062	-0.055	C39	-0.026	-0.107	0.228	-0.08	0.053
C18	0.158	-0.144	0.086	-0.003	-0.033	C41	-0.017	-0.143	-0.076	0.448	-0.141
C19	0.171	-0.154	0.004	0.034	0.013	C42	-0.002	-0.118	-0.114	0.458	-0.155
C21	-0.14	0.364	0.005	0.006	-0.174	C43	0.153	-0.128	-0.219	0.5	-0.238
C22	-0.032	0.352	-0.057	-0.027	-0.175	C44	-0.051	-0.166	-0.107	0.379	0.018
C23	-0.115	0.35	0.027	-0.005	-0.195	C45	-0.11	-0.019	0.013	0.102	0.088
C24	-0.036	0.296	-0.078	-0.067	-0.05	C51	-0.095	-0.48	-0.104	-0.149	0.913
C25	-0.061	0.31	-0.024	-0.004	-0.158	C52	0.028	0.083	-0.187	-0.184	0.331
C26	0.012	0.311	-0.099	-0.043	-0.119	C53	0.053	0.1	-0.265	-0.108	0.289
C27	-0.168	0.318	0.047	0.031	-0.167	C54	-0.187	-0.148	0.067	0.077	0.267
C28	0.031	0.13	-0.104	-0.1	0.111	C55	-0.104	0.129	-0.046	-0.148	0.238
C31	-0.171	-0.043	0.356	0.017	-0.091	C56	-0.015	0.101	-0.115	-0.093	0.193
C32	-0.122	-0.045	0.35	-0.103	-0.016	C57	-0.068	0.004	-0.031	0.011	0.158

According to table 6, the factor score equation is obtained

$$F_l = \beta_{1l}x_1 + \beta_{2l}x_2 + \cdots + \beta_{nl}x_n \qquad (1)$$

In Equation (1), F_l is the Score for factor l, $l = 1, 2, 3, 4, 5$, and x_i is the index value $n = 38$, β_{kl} is the coefficient of index.

$$e_l = \frac{\lambda_l}{\sum\limits_{l=1}^{m} \lambda_l} \ , \qquad (2)$$

In formula (2), λ_l is the eigenvalue of factor l.

p_k is the importance of the k-th indicator,

$$p_k = \left| \sum_{l=1}^{m} \beta_{kl} * e_l \right| , \quad k = 1, 2, \cdots, 38 \qquad (3)$$

Calculate the importance of each item index p_k. Renumber each item index according to the index systemthen and convert p_k to p_{ij}.

The weight of the indicator is w_{ij}

$$w_{ij} = p_{ij} \Big/ \sum_{j=1}^{n_j} p_{ij} \ , \ j = 1,2,3,4,5 \qquad (4)$$

In formula (4), n_j is the number of indicators included in the second level indicator j. Table 7 shows the calculation results of the third level index importance and weight.

Table-7: Average score, Importance and Weight of The Third Level Indicators

The Third Level Indicators	C11	C12	C13	C14	C15	C16	C17	C18	C19	C21	C22	C23	C24
Importance p_{ij}	0.357	0.311	0.261	0.258	0.209	0.212	0.152	0.138	0.148	0.113	0.018	0.091	0.023
Average $\overline{x}_i$	4.61	4.54	4.57	4.54	4.58	4.53	4.59	4.52	4.43	4.47	4.52	4.47	4.52
Weight w_i	0.175	0.152	0.127	0.126	0.102	0.104	0.074	0.067	0.073	0.236	0.037	0.190	0.049
The Third Level Indicators	C25	C26	C27	C28	C31	C32	C33	C34	C35	C36	C37	C38	C39
Importance p_{ij}	0.044	0.020	0.139	0.031	0.149	0.106	0.134	0.199	0.063	0.017	0.093	0.034	0.023
Average $\overline{x}_i$	4.5	4.53	4.44	4.53	4.46	4.48	4.49	4.42	4.51	4.47	4.47	4.54	4.5
Weight w_i	0.093	0.041	0.290	0.065	0.182	0.129	0.164	0.243	0.077	0.020	0.114	0.042	0.029
The Third Level Indicators	C41	C42	C43	C44	C45	C51	C52	C53	C54	C55	C56	C57	
Importance p_{ij}	0.018	0.004	0.133	0.049	0.097	0.099	0.026	0.048	0.168	0.088	0.011	0.059	
Average $\overline{x}_i$	4.38	4.39	4.44	4.41	4.47	4.37	4.52	4.5	4.4	4.47	4.53	4.5	
Weight w_i	0.059	0.013	0.442	0.163	0.323	0.197	0.052	0.096	0.337	0.177	0.021	0.119	

Sum each third level index to get the corresponding second level index importance $D_k \ (k = 1,2,\cdots,5)$. Total importance of the system to be evaluated

$$D = \sum_{k=1}^{5} D_k \qquad (5)$$

For the evaluation system of multi-layer structure, according to the principle of additivity, calculate secondary index weight A_j.

$$A_k = D_k / D \qquad (6)$$

According to formula (5) and (6), average score, importance and weight of the secend level indicators are calculated as shown in the table 8.

Table-8: Average score, Importance and Weight of The Secend Level Indicators

The Secend Level Indicators	B1	B2	B3	B4	B5
Average $\overline{Y}_j$	4.546	4.498	4.482	4.418	4.47
Importance D_k	2.047	0.479	3.752	2.471	3.115
Weight A_j	0.494	0.115	0.198	0.072	0.121

Analysis of Student Satisfaction Index

Calculation formula of student satisfaction index is

$$SCI = \frac{\sum_{j=1}^{m} \overline{Y}_j \cdot A_j}{5} \cdot 100\% \qquad (7)$$

In formula (7), $\overline{Y}_j$ is the average of the second level indicators. A_j is Weight, m is the number of the Secend level indicators, 5 is maximum satisfaction score.

$$SCI = \frac{\sum_{i=1}^{n_j} \overline{X}_{ij} \cdot w_{ij}}{5} \cdot 100\%, \ i = 1,2,\cdots,38, \ j = 1,2,3,4,5 \qquad (8)$$

In formula (8), $\overline{X}_{ij}$ is the average of the third level indicators. w_{ij} is Weight, n_j is the number of indicators, 5 is maximum satisfaction score.The satisfaction index of the secend level indicators are shown in the figure 3.

Fig-3: The Satisfaction Index of the Secend Level Indicators

The overall satisfaction index of the students is 79.40%, which shows that the students of our university are quite satisfied with the college mathematics course.

Analyze each secondary index in detail. Calculation formula of satisfaction index of the secendlevel indicators

It can be seen that students have the highest satisfaction index for teachers, which is the high recognition of students for the quality of school teachers. Secondly, the cultivation of talents and the effect of classroom teaching show that students are satisfied with the existing classroom teaching methods and management system of college mathematics. The satisfaction index of teaching resources and teaching management is low, which shows that in the future teaching, we should not only strengthen the teaching management, but also strengthen the construction of online and offline teaching resources.

Analysis of influencing factors

The independent sample t-test is used to test the influence of source type and gender on satisfaction index. The calculation results are shown in Table 9
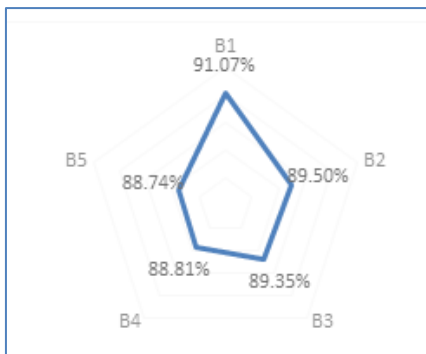
Table-9: Independent sample t-test

Influence factor	t	Sig.	Significance
gender	-1.461	0.144	not significant
the type of student source	-4.533	0	significant

The results showed that gender had no significant effect on the satisfaction index, and the type of student source had significant effect on the satisfaction index.The satisfaction of students from rural areas (average 88.72%) was significantly lower than that from urban areas (average 91.72%).

The results of variance analysis show that the satisfaction index of students in different majors and grades is significantly different, among which the satisfaction index of students in grade four is significantly higher than that of students in other grades.

Table-10: ANOVA (different majors)

	SS	df	MS	F	P-Value
Group	0.678	3	0.226	12.348	0.000
Error	30.591	1671	0.018		
Total	31.269	1674			

Table-11: ANOVA (Different grades)

	SS	df	MS	F	P-Value
Group	0.623	7	0.089	4.843	0.000
Error	30.646	1667	0.018		
Total	31.269	1674			

To sum up, the source of students, majors and grades have a significant impact on the student satisfaction index. When teaching, teachers should teach students according to their aptitude, combining with the students' quality and professional needs.

CONCLUSIONS

The key and importance of learning satisfaction lies in that it can be measured by scientific methods as the subjective expression of College Students' learning. The research data fully reflects the actual feelings of college students on college mathematics teaching. Through the research and analysis, the following conclusions are drawn:

(1)The students' overall satisfaction with mathematics teaching in our university is higher, the highest one is the satisfaction with teachers, and the satisfaction with teaching management and teaching resources is lower. In the future teaching, we should strengthen the improvement in the teaching management, pay attention to the construction of teaching resources, especially the construction of online resources.

(2) There are significant differences in student satisfaction index among colleges, which mainly shows that the student satisfaction index of the major of advantage discipline is higher than the graduate satisfaction index of general specialty, and there is no significant difference in the gender of student satisfaction, which is consistent with the experience judgment. However, it is worth noting that the source of students has a significant impact on the student satisfaction index. Therefore, in the future teaching, teachers should pay more attention to the characteristics of students and teach students according to their aptitude.

(3) Through the evaluation and analysis of the student satisfaction index, it is beneficial for teachers to understand their own weak links in teaching, find their own shortcomings, improve their own competitiveness, and help schools to formulate correct development strategies.

(4) Using this index system and analysis method, we can realize the historical data comparison of students' satisfaction, so as to determine whether the university mathematics work is effective and meets the needs of students, thus forming an effective interaction between the University and students. High student satisfaction will make the university have good social reputation, attract more high-quality students, more talents and funds, form the value-added of intangible assets, and realize a good cycle of school development.

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