Analysis Based on Structural Equation and Decision Tree Model of Higher Vocational Students' Learning Satisfaction Under Blended Learning

Take Data Processing Course as an Example

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Abstract. Based on the theory of customer satisfaction, this paper analyzes the status of students' learning satisfaction and explores the factors that affect learning satisfaction by constructing the structural equation and decision tree model under blended learning. The results show that in the blended learning practice, students' learning satisfaction is significantly affected by teacher image and platform support. The empirical conclusions obtained from this study have important value for improving learning satisfaction.

Keywords: structural equation · decision tree · blended learning · learning satisfaction · higher vocational students

1 Introduction

With the continuous development of educational informatization and the impact of the COVID-19 in recent years, blended learning, which combines the advantages of online and offline teaching, has gradually become an important part of today's higher education teaching reform [1]. In order to inspect the learning effect, many scholars collected data by designing questionnaires to analyze the influencing factors for blended learning. The customer satisfaction model is a commonly used model to determine variables and indicators in the questionnaire design [2, 3]. For the collected data, many scholars use statistical analysis methods to study the influencing factors, and the most used method is the mechanism equation model [4, 5]. This study takes the data processing course as an example, firstly construct a student satisfaction influence factor, then design a questionnaire survey based on these indicators for the students after taking blended learning. Next, we use structural equation model to analyze the students' satisfaction and its influencing factors. Our research provides a reference for the better development of blended learning in the later stage.

C. F. Peng et al. (Eds.): EIMT 2023, AHSSEH 8, pp. 228–235, 2023.
https://doi.org/10.2991/978-94-6463-192-0_32

2 Construction of Satisfaction Influence Factors and Research Hypothesis

2.1 Construction of Satisfaction Influence Factors

At present, the most influential satisfaction model is the American Customer Satisfaction In-dear (ACSI), which has become the research basis of satisfaction evaluation models in many related fields [2]. Based on the customer satisfaction model, this study regards students as consumers of education, the curriculum based on the blended teaching mode is a product that students choose, and student satisfaction is a psychological feedback based on students' experience of using this product. With reference to the relevant research results and in combination with the teaching practice of the course, a student learning satisfaction evaluation influence factors is established (see Table 1). Student expectation is the inner desire of students before they participate in the course based on blended teaching. Course design is students' intuitive feeling of course experience. The teacher is the implementer of blended teaching, the ability and quality of the teacher image will affect the students' attitude. The online platform provides support for teaching implementation, and the quality of its function setting will directly affect students' evaluation.

2.2 Research Hypothesis

Based on the previous theoretical research and teaching practice, this paper puts forward the following research hypothesis:

H1: Student expectations positively affect students' learning satisfaction.
H2: Course designs positively affect students' learning satisfaction.
H3: Teacher images positively affect students' learning satisfaction.
H4: Platform supports positively affect students' learning satisfaction.

Taking the course Data Set Processing as an example, the students who have participated in the blended teaching practice of the course as the survey object, design a questionnaire, conduct descriptive statistical analysis, reliability, and validity analysis, and construct a structural equation model, measure, and analyze learning satisfaction and its impact factors, and find out the main factors that affect students' learning satisfaction.

3 Data Collection and Analysis

3.1 Data Collection

Based on the above variable analysis, this study designs a questionnaire, which includes two parts: The first part is the basic information of the respondents. The second part is the student satisfaction questionnaire of mixed teaching, which includes four variables and 17 measurement items. The Likert 5-point scale [6] is used to score: 1 = very disagree, 2 = a little agree, 3 = half agree, 4 = most agree, 5 = very agree. This survey was conducted by filling in online questionnaires. A total of 211 questionnaires were received, with an effective rate of 100%.

Table 1. Satisfaction Influence factors

Variable	Index	Item
Student Expectation (SE)	SE1	My interest in this course has increased.
	SE2	My self-confidence has increased.
	SE3	My autonomous learning ability has increased.
	SE4	My programming practice ability has increased.
Course Design (CD)	CD1	I am satisfied with the content of this course.
	CD2	I am satisfied with the online resources of this course.
	CD3	I am satisfied with the online and offline activities.
	CD4	I am satisfied with the assessment of the course.
Teacher Image (TI)	TI1	I am satisfied with the professional skills of the teacher.
	TI2	I am satisfied with the professional ethics of the teacher.
	TI3	I am satisfied with the interaction and feedback of teachers.
	TI4	I am satisfied with the activity organization ability of the teacher.
Platform Support (PS)	PS1	The function of the teaching platform is easy to operate.
	PS2	The teaching platform has rich activities and diverse forms
	PS3	The internet speed of the teaching platform is fast.
	PS4	The mobile terminal of the teaching platform is powerful.
Learning Satisfaction	LS	I am satisfied with this learning based on the blended teaching mode.

3.2 Data Analysis

1) Exploratory Analysis

Carry out descriptive statistical analysis on the basic information of the respondents to understand the basic situation of the sample, as shown in Table 2.

Data obtained from the questionnaire, male students accounted for 73.93% and female students accounted for 26.07%, Sophomore occupied 63.98% and junior occupied 36.02%, 84.83% of students participated in blended teaching for the first time.

2) Reliability and Validity Analysis

Reliability analysis is one of the necessary analyses for questionnaire data processing, which is used to test the stability and consistency of the questionnaire results [7]. The most used coefficient for reliability analysis is Cronbach coefficient. In the five-point Likert scale, the higher the value of a coefficient, the better the consistency and reliability of the scale. The results of reliability analysis are shown in Table 3.

It can be seen from Table 3 that the Cronbach coefficient value is 0.977 greater than 0.9, which indicates that the reliability quality of the research data is high and can be used for further analysis.

Table 2. Exploratory analysis

Description	Item	Percentage
Gender	Male	73.93%
	Female	26.07%
Grade	Sophomore	63.98%
	junior	36.02%
Participated in blended teaching for the first time	Yes	84.83%
	No	15.17%

Table 3. Reliability analysis

Items	Samples	Cronbach Coefficient
17	211	0.977

The purpose of validity test is to evaluate whether the items of the questionnaire can truly and effectively reflect the variables [8]. KMO value and Bartlett sphericity are usually used for validity test. KMO value is used to check the partial correlation between variables. The results of validity analysis are shown in Table 4. From the results in Table 4, its KMO value is 0.980 (>0.8), and the significance of Bartlett's sphericity is 0.000 ($p < 0.05$). This shows that the results of the questionnaire are very consistent with the measured content, and the validity is high, and there is a significant correlation between the data of each item.

3) Structural Equation Verification

This study involves five variables: student expectation (SE) and class design (CD), teach image (TI), platform support (PS) and learning satisfactory (LS). The first four are independent variables and learning satisfaction is dependent variable. Independent variables are mutual Phase influence, comprehensively determining and influencing the dependent variable. The specific assumption is H1-H4.

According to relevant research results of structural equation [9, 10], combined with the hypothesis in this study, the student learning satisfaction model can be constructed, such as Eq. (1)–(4). a1, a2, a3 and a4 respectively represent the influence coefficient of

Table 4. Validity analysis

KMO		0.953
Bartlett's sphericity	p	0.000

independent variables SE, CD, TI, and PS on dependent variable LS, and e1, e2, e3 and e4 are residual terms.

$$LS = a_1 * SE + e_1 \tag{1}$$

$$LS = a_2 * CD + e_2 \tag{2}$$

$$LS = a_3 * TI + e_3 \tag{3}$$

$$LS = a_4 * PS + e_4 \tag{4}$$

In order to test the research hypothesis of this study, the influence of student expectation, teacher image, curriculum design and platform support on students' learning satisfaction was tested at the level of $P < 0.05$ by estimating the weight of standardized regression coefficient, as shown in Table 5. Student expectations have a significant negative impact on students' learning satisfaction ($p = 0.015 < 0.05$, $RC = -0.240$), Course designs doesn't have a significant positive impact on students' learning satisfaction($p = 0.723 > 0.05$, $RC = 0.074$), therefore, H1 and H2 assumptions are not tenable. Teacher image and platform support both have a significant positive impact on students' learning satisfaction ($p < 0.05$, $RC > 0.5$), so H3 and H4 are established. Removing student expectations and course designs, and reconducting structural equation model, the results are shown in Table 6. The final model of student learning satisfaction under the blended teaching is shown in Fig. 1.

4) Satisfaction Prediction Based on Decision Tree

Decision tree is a common classification algorithm in machine learning. Like any classification problem, the goal here is to establish a model to predict the value of dependent

Table 5. Significance test and standardized regression coefficient of the model 1

X	→	Y	P	Regression Coefficient (RC)	Test Results
SE	→	LS	0.015	−0.240	fail
CD	→	LS	0.723	0.074	fail
TI	→	LS	0.012	0.550	pass
PS	→	LS	0.000	0.596	pass

Table 6. Significance test and standardized regression coefficient of the model 2

X	→	Y	P	Regression Coefficient (RC)
TI	→	LS	0.000	0.505
PS	→	LS	0.000	0.470

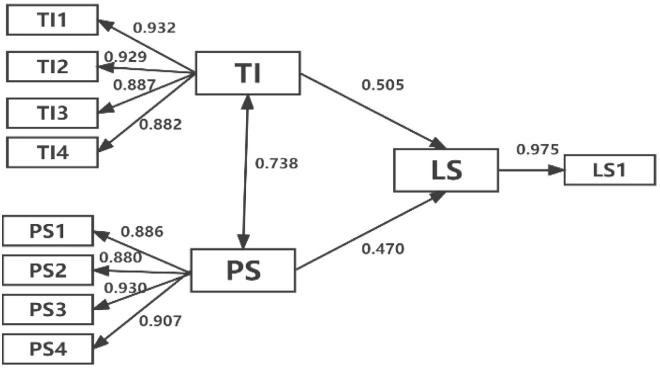

Fig. 1. Model of student learning satisfaction under the blended teaching

variables (learning satisfaction) according to the value of other influencing factor variables [11]. This paper uses the decision tree algorithm of the machine learning library scikit-learn to complete model prediction, as shown in Fig. 2. In order to measure efficiency and accuracy of the prediction model, evaluating metrics, such as accuracy, precision, recall, and F1 were commonly used [12]. The higher all these indicators are, the better the effect of the constructed model is. The results of the metrics of the model on testing set is shown in Table 7.

It can be seen from the above table that all indicators of the final model in the test set are greater than 0.9, and the model is very effective.

1. Input influence factorsX and dependent variable y
2. Split data set X and y into training set and test set respectively(test_size=0.2)
3. Build decision tree model
4. Train decision tree model by using training set
5. Evaluate decision tree model by using testing set
6. Output the evaluating indicators of the model based on testing set

Fig. 2. Decision tree algorithm

Table 7. The results of the metrics of the model on testing set

Metrics	Values
accuracy	0.907
precision	0.912
recall	0.907
F1	0.910

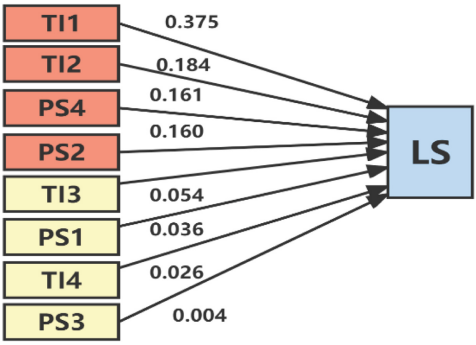

Fig. 3. The importance of the contribution of these eight factors

The importance of the contribution of these eight factors to the model is shown in Fig. 3. The four main factors affecting students' learning satisfaction are TI1, TI2, PS4 and PS2.

The analysis results based on the decision tree model show that the teachers' professional skills and ethics, and the mobile functions and rich forms of activities of the course platform have the most significant influencing in this blended learning satisfaction.

4 Conclusion and Suggestion

From the revised structural equation chart, we can draw the following conclusions: teacher image and platform support have a direct and positive impact on student satisfaction; students' expectation and course design have no significant impact on students' satisfaction; teacher image and platform support have mutual influence and complement each other. Based on the above conclusions, the following suggestions are put forward to carry out blended teaching in higher vocational colleges:

- Improve teachers' professional ethics, skills, and teaching abilities. Moreover, teachers should carefully design and arrange teaching activities, and timely feedback and evaluate students' communication content, so that students can obtain higher learning satisfaction.
- Choose a platform with powerful mobile functions and rich activities to complete blended teaching. Now students often like to use mobile phones to finish online learning, so improving the mobile terminal functions and design meaningful activities can enhance the learning satisfaction in blended learning.

Acknowledgment. This work is supported by 2021 Teaching Reform project of Guangdong Polytechnic Institute (No. 26), Scientific Research Projects for Special Talents of the Open University of Guangdong (RC1916).

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