Study on the Teaching Quality Evaluation of Flipped Classroom from the Perspective of Learners

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Abstract:

This study constructed the index system of flipped classroom teaching quality evaluation from the three dimensions of teaching effect, teaching process and teaching resources. Then based on this evaluation system, more than 30 courses of flipped classroom teaching were implemented for the student evaluation and 1,545 evaluation data were collected. Then the evaluation system index was used as the input variable, and the real evaluation results were taken as the output variable. The prediction of the teaching quality of the flipped classroom was evaluated using the C5.0 decision tree model. The prediction results showed that the prediction accuracy reached 73.19% for the training data and 63.24% for the test data.

Keywords: *Flipped classroom, Teaching quality, Evaluation system, Decision tree model*

I. INTRODUCTION

In recent years, the flipped classroom has become a hot topic in the research of international higher education and education theory. Professor Daphnne Koller at Stanford University believes that the new form of teaching supported by flipped classroom technology may be a major change in the classroom teaching since the European Renaissance[1].The flipped classroom is the teaching of knowledge through information technology, and knowledge internalization is completed through the assistance of teachers and students in the face-to-face teaching courses and the information interaction platform, so that the teaching and learning process is flipped [2].

It is well known that learner satisfaction is one of the core measures of flipped classroom formation assessment. This is because perceptual satisfaction is not only shown to largely predict learner learning effects and their affective tendency to continue learning, but also student satisfaction can actively promote cooperation and sharing among learners, which plays an important role in the effective

implementation of flipped classroom teaching [3].The significance of implementing the flipped classroom is to transform the students from the passive acceptance of the evaluation to the subject and active participant of the evaluation. Therefore, how to effectively improve learners' satisfaction and improve the teaching effect of the flipped classroom will be an important issue for education practitioners and researchers [4].

One of the important features of the flipped classroom is full respect for the subjectivity of learners, highlight personalized design in the teaching strategy and pay high attention to students' initiative and active participation, rather than passive acceptance of information. It is due to the characteristics of flipped classroom that pays attention to student participation and experience that we need to fully consider various factors such as the personal characteristics of learners and flipped classroom design when studying how to improve the learner satisfaction of flipped classroom. Therefore, from the perspective of student experience, it is particularly necessary to explore and flip the evaluation of classroom teaching quality.

II. THE CHARACTERISTICS OF THE FLIPPED CLASSROOM TEACHING QUALITY EVALUATION

In the traditional teaching, the teaching activities are relatively simple, the focus of the evaluation is generally placed on the learning results, mainly using the outcome evaluation method. Compared with the traditional classroom, the teaching process of the flipped classroom is more complex, more abundant learning activities, and more diverse learning results. To scientifically evaluate the teaching performance of the flipped classroom, not only to evaluate the students 'learning results, but also to focus on evaluating the students' learning process.

The learning mode of flipped classroom not only accepts learning, but also has autonomy, cooperation and inquiry learning. The learning activities of the flipped classroom are not only individual self-study, group discussion, practical operation, but also personal experience, summary and reflection, etc. Various learning methods and complex learning activities are bound to generate rich learning results. Various learning methods and complex learning activities are bound to generate rich learning results.

The teaching process of flipped classroom mainly includes before class, during class and after class, and the teaching activities are very rich. To scientifically evaluate the teaching effect of flipped classroom, it is necessary to comprehensively evaluate the attitude tendency, learning behavior and learning effect in the three links, that is, the evaluation should run through the whole process of flipped classroom teaching [5].

III.CONSTRUCTION OF THE INDEX SYSTEM OF FLIPPED CLASSROOM TEACHING QUALITY EVALUATION

3.1 The Theoretical Basis of Flipped Classroom Teaching Quality Evaluation

3.1.1 Fourth-generation theory of education evaluation

As early as 1989, American scholars Kuba and Lincoln put forward the "Fourth Generation Evaluation Theory" on the basis of reflecting and criticizing the traditional evaluation theory, which sets the evaluation at the development of the nature. They put forward the evaluation process to pay attention to the values of everyone, advocate evaluation is a "Psychological Construct" formed by people in their interaction with objects. Based on this, the evaluation ideas and methods such as "common construction", "full participation" and "value diversification" are put forward. The diversified evaluation subjects, comprehensive evaluation content, equal evaluation relations and diverse evaluation methods advocated by the fourth generation of educational evaluation theory are all important bases for the construction of flipped classroom teaching quality evaluation system [6].

3.1.2 Teaching theory based on effectiveness

Effectiveness-based teaching theory was created by Australian scholar Professor Biggs. He proposed that there cannot be contradictions in all aspects of the teaching process, which is an important aspect of evaluating the teaching design. The learning curriculum, teaching methods, learning environment and evaluation process covered should be agreed. Effectiveness-based teaching theory has been implemented and received good feedback in some countries, including Australia, New Zealand, Great Britain, the United States, South Africa and others. Flip classroom teaching quality evaluation system, pay attention to process evaluation at the same time, should also pay attention to the learning results, and should realize that the construction of education quality evaluation system is throughout the teaching process, including teaching project planning, curriculum, curriculum design, teaching and learning course evaluation and other links [7].

3.1.3 Blended learning theory

The flipped classroom makes full use of the Internet and closely integrates the pre-class network learning in class with the classroom teaching, and this kind of teaching exploration is closely related to the mixed learning theory, which combine the advantages of traditional learning methods and the advantages of network learning methods. Flip classroom is in line with the advantages of traditional and network learning advocated by mixed learning, and it is a learning way that can achieve the most optimal learning effect.

3.2 Construction Principle of the Teaching Evaluation Index System

Teaching process evaluation plays a key position in the classroom teaching evaluation, because the ultimate purpose of the teaching evaluation is to evaluate the students' learning situation and their own development situation. Teaching evaluation is a kind of evaluation method for the teaching process, using a systematic analysis method, to collect a large amount of data, and to make an accurate and effective value evaluation of the teaching process and teaching results. It is also an important basis for teachers to improve their self-teaching level and relevant departments to make adjustments to their teaching policies. To put it simply, teaching evaluation is a means of evaluating the content and effect of each class, and making a comprehensive evaluation of each class according to the evaluation method and content of the evaluation system. Barbansky once mentioned in "The Optimization of the Teaching Process" that the teaching process includes "teaching" and "learning", which are related to each other. They are not only a simple sum of teaching and learning, but organically combine the two "teaching" and "learning" processes together while maintaining their own characteristics. Therefore, the teaching evaluation is not only used to measure the quality of the teachers' teaching activities in the teaching process, but also an evaluation of the knowledge that the students obtain through learning, as well as the degree of their own improvement. The construction of the flipped classroom teaching evaluation index system should also be based on the general principle of the teaching evaluation index system construction.

3.2.1 Principles of overall integrity and objectivity

Overall integrity refers to the evaluation indicators can fully include the performance in the teaching activities of teachers and students, but also need to be able to systematically reflect the individual and overall evaluation results. The principle of objectivity is to make an objective evaluation of the specific situation in the teaching process of teachers and students. That is, the indicators can fully reflect the overall accurate development situation, and the upper index, as an important component, should form a sufficient and necessary relationship between each other, while the lower index should achieve the goals and requirements required by the upper index.

3.2.2 Direction principle

The directionality of evaluation refers to making the goal of education more detailed and making the teaching more specific and purposeful, which is a standard formulated for a specific direction of education. Therefore, in the formulation of evaluation indicators, to combine the purpose of teaching and education to carry out practical investigation, can not deviate from teaching.

3.2.3 Operability principle

Evaluation system as an objective basis for evaluation object behavior and concrete, should have easy to operate, applicable conditions, the description of it should reflect its operability, can be easily understood by users, and can do the practical guiding role, the evaluation results should also be able to achieve clear observation and understanding.

3.3 The Index System of Flipped Classroom Teaching Quality Evaluation

According to the above principles, the index system of flipped classroom teaching quality evaluation was constructed from the three dimensions of teaching effect, teaching process and teaching resources. The indicators of the specific evaluation system are shown in TABLE I.

TABLE I. The index system of flipped classroom teaching quality evaluation

PRIMARY INDEX	SECONDARY INDEX	VARIABLES
TEACHING EFFECTIVENESS	The course is more attractive after adopting the flipped classroom teaching model	X1
	The flipped classroom provides a better and effective learning environment	X2
	The flipped classroom is more helpful to improve my professional ability	X3
	The flipped classroom learning efficiency is higher than the traditional teaching	X4
	The flipped classroom helps to improve my comprehensive quality	X5
	The flipped classroom made me communicate more and get closer with my teachers and classmates	X6
	The flipped classroom can help me master my knowledge better	X7
TEACHING PROCESS	Pre-class learning tasks are clear, the learning volume and difficulty are moderate, and you have basic knowledge homework	G1

TEACHING MATERIALS	Each classroom teaching activity of the flipped class is based on our pre-class learning, and the classroom design is highly targeted	G2
	I can devote myself into my study and I am fully prepared for class every flip class	G3
	I can get help timely and effectively when I have problems studying before class	G4
	The group members have a clear division of labor, mutual cooperation and frequent interaction	G5
	Learning outcomes display (test, answer questions, discussion) atmosphere is good	G6
	Homework has expanded content and helps to improve my knowledge	G7
	The online course learning platform that supports course teaching is convenient and efficient to use	Z1
	Teaching video can replace the traditional teacher's classroom explanation, and effectively support my independent learning	Z2
	The teacher is rich in video, courseware, tests and other independent learning resources	Z3
	The current teaching places (classrooms) are suitable for flipped classrooms	Z4

IV. RESEARCH DESIGN

4.1 Sample Selection

Nearly 200 undergraduate students from an applied undergraduate university were selected as research subjects. More than 30 courses implementing flipped classroom teaching, including "Android Development Foundation", "J2EE Architecture and Application Development", and "WEB Programming Foundation" for the first semester of 2019, were selected for online student evaluation.

4.2 Data Collection

After a semester of flipped classroom teaching practice, the researchers used the secondary index in TABLE I as a issue of evaluation. Options were set using a five-level Likert scale. The options for all questions are set to 1 very disagree, 2 disagree, 3 general, 4 agree and 5 very agree. A total of 1,545 evaluation data were collected through an online questionnaire at the end of the semester. Some data

with unreasonable answer time and unreasonable evaluation results were discarded, and a total of 1,474 valid data were obtained, the efficiency was 95.4.Since the small sample size of the real evaluation results corresponds to excellent, the qualified samples were randomly sampled prior to constructing the model, balancing the sample size of the final two actual evaluation results. Finally the sample size was obtained with 103 data each for the two actual evaluation results.

4.3 Construction of the C5.0 Decision Tree and the Analysis of the Experimental Results

4.3.1 Introduction to the C5.0 decision tree model

The C5.0 algorithm was developed based on the earliest algorithm ID3 algorithm for the decision tree. The ID3 algorithm, since being proposed by J.R. Quinlan in 1979, has formed the C4.5 algorithm of landmark significance with decision trees. The C5.0 algorithm is a commercial version of the C4.5 algorithm at the same core as the C4.5, only with improvements in execution efficiency and memory usage.

The C5.0 algorithm can be used to generate a multi-branch decision tree. The input variable can be partial or numeric, and the output variable should be sub-type. The C5.0 algorithm determines the optimal grouping variables and segmentation points with the information gain rate criterion, and its core concept is the information entropy.

The information gain is actually used in the ID3 algorithm. It selects the attribute with the highest information gain as the split property of the node N. This property minimized the amount of information required for the tuple classification in the resulting partition. The desired information required for the tuple classification in D is the formula (1):

$$Info(D) = -\sum_{i=1}^{m} p_i \log_2(p_i) \tag{1}$$

Suppose that the tuples in D are divided by attribute A, and that attribute A divides D into v different classes. After this partition, the information needed to obtain an accurate classification is also measured by the formula (2):

$$Info_A(D) = \sum_{j=1}^{v} \frac{|D_j|}{|D|} \times Info(D_j) \tag{2}$$

Information gain is defined as the difference between the original information requirement (i. e.,

based on class proportions only) and the new demand (i. e., obtained after the division of A), that is:

$$Gain(A) = Info(D) - Info_A(D) \tag{3}$$

The information gain rate normalized the information gain using the "split information" value. Taxonomic information is similar to $Info(D)$. The definition is as follows:

$$SplitInfo_A(D) = -\sum_{j=1}^{v} \frac{|D_j|}{|D|} \times \log_2(\frac{|D_j|}{|D|}) \tag{4}$$

This value represents the information generated by dividing the training dataset D into the v-individual partitions corresponding to the v outputs of the property A test. Information gain rate is defined as:

$$GainRatio(A) = \frac{Gain(A)}{SplitInfo(A)} \tag{5}$$

This study has attempted multiple methods to model this evaluation outcome data before using the C5.0 decision tree, such as principal component analysis, BP neural network model, Logistic regression, etc, but the analysis results were not ideal enough. After comparing the above several analytical modeling methods, the C5.0 decision tree algorithm was finally selected.

4.3.2 Model construction process

The 18 secondary index in TABLE I were used as input variables, the actual evaluation results of all courses were used as output variables. The above 206 valid evaluation data were divided into training data and test data in a ratio of 7:3.The C5.0 decision tree model was constructed using the SPSS Modeler18 software.

4.3.3 Result analysis

From the perspective of the importance of the predictive variables (TABLE II), 8 variables entered the decision tree model, namely G6, G2, G4, Z3, X4, Z1, Z4, and X6.The importance degree of "better atmosphere of flipped classroom performance display (test, answer questions, discussion)" was higher than all other index, and the importance value was more than twice that of other index variables. It shows that the evaluation results of classroom atmosphere play a great role in the evaluation results of flipped classroom. From the primary index, the overall importance of teaching process is the highest,

followed by teaching resources, and the importance of teaching effect is relatively the lowest.

TABLE II. The importance of the index

VARIABLE	IMPORTANCE
G6	0.3274
G2	0.1504
G4	0.1125
Z3	0.1108
X4	0.0835
Z1	0.0753
Z4	0.0702
X6	0.0699

From the prediction effect of this model (TABLE III), the overall prediction accuracy for the training sample was 73.19%.This result also showed that the effectiveness of the model basically meets the standard.

TABLE III. Prediction accuracy for the training and test samples

	Training sample		Test sample	
Correct	101	73.19%	43	63.24%
Wrong	37	26.81%	25	36.76%
	138		68	

In terms of prediction errors (TABLE IV), there are many errors in discarding the truth, whether it is training samples or test samples.

TABLE IV. Specific rediction results of training samples and test samples

TRAINING SAMPLE	0	1
0(ACTUAL)	64	4
1(ACTUAL)	33	37
TEST SAMPLE	0	1

0(ACTUAL)	28	7
1(ACTUAL)	18	15

From the situation of decision tree (Fig 1), the primary evaluation basis is index G2, followed by index Z3 and index G4. Node branching was based on very agree and other options. This result also showed that students' evaluation of the teaching quality of flipped classroom was largely related to teachers' investment. Teachers' improvement in teaching design, teaching resources, communication and interaction will help to improve students' evaluation of the quality of flipped classroom teaching.
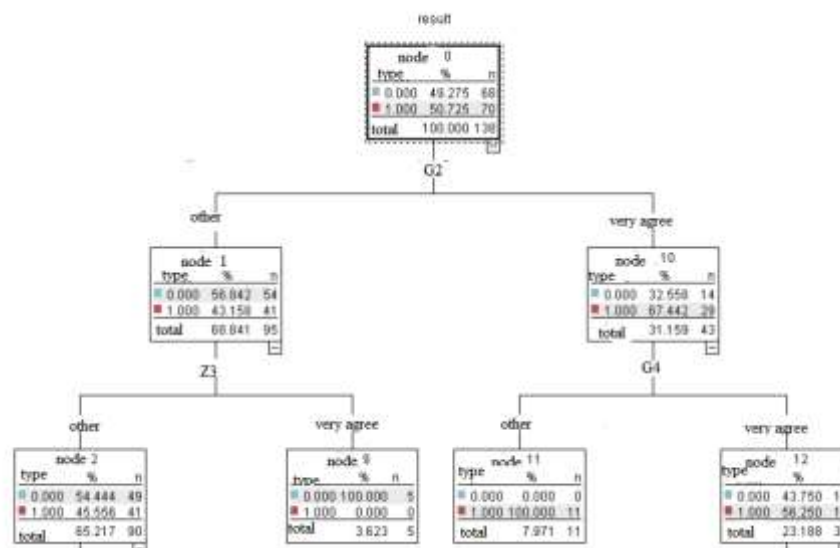

Fig 1: The Decision Tree (Part)

V. CONCLUSION

According to the characteristics of flipped classroom teaching quality evaluation, under the guidance of the fourth generation education evaluation theory, effectiveness based teaching theory and blended learning theory, and following the principles of overall integrity, objectivity, directionality and operability, this study designs a scale for flipped classroom teaching quality evaluation from the perspective of learners. The scale includes three primary index: teaching effect, teaching process and teaching resources, and 18 secondary index such as "the course is more attractive after adopting the flipped classroom teaching mode". The five level Likert scale was used to set the options. The options of all index was 1 very disagree, 2 disagree, 3 general, 4 agree and 5 very agree. Then, an online questionnaire survey was conducted on more than 30 undergraduate students who implemented courses

in flipped classroom teaching in an application-oriented undergraduate university in China. A total of 1545 questionnaires were collected, of which 1474 were valid. After sorting out and resampling the data, guided by the school evaluation results of teaching quality in flipped classroom, after comparing several analysis methods, C5.0 decision tree algorithm was selected to construct the prediction model. The prediction results showed that the overall prediction accuracy for training samples was 73.19%, and the overall prediction accuracy for test samples was 63.24%.Among the primary index, the overall importance of the teaching process was the highest. Students' evaluation of the teaching quality of flipped classroom was largely related to teachers' investment, and students' ability to evaluate the teaching quality of flipped classroom was limited.

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