Evaluation Method of Vocational Undergraduate Practice Teaching Quality Based on Fractal Dimension

Yongping Xiong(✉)

Guangzhou University of Science and Technology, Guangzhou, China
103386927@qq.com

Abstract. To improve the evaluation system of vocational undergraduate practical teaching and promote the sustainable development of practical education, an evaluation method of vocational undergraduate practical teaching quality based on fractal dimension is studied. This paper extracts the multi-dimensional evaluation index of vocational undergraduate practice teaching quality, applies the fractal dimension theory, constructs the sample matrix of the evaluation index of practice teaching quality, analyzes the correlation between evaluation indexes, determines the quantitative weight of fractal dimension, and realizes the evaluation of vocational undergraduate practice teaching quality. The simulation test results verify that for five random data samples, the error values of the evaluation results of this method are all lower than the set error target of 0.02. The average error value is 0.0056, which is accurate and stable, indicating that the application of fractal dimension theory improves the comprehensiveness and objectivity of the evaluation of practical teaching quality, and optimizes the teaching evaluation system. It provides an effective reference.

Keywords: Fractal dimension · Vocational undergraduate education · Undergraduate practice teaching · Practice teaching quality evaluation system

1 Introduction

Under the background of the rapid development of China's overall economy, the field of educational engineering is also constantly optimizing and progressing. As one of the important parts of educational engineering in our country, the teaching mode of vocational undergraduate is constantly innovating in the process of exploration. Among them, the practice teaching mode is widely used in vocational undergraduate teaching. The purpose of practical teaching is to improve students' comprehensive ability, including students' comprehensive analysis ability, practical ability, innovation and creativity, and self-control and self-study ability [2]. This kind of education mode, which combines theoretical knowledge with practical experience, has a significant positive impact on China's vocational education project. Under the vocational education mode of practical teaching, the evaluation of the quality and effect of practical teaching is a very critical link. By constantly analyzing the learning effect of students, we can improve the

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shortcomings of practice teaching in real time so as to promote the reform and innovation of vocational undergraduate practice teaching. The practice teaching is hoped to be truly implemented and achieved [3]. Because of the particularity and multidimensionality of practical teaching, the teaching evaluation methods of most schools at this stage can no longer meet the educational needs of today's society. Therefore, it is necessary to combine modern technology and ideas to develop a more scientific and reasonable evaluation method for practical teaching. Based on the above background, this paper analyzes the fractal dimension theory and studies an evaluation method of the quality of vocational undergraduate practice teaching, hoping to provide a reference scheme for the evaluation of the teaching effect of vocational undergraduate schools, which is to ensure the quality of practice teaching, promote the sustainable development of practice teaching, and enhance the overall economic and social benefits in the field of education engineering.

2 Extracting Multi-dimensional Evaluation Indicators of Vocational Undergraduate Practice Teaching Quality

According to the current development status of vocational undergraduate practical education in China, based on theory and logic, various evaluation elements of vocational undergraduate practical teaching quality are summarized. The multi-dimensional evaluation indicators of vocational undergraduate practice teaching quality are extracted, as shown in Table 1.

On the basis of the initial and multi-dimensional evaluation index of vocational undergraduate practical teaching quality shown above, combined with the fractal dimension theory, a scientific and reasonable evaluation method of vocational undergraduate practical teaching quality is studied.

3 Quantitative Evaluation of Vocational Undergraduate Practice Teaching Quality Based on Fractal Dimension

3.1 Construct the Sample Matrix of Teaching Quality Evaluation

Fractal dimension theory is a method that can identify and reflect the edge characteristics of objects. This is consistent with the quality evaluation of vocational undergraduate practice teaching, which has irregular, complex and nonlinear "fractal" morphological characteristics [5]. Therefore, this paper applies the fractal dimension theory to design the quality evaluation method of vocational undergraduate practice teaching. The sample matrix of the practical teaching evaluation index of fractal dimension is established to lay a good foundation for the subsequent accurate and scientific quality evaluation. The construction process is indicated in Fig. 1.

Suppose there are R kinds of evaluation indexes for the quality of vocational undergraduate practical teaching, in which different evaluation indexes correspond to a kinds of learning States. b represents the weight factor of the evaluation index, and $b = 1, 2, 3$. According to the above expression, the generalized dimension of the practical teaching evaluation index is determined as R_b^a, and then the sample matrix of the corresponding

Table 1. Multi-dimensional vocational undergraduate practice teaching quality evaluation index

No.	One-dimensional index	Two-dimensional index	Three-dimensional indicators
1	Teaching background	Teaching purpose	The feasibility of the teaching plan; the degree of understanding of the teaching objectives; the degree of recognition of the teaching objectives
		Teaching plan	The reasonableness of students' teaching plans and the clarity of teaching objectives
2	Teaching input	Capital input	The amount of funds for school-enterprise cooperation; the number of practice bases; the matching degree between practice bases and undergraduate majors; the utilization rate of base facilities; the perfection degree of base facilities
		Teacher resource	The degree of perfection of teacher team; the degree of reasonableness of teacher team structure; the degree of perfection of teacher training mechanism
		Safeguard system	On the perfection of practical teaching system for vocational undergraduates
3	Teaching process	Practice teaching content	The richness of practical teaching content, the proportion of practical and theoretical teaching, and the scientificity of practical teaching content
		Teacher's teaching process	Teachers' practical experience; teachers' teaching methods; teachers' emphasis on practical teaching

(*continued*)

Table 1. (*continued*)

No.	One-dimensional index	Two-dimensional index	Three-dimensional indicators
		Student learning process	The number of participating in practice activities; the total time of participating in practice activities; the attitude to participate in practice; the ability to learn practical knowledge
		Teaching assessment	The results of multiple examinations; the practicality of the evaluation system; the practicality of the graduation thesis
4	Teaching achievements	Student literacy	The mastery of basic professional knowledge; the mastery of core professional skills; the ability of autonomous learning
		Social practice	The degree of recognition of vocational colleges and the degree of satisfaction of enterprises.

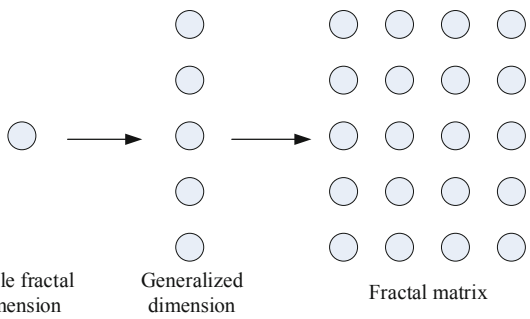

Fig. 1. Construction of sample fractal matrix for quality evaluation of vocational undergraduate practical teaching

vocational undergraduate practical teaching quality evaluation in the s th learning state can be obtained, which is expressed as:

$$R_b^s = [R_1, R_2, R_3] \tag{1}$$

where, R_1, R_2 and R_3 respectively represent the sample sequence of vocational undergraduate practical teaching quality evaluation under different weight factors. In the process of constructing the sample sequence of fractal dimension, it is necessary to determine the weight factor of the sample sequence corresponding to the generalized dimension so as to obtain a comprehensive quality evaluation scheme with different measures.

3.2 Correlation Analysis of Evaluation Index Based on Fractal Dimension

On the basis of the above generalized dimension sample sequence, combined with the fractal dimension algorithm, the correlation of vocational undergraduate practice teaching quality evaluation indicators is analyzed. The weight factor of the sample sequence is determined, which lays a good foundation for the multi-dimensional comprehensive evaluation of practice teaching [6]. The correlation function is introduced to determine the correlation of different vocational undergraduate practice teaching quality evaluation indicators according to the distance between the generalized dimension sample sequences, and the calculation is expressed as:

$$\eta(a,u) = 1 \Big/ \sqrt{\frac{1}{r}\sum_{b=0}^{r}\left(R_b^s - R_b^u\right)^2} \tag{2}$$

where, $\eta(a,u)$ represents the correlation function of the evaluation index distance of vocational undergraduate practical teaching quality; u represents the evaluation index factor to be analyzed. Through the calculation of the above correlation function, the correlation degree between different evaluation indexes can be determined. The larger the value of the correlation function is, the closer the distance of the generalized dimension sample sequence is, and the stronger the correlation between the two factors is, that is, the closer the state between the two sample sequences is, and vice versa. Through the correlation analysis of the evaluation index of vocational undergraduate practical teaching quality, the generalized dimension of the evaluation index can be classified to determine the quantitative weight of evaluation index, and realize the comprehensive and objective evaluation of vocational undergraduate practical teaching quality.

3.3 Determining the Quantitative Weight of the Evaluation Index

According to the results of the generalized dimension and correlation analysis of the above vocational undergraduate practice teaching quality evaluation index, the samples are arranged in descending order according to the fractal dimension of the evaluation index sample sequence. According to the arrangement order, the quantitative weights of the evaluation indicators of undergraduate practical teaching quality are determined respectively, as displayed in Table 2.

According to the weight value of the evaluation index, combined with the calculation results of fractal dimension, the evaluation of the quality of vocational undergraduate practice teaching is realized.

Table 2. Quantitative weight table of undergraduate practice teaching quality evaluation index

No.	One-dimensional index	Two-dimensional index	Three-dimensional index
1	Teaching background R_1^1	Teaching purpose R_5^2	Degree of recognition of teaching objectives R_{16}^3; Degree of understanding of teaching objectives R_{17}^3; Degree of clarity of teaching objectives R_{18}^3
		Teaching plan R_6^2	Reasonable degree of student teaching plan R_{19}^3; Feasibility of teaching plan R_{20}^3
2	Teaching input R_2^1	Capital input R_7^2	Amount of funds for school-enterprise cooperation R_{21}^3; Construction quantity of practice base R_{22}^3; The matching degree between the practice base and the undergraduate major R_{23}^3; Facilities utilization rate of the base R_{24}^3; The degree of perfection of base facilities R_{25}^3
		Teacher resource R_8^2	Perfection of teacher team R_{26}^3; Reasonable degree of teacher team structure R_{27}^3; Perfection of teacher training and refresher training mechanism R_{28}^3
		Security system R_9^2	On the perfection of practical teaching system for vocational undergraduates R_{29}^3

(*continued*)

Table 2. (*continued*)

No.	One-dimensional index	Two-dimensional index	Three-dimensional index
3	Teaching process R_3^1	Practice content R_{10}^2	The richness of practical teaching content R_{30}^3; Proportion of practical and theoretical teaching R_{31}^3; The scientificity of practical teaching content R_{32}^3
		Teaching process of teachers R_{11}^2	Teachers' practical experience R_{33}^3; The way the teacher teaches R_{34}^3; Teachers' emphasis on practical teaching R_{35}^3
		Student learning process R_{12}^2	Number of practices participated in R_{36}^3; Total time engaged in practice activities R_{37}^3 Attitude of participating in practical activities R_{38}^3; Ability to learn practical knowledge R_{39}^3
		Teaching assessment R_{13}^2	Results of multiple examinations R_{40}^3; Highlight the practicality of the evaluation system R_{41}^3; Practicality of graduation thesis R_{42}^3
4	Teaching achievements R_4^1	Student literacy R_{14}^2	Mastery of basic professional knowledge R_{43}^3; Mastery of core professional skills R_{44}^3; Autonomous learning ability R_{45}^3

(*continued*)

Table 2. (*continued*)

No.	One-dimensional index	Two-dimensional index	Three-dimensional index
		Social practice R_{15}^{2}	The degree of recognition of vocational undergraduate colleges R_{46}^{3}; Degree of satisfaction with the company in which they work R_{47}^{3}

4 Evaluation System Testing and Result Analysis

To test the feasibility of the quality evaluation method of vocational undergraduate practice teaching based on fractal dimension, a simulation experiment is designed. The Windows system is used to build the test platform of the experiment. In the database of the system, a vocational undergraduate school is randomly selected as the test target of this experiment. Matlab software is used to set the evaluation index value shown in Table 3. Then, input five groups of random sample data, and set the error target of vocational undergraduate practice teaching quality evaluation as 0.02. Based on this, the evaluation method based on the fractal dimension theory, the traditional method, and the evaluation method based on the analytic hierarchy process in this paper are applied respectively to carry out simulation tests in Matlab software. It is adopted to record the output results of different evaluation methods, and compare and analyze them with the actual values corresponding to the nodes, as shown in Table 3.

According to the comparison between the evaluation results of the three methods shown in the above table and the actual results, the error curves of the three evaluation methods are drawn based on the target error value of 0.02, as shown in Fig. 2.

It can be seen from Fig. 2 that for the 5 groups of random data samples, the error values of the evaluation results of the test group were lower than those of the control group 1 and 2. The average error value of the evaluation results of the test group was 0.0056, which was 0.0292 and 0.0188 lower than that of the control group 1 and control

Table 3. Record of fitting results of different evaluation methods

No.	Sample data	Evaluation results			
		Real value	Experimental group	Control group 1	Control group 2
1	Group 1	0	0.006	0.026	0.017
2	Group 2	1	0.995	0.982	0.974
3	Group 3	1	0.998	0.964	0.977
4	Group 4	0	0.004	0.035	0.024
5	Group 5	1	0.989	0.941	0.968

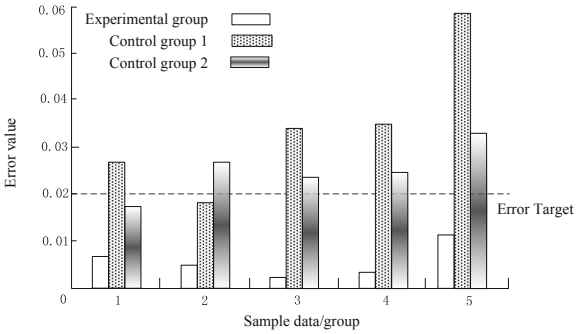

Fig. 2. Error comparison and analysis of evaluation results of different methods

group 2, respectively. It can be seen that the evaluation method of the test group is more feasible and has accuracy and stability. The above experiments indicate that the application of fractal dimension theory overcomes the subjectivity of the weight calculation of vocational undergraduate practice teaching evaluation index, improves the comprehensiveness and objectivity of practice teaching quality evaluation, provides a more effective evaluation scheme for the school's teaching quality evaluation. It also perfects the teaching evaluation system, and is conducive to the virtuous circle development of the teaching field.

5 Conclusion

In order to analyze and evaluate the teaching effect comprehensively and comprehensively, combined with the fractal dimension theory, the multiple factors affecting the effect of practical teaching are analyzed in depth. The integrity and objectivity of the evaluation results are enhanced, which lays a good foundation for the establishment of the evaluation system of the vocational undergraduate practical teaching and promotes the virtuous circle development of the practical teaching education.

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