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Research on Teaching Evaluation of Mathematics Online Open Courses Based on DEA

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Abstract: *Online open course construction uses information technology means to integrate and share high-quality teaching resources and micro courses, and further promote curriculum construction on the basis of promoting resource sharing. Online open courses play an important role in promoting the reform of education and teaching and the innovation of education system in colleges and universities, and improving the construction of education and teaching quality. Mastering the scale and scope of online open course teaching activities is an important means to evaluate the performance of online teaching mode and promote the promotion of online teaching mode. Firstly, this paper determines the selection principle of online open course evaluation index, designs the evaluation index system, secondly, expounds the principle and method of DEA evaluation model, and finally makes an empirical study on 9 online open courses of mathematics in a certain university.*

Keywords: *online open course, performance evaluation, data envelopment analysis*

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I. Introduction

In recent years, the rapid development of information technology has also brought about innovations in teaching methods and teaching models. The ever-changing student situation and the rapid development of information technology have determined that the teaching of applied mathematics in recent years must be accompanied by teaching reform. Since the Ministry of Education officially launched the "National Quality Open Course Construction and Sharing" project in 2011, China has gradually formed open video courses, resource sharing courses, MOOC (large-scale open online courses, referred to as MOOC courses) and SPOC (small-scale proprietary online courses) developed on the basis of MOOC, and many other types of Chinese special online open course systems. In 2018, the Ministry of Education in the newly released "Opinions of the Ministry of Education on Accelerating the Construction of High-Level Undergraduate Education and Comprehensively Improving Talent Cultivation Ability", put forward the need to promote the development of high-quality resource platforms such as MOOC, share high-quality teaching resources, at the same time, formulate corresponding standard systems, vigorously promote the construction of MOOC, and improve the quality of curriculum teaching.

Some scholars have studied the quality evaluation of online open courses. Zhang and Ren analyzes the construction and application of the online open course of higher mathematics in higher vocational colleges, and makes data survey and feedback on the comprehensive use of the course [1]. Xu took the online course construction of advanced mathematics as the research object, explained from the aspects of teaching courseware, video library, on-line question answering and test question bank, creating a mixed teaching model and learning model, constructed the process assessment system of multiple integration [2]. Based on the theory of course effectiveness, Qian and Ding attempted to build a feasible and multi-stage evaluation system of the effectiveness of online open courses through empirical investigation and quantitative analysis [3]. At present, the current curriculum quality evaluation mostly focuses on the evaluation of students 'knowledge learning and teaching conditions in classroom teaching, or it is measured around the students' test scores, progression rates and other indicators. Basically, there is no evaluation system with its own characteristics. Compared with the traditional classroom teaching evaluation, the open online course has its characteristics that cannot be ignored, and its evaluation is also difficult.

Data envelopment analysis (DEA) , as a new research field of operations research, can be used to study the relative effectiveness of decision-making methods between multiple inputs and outputs of the same type of department (decision unit). It can not only use linear programming to judge whether the production activities of the corresponding points of the decision unit are effective, but also can obtain many useful management information at the same time, and can use this information to assist managers in making scientific decisions. Since the first work published in [4] about efficiency in Decision Making Units (DMU) using DEA, many variants of the original DEA model and applications to real systems have grown exponentially. Regarding the

development of DEA models, many works have been proposed to handle special data, to include the DMU's internal process, to develop a two-stage contextual factor evaluation framework, and to handle variables which plays the role of input and output variable. Education is one of the first applications of DEA, e.g. efficiency of urban elementary schools [5] and efficiency of the program "Follow Through" a large-scale social experiment in public school education [6]. Since then, two major streams of literature have been identified. In the first one, the objective is to evaluate basic educations. In the second stream, the main objective is to evaluate the efficiency of higher education (academic departments and universities).

At present, the relevant research and empirical research on the effectiveness evaluation of online open courses are relatively scarce, and the absence or imperfection of online open course evaluation will lead to the lack of standardization of such course management, and the actual output of course construction cannot match the expected input. Therefore, it is necessary to further study the effectiveness evaluation of online open courses in colleges and universities, and establish a scientific and effective online open course evaluation system, so as to improve the quality of online open courses, which has a strong guiding role in the construction and future development of online open courses.

II. DEA mathematical model

Data envelopment analysis (DEA) is a non–parametric method to measure the efficiency of decision making units (DMU) with multiple inputs and outputs in relation to a group of interest. The emergence of the DEA method has extended the concept of engineering efficiency from the single input single output problem to the multiple inputs and outputs problem. Compared with other methods, the significant advantage of the DEA method is that it avoids subjective factors, does not need to estimate parameters in advance, and does not need to assume the weight of each vector. In addition, there is no need to clarify the functional relationship between input and output. The new "data-oriented" method with excellent performance has provided a new way for production evaluation since it was proposed. Researchers and practitioners have used DEA in the last thirty year as a benchmark tool mainly in banking, health care, agricultural and farm, transportation, and education [7].

DEA has two important models: C2R model and BCC model. The C2R model is used to evaluate decision-making units with multiple inputs and outputs to evaluate technical effectiveness. The BCC model is used to evaluate pure technical effectiveness of decision-making units. The following is an introduction to the C2R model.

DEA is the concept of technical efficiency as the ability of a $DMU_j(j=1,2,\cdots,k)$ to obtain maximum outputs $Y_j=(y_{1j},y_{2j},\cdots,y_{nj})$ from a given set of inputs $X_j=(x_{1j},x_{2j},\cdots,x_{mj})$. Therefore, DEA is a multi-criteria evaluation methodology in which X_j and Y_j are two sets of performance criteria where the inputs (X_j) are minimised while the outputs (Y_j) are maximised.

$$\min[\theta_c-\varepsilon(e^Ts^-+e^Ts^+)]$$

$$s.t.\begin{cases}\sum_{j=1}^{K}\lambda_jX_j+s^-=\theta_cX_0\\ \sum_{j=1}^{K}\lambda_jY_j+s^+=Y_0\\ \lambda_j\geq 0,\ j=1,2,\cdots,K\\ s^+\geq 0,s^-\geq 0\end{cases}\tag{1}$$

where s^- and s^+ are the input and output relaxation variables, respectively, ε is non-Archimedes infinitesimal, e^T is the unit row vector.

Equation (1) can find the optimal solution is θ^*, s^{+*}, s^{-*} and λ^*, and its economic meaning is:

①if $\theta^*=1$, $s^{+*}=s^{-*}=0$, then DMU_j is DEA effective;

②if $\theta^*=1$, $s^{+*}\neq 0$ or $s^{-*}\neq 0$, then DMU_j is weak DEA effective;

③if $\theta^*<1$, then DMU_j is non-DEA effective.

III. Analysis on the Quality of Mathematics Online Open Course Based on DEA Model

(1) Selection of decision-making units

On the basis of the DEA model evaluation method, the decision-making unit (DMU_j) is selected on the basis of: first, with the same input and output indicators, the same external environment and target tasks; second, to be able to more effectively discover the relationship between input and output, The total number of input and output indicators is 1.5 times the number of decision units. For the purpose of protecting the privacy and confidentiality of research materials and information, nine mathematics online courses of Anyang Normal College are expressed in DMU_1,DMU_2, …, DMU_9.

(2) Determination of input-output evaluation index

The evaluation index can not be chosen at will, and the following three principles must be followed to ensure the scientific nature of the evaluation results [8].

Principle 1: Need to focus on the principle of integration of integrity and hierarchy. The teaching process is not a simple system, but a complex system composed of many subsystems or elements. Each subsystem or element interacts to accomplish the established goal of teaching together.

Principle 2: we should grasp the principle of combining stage with continuity. The continuous progress and development of educational technology make the evaluation of teaching performance a process of constant change and development. In addition, there is a certain periodicity of teaching activities, and the performance of many inputs will not be reflected immediately.

Principle 3: grasp the principle of combining purpose and maneuverability. The selected indicators can not only achieve the purpose of evaluation, but also avoid tendency and maintain fairness. Maneuverability includes two levels, one is that the selected index data is easy to collect and can be measured by certain methods; the other is the simplification of indicators, because in the process of using DEA, too many indicators may have too strong linear relationship, which affects the evaluation results. In this sense, it is further explained that the DEA method does not need too many indicators to avoid losing maneuverability.

Under the guidance of the selection principle of evaluation indicators, six evaluation indicators were determined in this study, as shown in Table 1.

Table 1 Input and output index system

Input indicators	Unit	Output indicators	Unit
Overall style X1	score	Teacher self-evaluation Y1	score
Teaching resources X2	piece	Peer evaluation Y2	score
Interaction X3	person-time	Student evaluation Y3	score

(3) Calculation and analysis of indicator data

In this paper, the input and output index data of 9 mathematics online courses are obtained by telephone, mail and field visit research, see Table 2.

Table 2 Input and output data

Decision making unit	Input indicators			Output indicators		
	X_1	X_2	X_3	Y_1	Y_2	Y_3
DMU_1	92	66	212	94	90	95
DMU_2	90	54	349	91	88	92
DMU_3	86	194	457	92	89	94
DMU_4	91	181	126	88	86	90
DMU_5	82	70	46	80	76	85
DMU_6	89	75	35	83	85	88
DMU_7	85	39	24	89	85	86
DMU_8	92	258	390	95	92	94
DMU_9	81	176	272	92	90	93

Then we use MATLAB software to solve the model, and the results are shown in Table 3, which can judge the DEA effectiveness of each decision unit. It can be seen from table 3 that the performance results of the decision-making units DMU_1, DMU_5, DMU_7 and DMU_9 are good and in DEA effective states. These decision-making units vigorously improve relevant policies and regulations, attach great importance to the effectiveness of the construction of online course platforms, allocate resources reasonably, and realize the optimal output of online open course platforms in education and teaching.

Table 3 Results of performance evaluation of mathematics online open courses

Decision making unit	DMU_1	DMU_2	DMU_3	DMU_4	DMU_5	DMU_6	DMU_7	DMU_8	DMU_9
θ^*	1.0000	0.9991	0.9520	0.9294	1.0000	0.9698	1.0000	0.9091	1.0000

In Table 3, the performance results of the decision-making units DMU_2, DMU_3, DMU_4, DMU_6 and DMU_8 are in non-DEA effective state. The effective conversion rate of input and output of these mathematics online open courses is low, and there is a case of mismatch between input and output.

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References

[1]. Zhang H, Ren J. Construction and application of online open course under the background of " Internet Plus" —taking higher mathematics in higher vocational colleges as an example. Journal of Hunan Industry Polytechnic, 2018, 18(4): 79-81.
[2]. Xu X. Research on the construction of multi-integrated advanced mathematics online open course under the background of "Internet Plus". The Journal of Shandong Agriculture and Engineering University, 2019, 36(12): 130-132.
[3]. Qian F, Ding H. Research on the construction of effectiveness evaluation system of open online courses based on factor analysis, Shanghai Journal of Educational Evaluation, 2020(1): 32-36.
[4]. Charnes A, Cooper W W, Rhodes E. Measuring the efficiency of decision making units. European Journal of Operational Research, 1978, 2(6): 429-444.
[5]. Bessent A M, Bessent E W. Determining the comparative efficiency of schools through data envelopment analysis. Educational Administration Quarterly, 1980, 16(2): 57-75.
[6]. Charnes A, Cooper WW, Rhodes E. Evaluating program and managerial efficiency: an application of data envelopment analysis to program follow through. Management Science, 1981, 27(6): 668-697.
[7]. Liu J S, Lu L Y Y, Lu W M, et al. A survey of DEA applications. Omega, 2013, 41(5): 893-902.
[8]. Zhao X, Chen Z, Huo X. Empirical research on input t-output benefit of agricultural vocational colleges. Journal of Northwest A&F University(Social Science Edition), 2017, 17(3): 136-142.

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