CSCanada
Canadian Social Science
Vol. 11, No. 4, 2015, pp. 112-116
DOI: 10.3968/6801

ISSN 1712-8056[Print]
ISSN 1923-6697[Online]
www.cscanada.net
www.cscanada.org

Research Into Modularized Educational Equilibrium Information System Based on Automatic Network Matching

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Supported by National Social Sciences Funded Project (14BKS126); Chongqing City Board of Education Scientific Research Project (KJ1400423); Chongqing University of Posts and Telecommunications Social Science Project（K2014-122).

Received 10 February 2015; accepted 15 April 2015
Published online 26 April 2015

Abstract

Concerning the problem of regional educational disequilibrium, this paper puts forward the modularized equilibrium information system design project featuring the automatic matching of educational resources based on the modern information network, so as to achieve optimal allocation and sharing of resources in different schools. The educational resource information indexes of various schools are periodically collected in a dynamicalway. The educational assessment module is established according to the relative grading method. According to the analysis results of the assessment data, the author builds the educational equilibrium module based on the optimal matching theory so as to achieve the optimal allocation of public services and targeted assistance of educational resources through the information technology, and effectively promote the equilibrium development of regional education. At last, the promotion strategy of the system is put forward, fully emphasizing the role of the equilibrium system, and the necessity of "joint construction and sharing, mutual assistance, institutionalization and enhancement of accountability."

Key words: Informationalization; Educational equilibrium; Optimal matching; Resource sharing

Zhang, S. R., & Xiong, Y. (2015). Research into Modularized Educational Equilibrium Information System Based on Automatic Network Matching. *Canadian Social Science, 11*(4), 112-116. Available from: http://www.cscanada.net/index.php/css/article/view/6801
DOI: http://dx.doi.org/10.3968/6801

1. RESEARCH ISSUE

The regional education disequilibrium is a serious problem. For example, there is a great gap in the education quality between West China and East China, rural and urban area. In some sense, the gap is caused by the gap of regional economic development level, because regional economy can influence educational investment. The investment is mainly reflected as teaching facilities, faculty power and individual educational opportunities, and can directly influence the educational level and quality. On the other hand, regions with high educational level can employ more knowledge and techniques to promote the growth of regional economy. In this way, regional economic development influences regional educational equilibrium; while regional education equilibrium also restricts regional economic development. Finally, it might result in a vicious spiral. It is still a long way to develop the economy in a region, calling for long-term efforts of various parties. However, the issue of educational disequilibrium is more imperative to be resolved through a simple but effective solution.

China National Intermedium-and Long-term Educational Reform and Development Program Planning (2010-2020) emphasizes that balanced educational development is the key to educational equilibrium and that information technology can revolutionize educational development. The Third Plenary Session of the Eighteenth Central Committee of the CPC points out clearly in

Decisions about Major Issues to Comprehensively Deepen China's Reform the necessity to expand the coverage of quality educational resources through the informationalized methods, and to gradually shrink the gap between regions, urban and rural area, and schools. The internet information technology has the specific advantages of rapid knowledge transmission, wide coverage and convenient resource sharing. It can break through the spatial distance between schools, achieve reciprocity and interflow of resources, knowledge and techniques, and distance distributional education a possibility (Chen, 2010). Thus, it can be seen that a full utilization of the modern information technology for the balanced development of regional education is a strategic choice for the sound development of China's education undertaking. Educational informationalization has become the onlyway for the quality and balanced development of education.

The key to promoting balanced regional educational development is equalization of educational resources, including human resources, financial resources, material resources and information. To the end, Xiong Caiping promoted the urban-rural integration of faculty resources through Moodle learning platform, and put forward the model of "Regional Joint Building, Sharing and Exchange" to equalize the public services of educational information resources (Xiong, Yang, & Zhang, 2013). Regarding "video teaching" as the development trend of regional educational information resources, Hu Tiesheng predicted the growing popularity of mobile learning and ubiquitous learning based on "video teaching" resource sharing in the Web2.0 era (Hu, 2009). Based on the educational information ecological perspective and the integral optimization perspective, Yu Shengquan studied the role and positioning of information technology in education, emphasizing the nested relationship among resource flow, sharing and elements in the resource base (Yu & Zhao, 2009). Thus, it can be seen that the linchpin for informationalization to achieve balanced educational development lies in the sharing of educational resources. However, the current research mainly focuses on the network learning platform application, joint building and sharing system design and information resource base, lacking comprehensive consideration of the resource complementarity of educational resources in different schools, let alone analyzing the feasibility of mutual assistance between schools through forming alliances. If the gap of educational resources between different schools can be comprehensively evaluated, a resource flow and optimized allocation plan can be put forward to achieve the sharing of the education resources, maximize the effect of assistance of schools with quality resource to schools in a disadvantageous position in educational resources, and benefit the balanced and quality development of regional education. Thus, this paper puts forward the modularized educational equilibrium information system design plan based on the network automatic matching to evaluate the education power of every school through the educational balanced development factor, and achieves sharing of educational information resources through the optimal matching theory and the "one-by-one" individualized assistance.

2. EDUCATIONAL EQUILIBRIUM INFORMATION SYSTEM

Before analyzing the issue of regional education disequilibrium, the advantages and disadvantages of every school should be evaluated so as to confirm the disequilibrium degree. According to the disequilibrium situation, the corresponding countermeasures or solutions should be put forward. Therefore, the modularized education equilibrium informationalization system can be divided into two modular. The first module is education assessment module, whose function is to collect the key educational quality parameters and scientifically evaluate their strengths and weaknesses. The second module is educational equilibrium module, whose function is to gather the competitive resources of different schools on the public service platform for educational resource sharing according to the evaluation results, providing the assisting school for those in a disadvantageous position to eliminate regional educational disequilibrium and promote balanced educational development. The system model is shown in Figure 1.

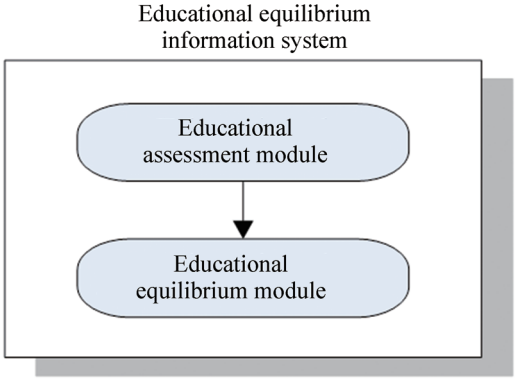

Figure 1
Modularized Educational Equilibrium Information System

2.1 Educational Assessment Module

Research suggested that a reference value of educational development quality and level can be obtained through statistics, summary and analysis of a series of important and sensitive educational resource information index, *j* (students' average budget expenditure, faculty power, teaching facilities, enrolment rate, graduation rate, dropout rate, etc.) (Si & Yang, 2006). In order to scientifically and objectively evaluate the school's educational quality, various critical education information indexes can be collected from different schools on a regular basis

to define a coefficient. Assume schools' educational balanced development factor, i, as, μ_i, then Equation (1) can be obtained:

$$\mu_i = \sum_{j \in J} x_{ij} / \overline{x_j} \quad . \tag{1}$$

Where, x_{ij} stands for the index value of j in the school of I; x_j stands for the value of the information index, j; $\overline{x_j}$ stands for the average value of the information index, j, in all schools; J is a collection of all assessment indexes. In other words, the overall average level of certain index in all schools can be obtained based on the collected information index data, and the relative grades can be obtained through the comparison between certain index in all schools and overall average level; the education equilibrium development of a school can be obtained. Thus, it can be seen that the education equilibrium development factor, μ_i, reflects a school's educational balanced development degree, and that the value of μ_i is positively correlated to the school's educational development level.

Assessment example: Assume that the assessment index set of schools is $J=\{j_1, j_2\}$, of which j_1 stands for the enrolment rate and j_2 stand for the grades in unified examinations. The average enrolment rate of all schools is 60%, the average grades in united examinations are 40. However, the enrolment of school i_1 and i_2 is 50% and 90%, respectively. Their grades in the unified examinations average at 300 and 500, respectively. The educational balanced development factor of the two schools can be worked out through Equation (1):

School i_1: $\mu_1 = \frac{50\%}{60\%} + \frac{300}{400} \approx 1.58$,

School i_2: $\mu_2 = \frac{90\%}{60\%} + \frac{500}{400} = 2.75$.

Thus, the education equilibrium development situation of two schools can be put in the following order: i_2, i_1.

2.2 Educational Equilibrium Modules

After the educational balanced development factor of every school is evaluated, it is necessary to turn to the system's education equilibrium modules to implement the matching measures. The educational equilibrium modules can be divided into the public service module and the matched assistance module (see Figure 2). The public service module has the function of sharing quality educational resources to help different schools to share the same educational resources on a public platform. For example, schools can share their quality teaching videos, PPTs and exercises on the network. Through the platform, students can achieve online ubiquitous learning and interaction through PC and mobile intelligent terminals, and teachers can share their teaching experiences and help to solve students' problems online. In terms of the matched assistance module, the system distributes schools with quality educational resources for schools in a disadvantageous position through automatic network matching and based on the data mining results of the education assessment module. It will also clarify the assistance scope and supervise the fulfillment of the assistance duty.

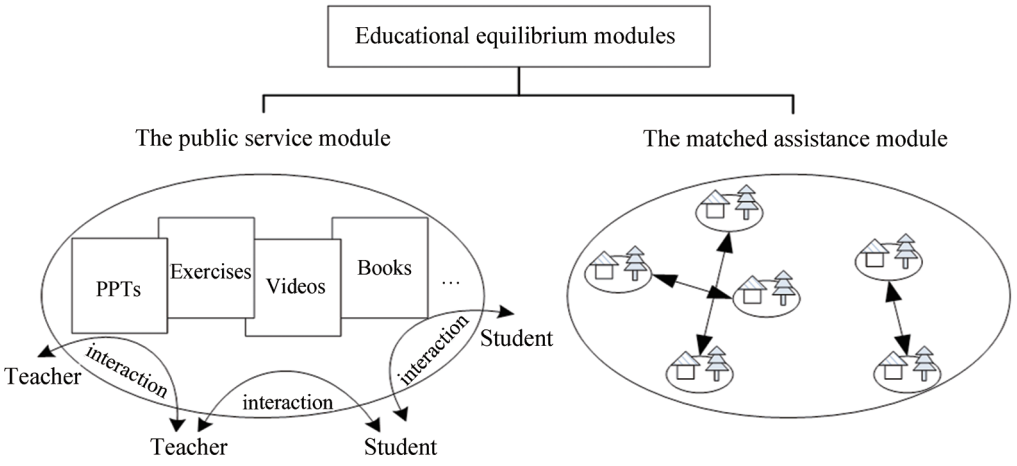

Figure 2
Schematic Diagram of Educational Equilibrium Modules

Due to the differences in the quality and weak resource information index of every school, the assistance based on the simple random matching can hardly achieve the optimal assistance effect. It can be seen that the optimal assistance effect is a key problem facing the system design. The optimal assistance effect means the more complementary information indexes between the quality resource school and the weak quality resource school are, the better the effect is. In the graph theory, the optimal matching algorithm can achieve the best perfect matching. The basic idea is to divide the dataset into two non-void subsets which are not belonging to each other to form a bipartite graph. Then, find the matching with the most sides in the bipartite graph to obtain the maximal

matching. Here, the weighted matching algorithm of the bipartite graph can be used to achieve the optimal matching of educational resource information index, j, to ensure the sum of the weight of sides in the matching collection to be the largest. Below are the specific steps:

Step 1: Divide the bipartite graph. Arrange the education equilibrium development factors of different schools in a descending order according to the educational assessment. Divide schools into two groups based on the specific value into the former and latter two groups to form a bipartite graph. (If the number of schools is not an even number, the mid-value school can be regarded as the demarcation line.) Obviously, the former two groups are the schools with quality educational resources; the latter two groups are schools with poor educational resources. School i is at the vertex of the bipartite graph. If school i_1 with quality educational resources and school i_2 with poor educational resources are matched for assistance, it suggests that there is side connecting the two schools.

Step 2: Set the weight. According to the data statistics of the educational assessment module, the value, x_j, of certain resource information index, j, can be obtained. The assistance weight of the side, k, is defined as the number of resource information indexes of school i_1 which are higher than those of school i_2. In other words, k means school i_1 has k indexes which are helpful for school i_2. Thus, the higher the value of the assistance weight, k, the better the effect of the matched assistance.

Step 3: Solve the assistance matrix. Work out the weight of side matched among different schools to form an assistance matrix and lay a data foundation for the optimal matching.

Step 4: Calculate the maximal weight matching. Use the Kuhn-Munkres matching algorithm (shortened as KM algorithm) to solve the problem. Its basic idea is to give a label to every vertex, which is called topmark. Transform the issue of solving the maximum weight matching into the issue of solving the perfect matching. The solution of the perfect matching can refer to the mature Hungary matching algorithm. The specific solution steps are omitted here.

Matching example: Assume the educational balanced development factor, μ_i, of ten schools, i_1-i_{10}, is arranged in a descending order. Divide them into two groups, then the weight matrix of the former semigroup of schools to the latter semigroup of schools can be obtained. Assume that its value is shown below:

$$M = \begin{array}{c} \\ i_1 \\ i_2 \\ i_3 \\ i_4 \\ i_5 \end{array} \begin{array}{c} \begin{array}{ccccc} i_6 & i_7 & i_8 & i_9 & i_{10} \end{array} \\ \begin{bmatrix} 3 & 5 & 5 & 4 & 1 \\ 2 & 4 & 4 & 1 & 0 \\ 1 & 2 & 1 & 3 & 3 \\ 2 & 2 & 0 & 2 & 2 \\ 0 & 1 & 1 & 0 & 0 \end{bmatrix} \end{array}.$$

The above assistance matrix can be expressed through the bipartite graph. As is shown in Figure 3, the random matching might not achieve the optimal assistance effect. Therefore, the matching between the former semigroup, i_1-i_5, and the latter semigroup, i_6-i_{10}, should be found out to ensure the optimal overall assistance value. The optimal overall assistance value means schools with quality educational resources offer greatest help to schools with poor educational resources.

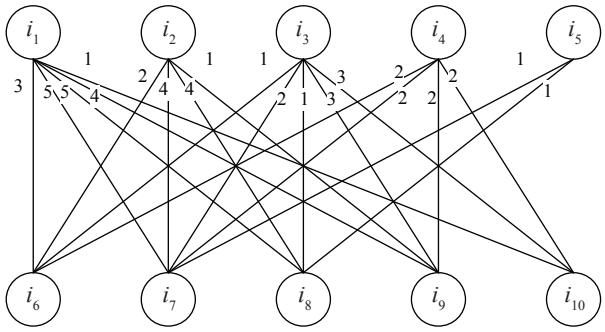

Figure 3
Interschool Assistance Relationship Bigraph

Through KM algorithm, the optimal matching can be obtained, $\{i_1i_9, i_2i_8, i_3i_{10}, i_4i_6, i_5i_7,\}$. Its corresponding assistance weight value is the maximal weight value, 14. In other words, schools with poor educational resources can obtain assistance from schools with quality educational resources in terms of 14 indexes. The matching schematic diagram is shown in Figure 4.

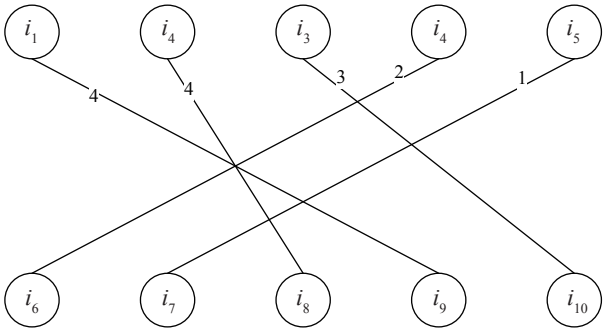

Figure 4
Schools' Optimal Matching Schematic Diagram

3. STRATEGIES TO PROMOTE THE APPLICATION OF EDUCATIONAL EQUILIBRIUM INFORMATION SYSTEM

The research and design of the information system are just the first step of the system's construction and application. In order to ensure the smooth construction and promotion of the educational equilibrium information system, the corresponding supporting policies and measures are required. Based on the above research findings, the author puts forward the following suggestions:

(a) Regional joint building and sharing: Considering counties as the major educational investors of China and the educational information resources with the local

characteristics, the author suggests that educational supervision department of the county level should act as the major investment and construction body of the system to directly build the educational equilibrium information platform and the large-scale educational information resource base, and spearhead in achieving the auto-matching assistance of the educational resources within a specific region.

(b) Regional mutual assistance: As to the issue of resource sharing and assistance matching, the author suggests the payment, purchase and exchange, and balance settlement for resource sharing and interschool assistance can be negotiated so as to achieve regional educational equilibrium gradually. Different counties can build the equilibrium system so as to cover the whole country with the system through a down-top fashion.

(c) Institutionalization to form a long-term effective mechanism: The education assessment model is the basis of this system. The accuracy of educational assessment is directly related to the periodicity and accuracy of the data collection. Therefore, it is necessary to establish institutions to collect relevant education resource information indexes in various schools on a regular basis; issue relevant guarantee policies, building a system maintenance and promotion team, providing system construction and upgrading funds and ensuring the smooth construction of the system.

(d) Enhancement of responsibility to maximize the assistance effect: The educational equilibrium module is the core of the system. Apart from passive public services of sharing quality educational resources on the internet, the active services featuring matched assistance is more important to schools with poor resources. After the matching is done, the assistance responsibility should be clarified for the matched schools, such as arranging quality faculty to support schools in a disadvantageous position, inviting faculty of the schools in a disadvantageous position to have advanced study in schools with quality educational resources, allowing schools to share the digital library of schools with quality educational resources, setting up targeted online video teaching courses for schools in a disadvantageous position, etc..

CONCLUSION

Informationalization is an effective mechanism to expand the coverage of the quality educational resources and an important approach to promote balanced regional educational development. The educational equilibrium system proposed in this paper adopts the modularized design idea, and makes full use of the information technology to define the educational balanced development factor to evaluate the education level of various schools. Based on the knowledge of the modern graph theory, strategies for the public exchange services of educational resources and the strategies of optimal matched assistance are put forward to effectively boost the joint progress of educational quality in various schools, and the balanced development of regional education. However, educational balanced development is a long-term and complex task. Information technology is just a new driving force brought by technological innovation. To achieve the educational balanced development calls for the joint efforts of economic, social and educational forces.

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