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Learner-oriented distance education supporting service system model and applied research

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ABSTRACT: Distance education is a product of social progress and an emerging way of life-long learning as well. This paper describes the construction of the distance education supporting service system and establishes the distance education supporting service system from the perspective of distance education learners. Under the premise of considering to provide six influencing factors--learning facilities, learning coaching and counseling, learning resources, education and teaching information, assessment of student learning situation and organization of practical teaching activities, this paper assesses the distance education supporting service system of Beijing, Shanghai and Shenzhen by using AHP.

Keywords: distance education supporting service system; learner; influencing factors; AHP

1 INTRODUCTION

With the rapid development of network, the distance education has become an important way of modernization education. Its unique teaching method breaks the age limit and location restriction of the traditional teaching, which is conducive to the lifelong learning of all the people. The competition in the 21st century ends up as the talent competition, and the distance education is even a necessary way to possess the competitive advantage. For learners, the distance education supporting service system should possess multiple functions. For example, in the process of preparation and the learning and review, multiple responses can be made to meet multiple needs of learners.

From a macro-aspect, the distance education supporting service system is an inevitable product of education virtualization [1]. The learner is the center of virtual education. In the entire virtual education environment, the learner must be able to give play to subjective initiative to construct their own knowledge level by learning [2]. Currently, the distance education supporting service system supports the learning exchange, mutual assessment and public learning function, with a weak pertinence for individualized learning. The main reason is that the system's ability to identify information resources is not enough; unique knowledge resources are generated in the individual learning process, while they could not be used effectively [3].

Since the late 1990s, China began to implement the distance education and it's continued until now. Currently, the territorial scope of distance education has covered the whole country. The distance education supporting system is a support to improve the teaching efficiency. Under the premise of separation between "teaching" behavior and "learning" behavior, this teaching process is different from that of the traditional face-to-face teaching. The superiority of distance education supporting system is embodied in the knowledge acquisition of the learner, such as timeliness and selectively of the learning resources and so on. The superiority of distance education supporting system is even embodied in the number of learners. An open education way can make students choose whether to continue to learn, thus resulting in learning randomness of distance education students. Thus, the distance education is troubled by the problem of student loss. This paper will analyze the factors affecting the distance education supporting system and establish an assessment model affecting the distance education supporting system from the perspective of the learner.

2 COMPOSITION OF DISTANCE EDUCATION SUPPORTING SERVICE SYSTEM

The distance education supporting service system is

composed of various parts. Each module has specific learning function, and interrelation between many parts plays a combined role in the distance education learning. The role of this system is to help students to do independent learning and interaction among the hardware, software and operator, so as to achieve the purpose of finishing learning tasks.

2.1 *Hardware part*

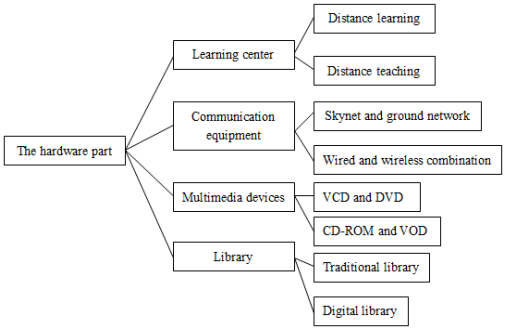

Figure 1. Diagram of detailed configuration in each device

Distance education requires not only the network, but also the support by hardware facilities. The hardware part includes a learning center and its supporting facilities. Taking a network classroom as an example, the network classroom is a learning center of distance education learners. To achieve more education, there is also a need to equip with a variety of communication equipment, for example, a personal computer as a terminal of distance education and a network server as the conveying equipment of distance education. In addition, a variety of multimedia devices are also included, for example, projectors, VCD players and other hardware facilities. The detailed configuration of each device is shown in Figure 1.

2.2 *Software section*

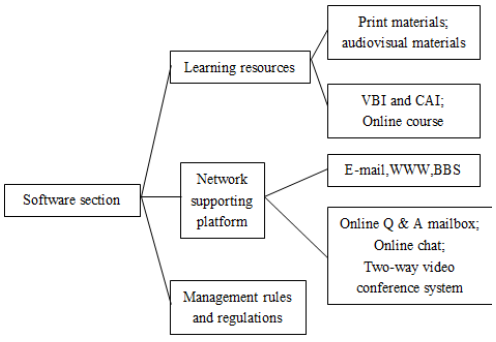

Figure 2. Diagram of detailed configuration in each device

In the distance education supporting service system, the software section is presented invisibly. For students learning, it plays a vital role. This section contains learning resources, network supporting platform and management system. Construction conditions of each sub-section affect the student learning effect. The detailed configuration of each sub-section is shown in Figure 2.

2.3 *Personnel section*

Personnel section refers to the personnel who assist in answering questions for students and technical management personnel. These personnel cooperate with each other and undertake supporting service work for the distance education students. This section is a core part of the distance education supporting system. These personnel are required to support all service functions of the system. The detailed configuration of this section is shown in Figure 3:

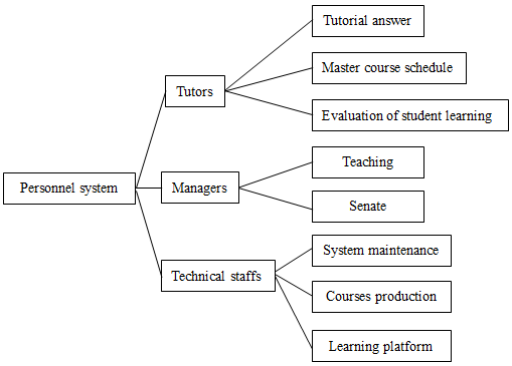

Figure 3. Diagram of detailed configuration in each device

3 FUNCTION OF DISTANCE EDUCATION SUPPORTING SERVICE SYSTEM

From the perspective of the learner, the distance education supporting service system needs to possess four offering services and two teaching services. The offering services include provision of learning facilities, learning coaching and counseling, learning resources and the education and teaching information. The teaching services include the assessment of student learning situation and the organization of practical teaching activities. The service quality of these six functions has a common effect on the advantages and disadvantages of the distance education supporting service system. This paper will assess the distance education supporting service system by using AHP.

4 DISTANCE EDUCATION SUPPORTING SERVICE SYSTEM MODEL

4.1 *Principle of Analytic Hierarchy Process (AHP)*

AHP[4] solves decision problems in more complicated

and ambiguous questions, which can be generally used to build a model with the following four steps:

1. Establish a hierarchical structure program;
2. Construct each level of matrix which is completely used for judgment;
3. Test single hierarchical arrangement and consistency;
4. Test total hierarchical arrangement and consistency;

The following content respectively describes detailed process of each step.

4.1.1 *Hierarchical structure*

The problems solved by *AHP* are required to be hierarchical, methodical and logical. Only in this way can we construct a hierarchical scheme. The elements in the complicated issues form a plurality of progressive layers according to their properties, degree of membership and their relationship. The elements in the upper layer are capable of generating a dominant role. Under normal circumstances, these layers are divided into three categories:

(1) Top layer: This layer contains only one factor. Generally, it is the ultimate goal of the researched issue, which can also be called as the target layer.

(2) Middle layer: This layer contains an intermediate process which is involved in achieving the target. It may be a plurality of layers and contain a plurality of multilayer criteria to be considered, which can also be called as the criterion layer.

(3) Bottom layer: This layer contains a variety of methods and means that are available to achieve the target, which can also be called as the measure layer or scheme layer.

The hierarchy number in the hierarchical structure is related to the complicated degree of the researched issues and detailed requirements analyzed, which is generally not limited. The factors dominated by each factor in each layer are generally no more than nine.

4.1.2 *Construction of judgment matrix*

The structure between each layer is capable of expressing the relationship between factors, but the proportion of each factor in the middle layer is basically not the same in the target assessment. In the heart of the valuator, each factor has a certain proportion.

In determining the proportion of each factor, that is, comparing the impact of n factor(s) $X=\{x_1,\cdots,x_n\}$ on the element Z, *Saaty* et al. propose to compare two factors and establish a method of pairwise comparison matrix. That is, select two factors, x_i and x_j at each time. a_{ij} is used to express the proportion of the impact of x_i and x_j on Z, and all of comparison is expressed by the matrix, $A=(a_{ij})_{n\times n}$, so that A is a judgment matrix between $Z-X$. As can be seen from the matrix, if the proportion of the impact of x_i and x_j on Z is a_{ij}, then the proportion of the impact of x_j and x_i on Z is $a_{ji}=\frac{1}{a_{ij}}$.

According to the theoretical knowledge of linear algebra, if the matrix $A=(a_{ij})_{n\times n}$ satisfies that $a_{ij}>0$ and $a_{ji}=\frac{1}{a_{ij}}(i,j=1,2,\cdots,n)$, then the matrix A is a positive reciprocal matrix.

The determination of the value of a_{ij} can be based on the scale value table, as shown in Table 1:

Table 1. Table of scale value

Scale	Meaning
1	Indicating that two comparison elements have the same importance
3	Indicating that the former comparison element is slightly more important than the latter one
5	Indicating that the former comparison element is obviously more important than the latter one
7	Indicating that the former comparison element is much more important than the latter one
9	Indicating that the former comparison element is extremely more important than the latter one
2,4,6,8	Indicating the intermediate degree in the above judgment
Reciprocal	Indicating that the proportion of the importance of i and j is a_{ij}, then the proportion of the importance of j and i is $a_{ji}=\frac{1}{a_{ij}}$.

4.1.3 *Construction of judgment matrix*

The eigenvector W of the maximum eigenvalue $\lambda_{\max}$ corresponding to the matrix A is normalized, that is, the corresponding elements in the same layer for the rank weight value of the important comparison of some factors in the upper layer. This process is called as the single hierarchical arrangement. Although this process can reduce the interference of other factors, there is inevitable inconsistency in the comprehensive comparison results. If the comparison results are consistent, the factor of A also needs to meet:

$$a_{ij}a_{jk}=a_{ik},\forall i,j,k=1,2,\cdots,n \tag{1}$$

The positive reciprocal matrix which is in line with the above formula is called as the consistent matrix. To conveniently determine whether A can be accepted, there is a need to verify whether inconsistency of A is very serious.

If A is a consistent matrix, then:

1) A must be a positive reciprocal matrix.

2) The transposed matrix A^T is a consistent matrix.

3) Any two rows of the matrix A are proportional, and the factor is greater than 0, so that $rank(A)=1$, and the column is the same.

4) In A, $\lambda_{\max}=n$, where n is the order of the matrix A. Other eigenvalues of A are 0.

5) The eigenvector $W=(w_1,\cdots,w_n)^T$ corresponding to $\lambda_{\max}$, then $a_{ij}=\frac{w_i}{w_j},\forall i,j=1,2,\cdots,n$:

$$A=\begin{bmatrix} \frac{w_1}{w_1} & \frac{w_1}{w_2} & \cdots & \frac{w_1}{w_n} \\ \frac{w_2}{w_1} & \frac{w_2}{w_2} & \cdots & \frac{w_2}{w_n} \\ \vdots & \vdots & \vdots & \vdots \\ \frac{w_n}{w_1} & \frac{w_n}{w_2} & \cdots & \frac{w_n}{w_n} \end{bmatrix} \tag{2}$$

A is the positive reciprocal matrix of order n. When it is a consistent matrix, if and only if $\lambda_{\max}=n$ and when A is inconsistent, there must be $\lambda_{\max}>n$. Accordingly, the test of relationship between $\lambda_{\max}$ and n can determine whether A is a consistent matrix.

The steps of testing the consistency of A are shown as follows:

1) Calculate the constancy target CI :

$$CI=\frac{\lambda_{\max}-n}{n-1} \tag{3}$$

2) Seek for the corresponding average random consistency index RI. Saaty has researched RI value, which is shown in Table 2.

RI value is obtained through randomly constructing 500 sample matrixes. The positive reciprocal matrix is constructed by randomly selecting digits from 1 to 9 and its reciprocals, so as to calculate the average value of the largest eigenvalue $\lambda'_{\max}$, and define:

$$RI=\frac{\lambda'_{\max}-n}{n-1} \tag{4}$$

3) Calculate the consistency proportion CR :

$$CR=\frac{CI}{RI} \tag{5}$$

When $CR<0.10$, the consistency of A can be passed. On the contrary, it shall be adjusted.

This process also contains the total hierarchical arrangement and consistency test. Due to limited space, there is no theoretical narration, and it can be applied directly.

4.2 *Modeling*

(1)The target layer, criterion layer and scheme layer are to be constructed. The target layer is the standard distance education supporting service system based on learner. The criterion layer is the provision of learning facilities, learning coaching and counseling, learning resources, education and teaching information, assessment of student learning situation and organization of practical teaching activities. The scheme layers are Beijing, Shanghai and Shenzhen, as shown in Figure 4.

Table 2. RI value

n	1	2	3	4	5	6	7	8	9
RI	0	0	0.58	0.90	1.12	1.24	1.32	1.41	1.45

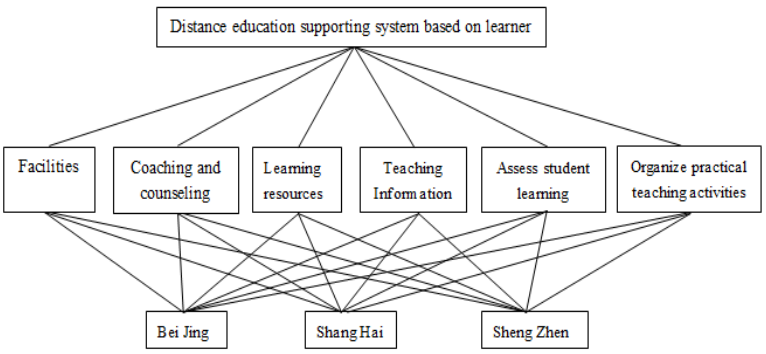

Figure 4. Hierarchy diagram

Table 5. Calculation results

Target layer		B_1	B_2	B_3	B_4	B_5	B_6	Total weight
Weight in the target layer		0.3604	0.2412	0.1628	0.1102	0.0748	0.0506	
Single ranking in the target layer	Shanghai	0.5276	0.4258	0.2970	0.4370	0.2672	0.2270	0.4208
	Shenzhen	0.1694	0.3906	0.3634	0.2647	0.2205	0.2147	0.2709
	Beijing	0.3032	0.1836	0.3396	0.2983	0.5123	0.5583	0.3083

(2) Construction of judgment matrix

The construction of judgment matrix first needs to determine the importance of six factors affecting the distance education supporting service system. In Beijing, Shanghai and Shenzhen, the questionnaire survey (multiple choices) is mainly based on these six influencing factors, and the distance education learners are extracted by the method of quota sampling [5]. A total of 600 questionnaires are distributed, and 578 valid questionnaires are recovered, with an effective recovery rate of 96.33%. The survey results are shown in Table 3 after arrangement [6]:

Table 3. Importance of factors in distance education supporting service system

	Number	Percentage (%)	Ranking
Learning resources	379	65.57	1
Learning coaching and counseling	308	53.28	2
Learning facilities	256	44.29	3
Education and teaching information	211	36.50	4
Organization of practical teaching activities	123	21.28	5
Assessment of student learning	71	12.28	6

According to the data in Table 3, combined with the principle of construction of the judgment matrix, the comparison matrix in the target layer is constructed as shown in Table 4:

Table 4. Pairwise comparison matrix in the target layer

A	B_1	B_2	B_3	B_4	B_5	B_6
B_1	1	2	3	4	5	6
B_2	1/2	1	2	3	4	5
B_3	1/3	1/2	1	2	3	4
B_4	1/4	1/3	1/2	1	2	3
B_5	1/5	1/4	1/3	1/2	1	2
B_6	1/6	1/5	1/4	1/3	1/2	1

The comparison matrix in the scheme layer is compared with several schemes under one influencing factor. Because the matrix construction method here is the same with the aforementioned, the detail is omitted.

(3) The calculation process described above can be calculated and programed by *Matlab* , and the calculation results are shown in Table 5.

As can be seen from Table 5, the learner has a relatively high satisfaction with the distance education supporting service system in Shanghai, followed by Beijing and Shenzhen. As one of China's foreign exchange windows, Shanghai has rapid social development and fierce competition, which is more conducive to forming a good habit of lifelong learning for people. Under the premise of expanding the demand for distance education, the distance education supporting service system in Shanghai will be better.

5 CONCLUSION

AHP is a kind of mathematical algorithm, which is capable of combining with quantitative and qualitative analysis of the issues [7]. This paper establishes the model based on the distance education supporting service system and assesses the distance education supporting service system in Shanghai, Shenzhen and Beijing. The analysis is combined with the actual situation, and the assessment results obtained are relatively reasonable. In the assessment process, the weight of six influencing factors involved in can be changed with different situations so that the model is real-time.

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