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Calculation Optimization Methods for Diversified Teaching Designs in Secondary-Higher Vocational Education

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Abstract In the current vocational education system in China, there is an obvious articulation fault between secondary vocational education and higher education, and the traditional teaching mode is difficult to meet the demand for composite talents in the digital era. Industrial transformation and upgrading puts forward higher requirements for skilled talents, while the existing talent cultivation mode is still deficient in the combination of theory and practice, and school-enterprise collaborative education. This paper uses computational optimization method and new media assisted technology to construct a multivariate instructional design talent cultivation model for the articulation of secondary education and higher education. The study adopted the DBSCAN density clustering algorithm to analyze the talent training data, established the talent training quality evaluation index system by using principal component analysis, and collected 2649 valid samples through questionnaires for empirical research. The results show that in the correlation test between the existing problems of talent cultivation and the single direction of college graduates' professional competence mastery, the Pearson's chi-square value is 3.47, and the significance is 0.055; the principal component analysis extracts four key factors, and the cumulative variance contribution rate reaches 84.733%; the common degree of seven variables in the evaluation system of the faculty is more than 0.825, and the interpretable variance is controlled at 0.409 within 0.409; cluster analysis divided the 10 institutions into 3 categories, and the average score of the principal components of the first category of institutions was 15.1229. The study constructed a model of articulation of professional teaching resource library, and formed a framework of multi-dimensional instructional design based on the assistance of new media. The model effectively improves the articulation quality of middle and higher vocational education, provides theoretical basis and practical path for cultivating compound skilled talents adapted to the needs of the digital era, and is of great significance in promoting the high-quality development of vocational education.

Index Terms computational optimization, new media-assisted, multiple instructional design, principal component analysis, cluster analysis, talent cultivation

I. Introduction

Since the reform and opening up, China's vocational education has been further developed, which has continuously delivered a large number of talents to the country. With the economic development, industrial transformation and upgrading, secondary vocational education has been difficult to meet the national demand for high-level, high-level, high-quality skilled personnel [1]. Vocational education faces more challenges, not only to follow the internal development requirements from quantitative to qualitative change, but also to meet the high external requirements for talent training [2]. Realize the organic articulation of secondary vocational education and higher vocational education, so that more secondary students can improve their professionalism through the higher vocational stage of learning, and become an important part of the improvement of the modern vocational education system [3]-[5].

The articulation of middle and higher vocational education not only provides space for the enhancement of middle vocational education and improves the teaching level of cultivating applied talents, but also lays a solid student base for higher vocational education and promotes the sustainable development of vocational colleges and universities [6]-[8]. For this reason, it is of great significance to study the development of middle and higher vocational education articulation. First of all, the articulation of middle and higher vocational education is conducive to the sharing of resources between middle and higher vocational education, so as to make full use of teaching resources and improve the efficiency of running schools [9], [10]. Secondly, the articulation of middle and higher vocational education is conducive to optimizing the structure of higher education and improving the talent cultivation mode of vocational education [11]. Finally, the articulation of middle and higher vocational education is conducive to improving the learning ability and quality level of students, expanding the enrollment scale of higher vocational education and improving the quality of higher vocational education [12], [13]. The articulation between secondary education and higher vocational education involves many aspects such as hardware configuration, cultivation objectives, academic system, curriculum, etc., and the key and core issue of articulation is the articulation of middle and higher vocational curriculum design [14]-[16]. Therefore, efforts should be made to explore multiple instructional design methods to solve the problem of articulation between secondary and higher vocational education in order to improve the vocational education system [17].

This study adopts a combination of quantitative and qualitative research methods, uses the DBSCAN density clustering algorithm to deeply analyze the key influencing factors in the process of talent cultivation, constructs a talent cultivation quality evaluation index system based on principal component analysis, and collects empirical data through a large-scale questionnaire survey, so as to systematically explore the application mechanism and effect of new media technology in the articulation of middle and higher vocational education. The study will focus on the key links such as professional teaching resource library construction, faculty optimization, teaching mode innovation, etc., to build a scientific and reasonable articulation model, which will provide decision-making references and practical guidance for relevant institutions and education management departments.

II. Data analysis of talent development in the interface between secondary and higher education

II. A. DBSCAN density clustering algorithm

The fundamental principle that makes the DBSCAN density clustering algorithm possible is that the sample points within each cluster are closely connected to each other, and the density of a point inside the cluster must be greater than the density of the points outside the cluster, i.e., the points within the same category must be related [18]. The density is defined as a set of parameters (ε , minPts), ε denotes the maximum value of the distance between the sample points, i.e. the distance between the sample points can not exceed this maximum value, which is also equivalent to the radius. minPts describes as the number of sample points clustered in the smallest cluster within a density region, i.e. the number of sample points contained within the range of distances from a certain point, i.e. the number of sample points contained within the range of distances from a certain point. The core idea of the DBSCAN algorithm is to find the core object, and then use the object as the center to find the sample points falling within a specific distance (ε), and ultimately all the sample points in series to form a cluster. Let the set of sample points be D. Some basic parameters of the algorithm are defined as follows.

The $\varepsilon-$ neighborhood of a point: the $\varepsilon-$ neighborhood of an A point indicates the set of sample points in the sample set whose distance from the A point is less than ε , as defined in Equation (1).

$$N_{\varepsilon}(A)=\{B\in D\,|\,dist(A,B)\leq\varepsilon\} \tag{1}$$

In a sample set, assuming that the distance between data point A and data point B is less than ε , the point A is said to be in the $\varepsilon-$ neighborhood of the point B , and, of course, the point B is also in the $\varepsilon-$ neighborhood of the point A .

Core object: the distance is ε within the range of not less than minPts of sample points, and this sample point belongs to it, then the sample point is the core object point, such as Figure 1 in the P point that is the core object.

Direct density reachability: if data points A and B satisfy the following constraints:

(1) Data point B belongs to the $\varepsilon-$ neighborhood of data point A .

(2) The number of data points within the $\varepsilon-$ neighborhood of data point A exceeds the maximum number of minPts for which A is a core object, when there exists a direct density-reachable pathway for B through A . Assuming that B is also a core object, then there also exists a direct density reachable pathway for A through B . For example, the point O in Figure 1 is directly density reachable from the point P .

Density reachable: if a sample point is connectable to another sample point and the distance between these two sample points is less than ε . As in Figure 1 data points P and Q , there is a density reachable relationship between them, the density reachable can actually be passed through the direct density, the figure point Q can be reached by the point P density reachable.

Density connected: for data points A and B , if there exists another core object K such that B and A can be density reachable by K departure, then point A and point B are density connected. As shown in Fig. 1, points A and B can be density-connected through point K .

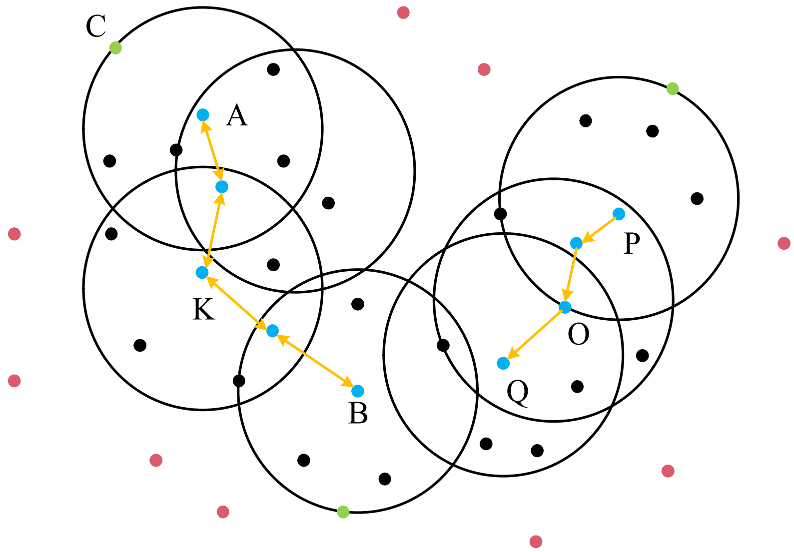

Figure 1: DBSCAN clustering principle

Boundary point: a sample point that belongs to a class, but the $\varepsilon-$ neighborhood of that sample point does not contain the rest of the points, is called a boundary point. Such as the C point in Figure 1.

Noise point: If there exists a point that is not in all the clusters, all other core objects are density unreachable for this point, so that the point is called a noise point. For example, the red point in Fig. 1 is labeled as a noise point.

Based on the above definition, the steps of the DBSCAN clustering algorithm can be described in this way, the category obtained by executing the algorithm is the largest set of samples that are density reachable and density connected between the sample points, and the specific process can be described as:

(1) Mark all sample points as not accessible.

(2) Randomly select a sample point A, given a distance threshold ε and a threshold minPts for the number of sample points in the neighborhood of $\varepsilon-$, and determine whether point A is a core object.

(3) If A point is the core object, create a new category with A point as the core object, and process other sample points in this category in turn.

(4) Iteratively execute the third step to find the points directly density reachable by each core object in turn, and for the same sample points that may be implied in the middle of multiple core points with direct density reachable relationship, they belong to the same cluster.

(5) Until no new sample points are added to the set, the clustering process ends.

II. B. Data analysis from different perspectives

II. B. 1) Talent training model perspective

To understand the selection and distribution of new media-assisted problems related to the cultivation of diversified talents in the connection between secondary vocational education and higher education, five options were set: A1: "very consistent", A2: "compliant", "conformed", "uncertain", "uncertain", A4: "not compliant" and A5: "extremely inconsistent". Based on the three items of Q3, Q8 and Q12, the results of five different options were statistically analyzed, as shown in Table 1. Among them, Q3, Q8 and Q12 respectively expressed "what do you think is the mastery of intelligence-related skills by school recruits in the past five years", "what kind of relationship do you hope to establish with colleges and universities according to the needs of intelligent development", "the current evaluation of the current situation of the government, enterprises and schools jointly promoting education integration"

Through data analysis, it is found that most of the schools are not satisfied with the current situation of enterprise talent training, and the main reason for this situation is the lack of driving force of the school, enterprise and government, and the problem that needs to be solved urgently is to strengthen the incentive for the integration of industry and education.

Table 1: The selection of personnel training related problems

Options results	Q3	Q8	Q12
A1	185	85	197
A2	917	957	783
A3	1094	969	1279
A4	352	531	368
A5	101	145	89

In order to further explore the evaluation of the main problems of diversified talent cultivation in the interface between secondary education and higher education with the aid of new media and the evaluation of the main factors contributing to this problem, two visual questions, “What enterprises think are the existing problems of diversified talent cultivation in the interface between secondary education and higher education” and “How well have employees mastered intelligent related skills in the last five years”, were selected for analysis. Two intuitive questions were chosen to analyze the “existing problems of diversified talent cultivation in the interface between secondary education and higher education as perceived by enterprises” and “how well employees have mastered the skills related to intelligence in the past five years”. Since each item is a fixed-type question, the chi-square test is the most appropriate way to determine the difference, as shown in Table 2.

The data analysis in the table shows that the Pearson's chi-square test value between the two items is 3.47. Because of the large sample size, the asymptotic significance is chosen to test whether the data results are reliable, and the significance in the table is 0.055, which is less than 0.1, so the data have a certain degree of correlation. Since the larger the chi-square value, the greater the variability between the data, then the smaller the deviation, therefore, it can be concluded that there is a certain degree of correlation between the existing main problems of talent cultivation and the factors of the single direction of mastery of professional competence of the employees of the college graduates in the last five years.

Table 2: chi-square test coefficient

Test method	Test value	Freedom	Progressive significance (Sig.)	Progressive significance (Sig.)	The significance is clear (unilateral)
Pearson card	3.47	1	0.055	-	-
Continuity correction	2.63	1	0.077	-	-
Continuity correction	-	-		0.073	0.052

II. B. 2) Professional Faculty Perspective

To address the problem of weak professional faculty and the difficulty of balancing theory and technology, the question items in the dimension of the faculty strength evaluation system were selected for data analysis respectively. Since the dimension includes eight question items, factor analysis using principal component analysis method was used to obtain the most important factor question items. The specific data are shown in Table 3.

Among them, the factor load represents the correlation coefficient between each variable, i.e., the question item and the common factor, reflecting the importance of the variable to the common factor. Commonality indicates the degree to which the information contained in the data can be interpreted by common factors; Explainable variance indicates the degree to which items are related to each other. From the analysis of the table data, it can be seen that all factors can be mainly interpreted as four factors: x_1, x_3, x_5 and x_6, that is, "the degree of professional knowledge and ability of college teachers", "satisfaction with college teachers", "extracurricular extension of teachers' knowledge system" and "evaluation of college assessment system", etc., the commonality of each item is high, and the explanatory variance is small. It shows that these four items are closely related and can be grouped into one category.

Table 3: factor analysis results

Variable	The rotation factor load estimation				Rotary score function				Common degree
	F_1	F_2	F_3	F_4	Factor 1	Factor 2	Factor 3	Factor 4	
1	0.961	0.129	0.213	0.153	0.854	0.015	-0.602	0.0548	0.9896
2	0.372	0.061	0.912	0.593	-0.459	0.094	0.973	-0.803	0.975
3	0.227	-0.811	0.379	-0.281	-0.068	-0.263	0.253	0.179	0.8738
4	0.809	0.002	0.571	-0.419	0.337	0.015	0.057	-0.434	0.971
5	0.147	0.974	0.064	-0.511	0.035	0.341	0.062	0.147	0.977
6	0.131	0.89	0.173	-0.243	-0.85	0.349	0.236	0.324	0.982
7	-0.514	0.538	-0.472	0.015	-0.172	0.172	-0.111	-0.273	0.825
Interpretative variance	0.315	0.409	0.231	0.257	-	-	-	-	-

II. C. Digital Talent Development in the Interface between Secondary and Higher Education

II. C. 1) Construction of articulation mode of professional teaching resource base

When constructing the model of articulation of teaching resources of the same discipline, the steering committee of professional construction can be used as the basis, and the secondary and higher vocational colleges and universities that carry out professional articulation should be the main builders, while other cooperative enterprises or colleges and universities should be introduced as the participants, so as to jointly plan and build the professional teaching resource base.

The articulation mode of the same professional teaching resource base mainly involves three parties:

(1) Steering committee of professional construction. The steering committee of professional construction consists of senior engineers from professional counterpart industries and enterprises, and professional leaders from other outstanding institutions of similar professions. It is responsible for coordinating and planning the middle and high vocational professions in terms of talent cultivation program, curriculum system articulation, positioning of curricular objectives and selection of curricular contents, introducing the standards for the construction of teaching resource base, assigning the construction objects of curricular resources, regulating the construction of curricular resource base undertaken by middle and high vocational institutions, and reviewing the status quo and regulating the construction of curricular resource base. The situation is regulated and feedback is given on the current situation, so as to coordinate the responsibilities and interests of each construction party and guarantee the smooth construction of the shared professional teaching resource base.

(2) Resource construction master builder. The main builder of resource construction is undertaken by the middle and high vocational colleges and universities that articulate courses, and is responsible for the planning, construction, updating and maintenance of the course resource library that belongs to the part of the curriculum system that is under the responsibility of the university. In addition, the main builder also needs to do a good job of coordinating with each other and with the participating parties.

(3) Resource construction participants. Resource construction participants are mainly various middle and higher vocational colleges and universities that include the specialty and have strong strength, rich teaching resources and good teaching effect in the construction of the specialty. Resource construction participants mainly assist the main construction party in building professional resources, including providing excellent teaching cases, classroom videos, examination questions and other digital resources, and need to communicate and coordinate with the main construction party to standardize the resource specifications and optimize the quality of resources under the requirements of the main construction party, so as to ensure the sharing of resources.

II. C. 2) Professional Teaching Resource Library Articulation Model Implementation

Under the guidance of the “articulation model of specialized teaching resources library of the same discipline”, the main resource builder should carry out a coordinated planning for the construction of professional resources, and the participating builders should provide teaching resources materials that meet the standards, so as to build up a professional teaching resources library and provide professional teaching resources for the students of middle and higher vocational colleges and universities, and the implementation process is as shown in Fig. 2. .

In the construction process, the construction of professional digital teaching resources needs to follow a reasonable order: (1) first standardize and then classify, first standardize the type of construction module of the resources, divide the overall structural framework, and then classify the resources, unify the naming format, and enrich all kinds of resources in the resource library according to the type of the module; (2) first collect and then process, due to the professional teaching resource library for the excellent digital teaching resources Due to the high demand for professional teaching resources library for excellent digital teaching resources, it is necessary to obtain rich teaching resources as much as possible, and then process and handle the resources to optimize the quality of the resources; (3) first course and then professional, the construction of the resource library is a long-term process, according to the curriculum system to take the stage of construction, and gradually improve the construction of the resources of each part of the curriculum, and then form the integration of the professional teaching resources library.

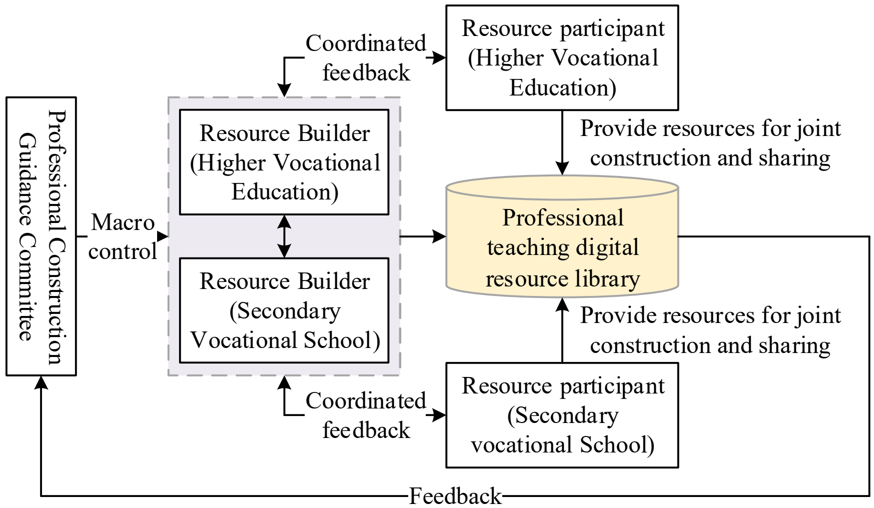

Figure 2: The process diagram of the professional teaching resource library

III. Comprehensive evaluation of the quality of multi-teaching personnel training

III. A. Research methodology

III. A. 1) Principal component analysis

Principal Component Analysis (PCA) was first proposed by K. Pearson in 1901, and later H. Hotelling popularized this method in the case of random vectors PCA is a data dimensionality reduction technique that transforms a large number of variables in the original data that are correlated into a set of very few uncorrelated variables [19]. By transforming numerous variables with high correlation in the original data into variables that are uncorrelated with each other, the ultimate goal is to explain most of the variation in the original data through a very small number of variables. The basic idea is:

Let $x_1, x_2, \cdots, x_p$ denote the indicators of p categories of students' ability, and $a_1, a_2, \cdots, a_p$ denote the weights of each category of student's ability indicators, respectively. Then the weighted sum is:

$$s = a_1 x_1 + a_2 x_2 + \cdots + a_p x_p \tag{2}$$

Each student corresponds to one such composite student ability indicator, denoted as $s_1, s_2, \cdots, s_n$, with n being the number of students. What we hope is that the selection of appropriate weights will better distinguish the differences between students. The more dispersed these values are obtained from the weighting calculation indicates better differentiation, which means that we need to find such weights that can make $s_1, s_2, \ldots, s_n$ as dispersed as possible, and next we look at its statistical definition. Suppose that $X_1, X_2, \ldots, X_p$ denotes a random variable with $x_1, x_2, \cdots, x_p$ as the sample observations, and that if $a_1, a_2, \cdots, a_p$ such that the value of $Var(a_1 X_1 + a_2 X_2 + \cdots + a_p X_p)$ is maximized, then we can follow the statistical principle that variance reflects the degree of difference between the data to capture the maximum of this p indicator of students' ability. Variance.

Of course, in order to prevent choosing weights that are infinite and not practically meaningful, we have to put some kind of restriction on $Var(a_1 X_1 + a_2 X_2 + \cdots + a_p X_p)$. Usually we specify:

$$a_1^2 + a_2^2 + \cdots + a_p^2 = 1 \tag{3}$$

Under this constraint, the optimal solution of $Var(a_1 X_1 + a_2 X_2 + \cdots + a_p X_p)$ is found. The calculation of principal components in this paper is done by R software.

The specific steps of principal component analysis are as follows:

① Calculate the covariance matrix

Calculate the covariance matrix of the sample data: $\Sigma = (s_{ij})_{p \times p}$, where:

$$s_{ij} = \frac{1}{n-1}\sum_{k}^{n}(x_{ki}-\overline{x})(x_{kj}-\overline{x}) \quad (i,j=1,2,\cdots,p) \tag{4}$$

② Find all eigenvalues λ_i of Σ and corresponding orthogonalized unit eigenvectors a_i

The first m larger eigenvalues $\lambda_1 \ge \lambda_2 \ge \cdots \ge \lambda_m$ of Σ are the variances corresponding to the first m principal components, and the unit vectors a_i corresponding to λ_i are the coefficients of the principal components F_i about the original variable, which is then the i th principal component F_i of the original variable:

$$F_i = a_i^{'}X \tag{5}$$

The variance contribution of each principal component represents how much raw information that principal component can represent, α_i is:

$$\alpha_i = \lambda_i / \sum_{j=1}^{m}\lambda_j \tag{6}$$

③ Selection of principal components

The final determination of the number of principal components, i.e., m in $F_1, F_2, \cdots, F_m$ is determined by calculating the cumulative contribution to variance $G(m)$:

$$G(m) = \sum_{i=1}^{m}\lambda_i / \sum_{k=1}^{p}\lambda_k \tag{7}$$

In general, when the cumulative variance contribution reaches 70% to 80%, we consider that it can represent most of the information of the original variable, and the corresponding m is the first m principal components extracted.

④ Calculate principal component loadings

Principal component loading is to indicate the degree of correlation between the principal component F_i and the original variable X_j, the original variable $X_j (j=1,2,\cdots,p)$ on the principal component $F_i (i=1,2,\cdots,p)$, and the loading of the original variable $l_{ij} (i=1,2,\cdots,m; j=1,2,\cdots,p)$

⑤ Calculate principal component scores

Calculate the score of the sample on m principal components:

$$F_i = a_{1i}X_1 + a_{2i}X_2 + \cdots + a_{pi}X_p \quad (i=1,2,\cdots,m) \tag{8}$$

If the variables in the sample have different measures, then the effect of the measures needs to be eliminated before calculating the principal components. The most common way to eliminate the magnitude is to standardize the original data, i.e., to do the following transformation of the data:

$$x_{ij}^{*} = \frac{x_{ij}-\overline{x}_j}{s_j} \quad i=1,2,\cdots,n; j=1,2,\cdots,p \tag{9}$$

Of these, $\overline{x} = \frac{1}{n}\sum_{i=1}^{n}x_{ij}, s_j^2 = \frac{1}{n-1}\sum_{i=1}^{n}(x_{ij}-\overline{x}_j)^2$.

III. A. 2) Clustering

1. Clustering Methods

Cluster analysis is widely used and studied in data analysis and data mining. Nowadays, more and more data are analyzed in various industries, which makes the use of cluster analysis more and more widespread. Clustering is a basic human cognitive activity, through the reasonable clustering of the characteristics of things, which is conducive to the next study, and its internal laws may be mastered by human beings. The so-called clustering is to gather things into classes according to certain characteristics of things, so that the similarity between different classes is as small as possible and the similarity within the classes is as large as possible. Unlike the classification task, cluster analysis is an unsupervised learning process in machine learning, which is fundamentally different from classification in that: in classification, we need to know in advance the characteristics of the data on which we are basing our work; in clustering, we need to find these data characteristics. Therefore, in many applications, clustering analysis is used as a data preprocessing process, which is the basis for further data analysis and data processing.

2. Similarity Measure

Clustering algorithms perform clustering by calculating the distance between points, i.e., the distance between different points is used as a measure of similarity between them. In general, the distance between points categorized as one class is smaller than the distance from that point to other points, while the distance between points categorized as different classes is relatively larger. Alternatively, the distance between points categorized as one is less than a certain value, and the distance between separated points is greater or much greater than this value. There are many algorithms for calculating distances between points, and the following briefly describes a few of them for calculating distances between points.

The most commonly used measures of similarity between samples are the Euclidean distance, the Manhattan distance, and the Minkowski distance; the distance between samples and clusters can be expressed as the distance from the sample to the center of the cluster $d(e_i, x)$; and the distance between clusters can be expressed as the distance from the center of the cluster $d(e_i, e_j)$.

The data matrix with p attributes for n samples is as follows:

$$\begin{bmatrix} x_{11} & \cdots & x_{1p} \\ \vdots & \ddots & \vdots \\ x_{n1} & \cdots & x_{np} \end{bmatrix} \tag{10}$$

Euclid distance:

$$d(i,j) = \sqrt{(x_{i1} - x_{j1})^2 + (x_{i2} - x_{j2})^2 + \cdots + (x_{ip} - x_{jp})^2} \tag{11}$$

Manhattan Distance:

$$d(i,j) = |x_{i1} - x_{j1}| + |x_{i2} - x_{j2}| + \cdots + |x_{ip} - x_{jp}| \tag{12}$$

Minkowski is out of range:

$$d(i,j) = \sqrt[q]{(|x_{i1} - x_{j1}|)^q + (|x_{i2} - x_{j2}|)^q + \cdots + (|x_{ip} - x_{jp}|)^q} \tag{13}$$

q is a positive integer, $q=1$ is the i.e. Manhattan distance; $q=2$ is the i.e. Euclidean distance.

III. B. Determination of the evaluation indicator system

The goal of talent training is mainly divided into two levels: quality goal and ability goal, and the quality goal reflects the internal cultivation of a talent, including personal psychological quality and moral quality; The ability goal reflects a person's ability to interact with the society and contribute to the society, that is, the social value of talents, including the individual's knowledge structure, practical ability, innovation ability, social adaptability, etc. Therefore, starting from the social demand for clinical psychology talents, this paper constructs an evaluation index system for the quality of clinical psychology talents from five aspects: knowledge structure, practical ability, innovation ability, social adaptability, and psychological and ideological and moral quality. Table 4 shows the evaluation index system of talent training quality.

Table 4: The quality evaluation index system of talent cultivation

Primary indicator	Secondary indicator	Tertiary index	Code
The secondary and higher education society is developed	Knowledge structure	Learning knowledge	X_1
		education	X_2
	Practical ability	Hands-on ability	X_3
		Learning knowledge application ability	X_4
		Experimental ability	X_5
	Innovative ability	Innovation consciousness	X_6
		Creative thinking	X_7
		Innovative behavior	X_8
	Social adaptability	Cooperative ability	X_9
		Communication ability	X_{10}
	Psychological and ideological and moral qualities	Mental quality	X_{11}
		Moral quality	X_{12}

III. C. Empirical analysis

III. C. 1) Data collection and processing

This paper aims at the phenomenon that the practical ability and innovation spirit of higher education professionals in secondary vocational colleges and universities are not high, and combines the objective requirements of China's economic and social development on professional talents to design and distribute the questionnaire on the quality of professional talents training, the whole process is in line with the principle of randomness of survey sampling, and the questionnaire is mainly distributed to medical schools with clinical psychology majors, because most of the talents in clinical psychology majors originate from these colleges and universities, and the results of the survey can better reflect the real quality of talents training. Because most of the talents in clinical psychology in society originate from these colleges and universities, the results of the survey better reflect the real situation of the quality of personnel training.

III. C. 2) Model solving

Firstly, the raw data of the selected 12 evaluation indicators were imported into SPSS19.0 for data standardization, from which the variance contribution rate, cumulative variance contribution rate and component matrix of each component were obtained, and the specific results are shown in Table 5 and Table 6.

Table 5: Interpretation of variance and contribution

Constituent	Initial eigenvalue			Extract the sum of squares and load		
	Total	Variance %	Cumulative%	Total	Variance %	Cumulative%
1	6.741	56.175	56.175	6.741	56.175	56.175
2	2.415	20.125	76.3	2.415	20.125	76.3
3	1.012	8.433	84.733	1.012	8.433	84.733
4	0.722	6.017	90.75			
5	0.573	4.775	95.525			
6	0.291	2.425	97.95			
7	0.146	1.217	99.167			
8	0.068	0.567	99.734			
9	0.032	0.267	100.00			
10	0.000	0.000	100.00			
11	0.000	0.000	100.00			
12	0.000	0.000	100.00			

Table 6: Component matrix

	Constituent		
	1	2	3
X_1	0.305	0.858	0.168
X_2	0.342	0.871	0.022
X_3	0.908	-0.376	-0.031
X_4	0.801	-0.414	-0.001
X_5	0.749	-0.309	0.493
X_6	0.817	-0.435	-0.324
X_7	0.757	-0.042	0.295
X_8	0.869	0.163	-0.274
X_9	0.764	0.436	0.397
X_{10}	0.725	0.629	-0.386
X_{11}	0.691	0.625	0.247
X_{12}	0.873	0.141	-0.362

In this paper, the first three components are selected as the principal component indicators for evaluating the quality of higher education professional training in each secondary school. According to Tables 5 and 6, the corresponding characteristic roots of the principal components are squared, and the corresponding data obtained by dividing the coefficient matrix of each column in the principal component coefficient matrix with it are substituted into formula (3) to obtain the expression of the principal components:

$$F_1 = 0.1195X_1 + 0.1457X_2 + 0.3415X_3 + \cdots + 0.2762X_{10} + 0.2699X_{11} + 0.3451X_{12}$$
$$F_2 = 0.5013X_1 + 0.5245X_2 - 0.2311X_3 + \cdots + 0.2469X_{10} + 0.3631X_{11} + 0.0794X_{12}$$
$$F_3 = 0.1597X_1 + 0.0257C_2 - 0.0284X_3 + \cdots - 0.3614X_{10} + 0.2384X_{12} - 0.3419X_{12}$$

The expression for the composite score is $F = 0.53491F_1 + 0.24158F_2 + 0.08260F_3$.

According to the above expression of principal components and the expression of composite score, the individual principal component scores and composite scores of the 10 institutions were calculated and ranked according to the high and low scores as shown in Table 7. As can be seen from the table, the first principal component mainly reflects the information on practical application ability, the second principal component mainly reflects the information on knowledge ability, and the third principal component mainly reflects the information on psychological and ideological and moral quality.

Table 7: Main component score and comprehensive score

	F_1	F_2	F_3	Comprehensive score	Total sort
1	4.7067	4.7144	2.3794	3.6558	9
2	20.7646	6.3473	4.0556	13.9191	3
3	4.7649	4.4208	2.056	4.1318	7
4	5.3862	6.2369	-2.0421	3.9211	8
5	4.7233	3.4014	-0.6077	3.4749	10
6	13.4817	0.8244	-1.5402	8.1403	5
7	13.6485	0.0309	-2.8091	8.4098	4
8	5.9797	6.0134	0.7939	4.3519	6
9	21.8321	5.9212	4.2073	14.4173	1
10	22.2313	4.2658	4.8344	14.2992	2

Finally, SPSS 19.0 was used to do a cluster analysis of the three principal components, and the dendrogram of the clusters is shown in Figure 3. This shows that the clustering results in three categories, {6, 7}, {1, 3, 4, 5, 8}, and {2, 9, 10}. The results are then sorted according to the scores of the principal components in each category and the following results are obtained: {9, 10, 2, 6, 7, 8, 3, 4, 1, 5}.

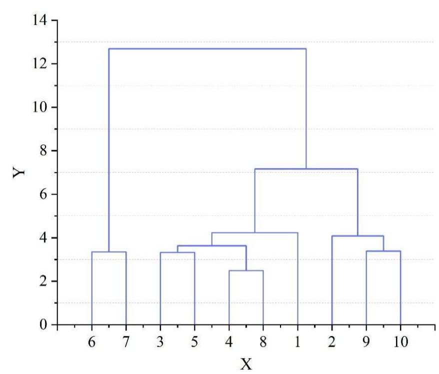

Figure 3: Cluster analysis tree diagram

III. C. 3) Empirical results and analysis

① The first category {9, 10, 2}, with an average principal component score of 15.1229, the analysis shows that these institutions have clear cultivation objectives, are able to carry out scientific and reasonable settings for their own characteristics of specialized courses, and at the same time pay attention to the cultivation of students' professional practice ability, and professional apprenticeships, internships, and social practice work are more adequate, which makes these institutions have higher evaluation in the aspects of the knowledge structure of talent cultivation, the ability of application, innovative ability, and psychological and ideological and moral qualities, etc., innovation ability and psychological and ideological and moral qualities are rated higher, which can provide professionals with higher comprehensive qualities for scientific research, psychological counseling services and psychology teaching and other fields.

② The second category {6, 7}, with an average principal component score of 8.7531, the analysis shows that these institutions are oriented to the needs of the society, favoring the cultivation of the practical application ability and innovation ability of professional students, vigorously carrying out experiments and other practical teaching, and at the same time, they have established a good cooperative relationship with psychological counseling centers, affiliated schools, and some local enterprises and public institutions, which provide the necessary internship venues for the students, so that the students can be better qualified for their professional duties and responsibilities. Students are able to be better qualified to meet the occupational needs of their specialized fields of study, but their mastery of basic theoretical knowledge is relatively weak.

③ The third category {8, 3, 4, 1, 5}, with an average principal component score of 4.3784, the analysis shows that these institutions have ambiguous positioning of professional training objectives, have not formed their own training characteristics, the curriculum system is not reasonable enough, and have neglected the cultivation of professional students' application ability. Therefore, these institutions should clarify the goals and directions of professional training, improve the curriculum system, provide more internship opportunities and internship places for students while strengthening the basic knowledge training of students, and improve the social practice ability of students, so as to improve the overall quality of professional training.

IV. Conclusion

In this study, through the deep integration of computational optimization methods and new media assistive technologies, we successfully constructed a multivariate instructional design talent cultivation model for the articulation of secondary education and higher education.

Data analysis showed that the cumulative variance contribution rate of the first three components extracted by principal component analysis reached 84.733%, effectively explaining the main influencing factors of talent cultivation quality. In the faculty evaluation system, the common degree of all 7 variables remained above 0.825, indicating that the indicators had strong intrinsic correlation. The results of cluster analysis show that the 10 institutions are divided into 3 different types, among which the average score of the principal components of the third type of institutions is only 4.3784, reflecting the obvious deficiencies of some institutions in talent cultivation.

The construction of professional teaching resource base articulation mode provides an effective path to solve the problem of disconnection between middle and higher vocational education, and through the tripartite synergy mechanism of the professional construction steering committee, the main builder of the resource construction and the participant, the optimal allocation and shared use of teaching resources are realized. The application of new media technology significantly improves the teaching effect and learning experience, and the implementation of the concept of multiple teaching design effectively meets the personalized needs of learners at different levels. Computational optimization algorithms play an important role in data processing and decision support, providing a scientific basis for education management.

The implementation of the model in this paper not only improves the quality of talent cultivation, but also promotes the deep integration of school-enterprise cooperation, lays a solid foundation for the cultivation of high-quality skilled personnel adapted to the requirements of the digital era, and has important theoretical value and practical significance for promoting the modernization and development of vocational education.

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