

A Study of Clustering Analysis Based on the Classification of Higher Vocational Colleges in Hb Province

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ABSTRACT

By using the SPSS cluster analysis method, it's analyzed the index system of education condition, educational management, teaching staff, specialty and curriculum construction of 58 Higher Vocational Colleges in Hb Province, and divided the Higher Vocational Colleges into five categories: high-level, relatively high-level, medium-level, general-level and low-level in this paper. The classification study provides new ideas and new methods for the classification of Higher Vocational Colleges in Hb Province. The relevant government agencies can make accurate positioning of the Higher Vocational Colleges in Hb Province and formulate more pertinency development policies for different types of colleges, which can formulate more specific development plans and improve their employment rate.

Keywords: HB province, higher vocational colleges, cluster analysis, classification, employment rate

1. INTRODUCTION

In February 2019, the Party Central Committee and the State Council issued "China's education modernization 2035" and proposed to optimize the education system structure and school layout structure. As a basic means of the higher education management, classified evaluation of higher education can improve the structure of higher education system, and it is an important symbol of the development and modernization of Higher Education [1].

From a global perspective, the research on the classification of colleges and universities in developed countries has been quite mature. The Carnegie Foundation for the Advancement of Teaching in the United States divides American universities into six categories according to the postgraduate training plan, the undergraduate training plan, students' schooling, type and scale [2]. The European classification of higher education institutions (u-map) is a higher education classification scheme for EU countries. It not only has a complete classification framework, but also has the characteristics of wide classification dimension, strong pertinence and high transparency [3-6]. The most widely used classification of higher education research in Japan is AMANO Ikuo, who takes the strength of university research function as the classification basis [7].

The research on the classification of colleges and universities in China started relatively late. As one of the main types of the higher education systems, higher vocational education plays an indispensable role in the classification research of colleges and universities. However, the research on the classification of Higher

Vocational Colleges by cluster analysis is imperfect. At the same time, the research on the classification of Higher Vocational Colleges in Hb Province is still at the initial stage, lacking the classification research based on the cluster analysis under SPSS. Therefore, it is necessary to analyze and explore the index system related to the classification of Higher Vocational Colleges in Hb Province, and classify the Higher Vocational Colleges in Hb Province, to give full play to the significance of College classification. This paper uses SPSS cluster analysis to study how to classify the Higher Vocational Colleges in Hb Province.

2. CLASSIFICATION METHOD AND FUNCTION

2.1. classification Method

SPSS cluster analysis was used to study. Cluster analysis is a kind of multivariate statistical analysis method which classifies according to the specific digital characteristics of statistical objects. Its basic principles are: suppose there are n samples, each sample contains P indexes, n samples are regarded as n points in p -Dimensional Space, and the distance between two points in p -Dimensional Space is the approximate degree of two samples. Taking n samples as a class, the distance between them is calculated, and the two samples with the smallest distance are clustered into a new class until the clustering is completed. When there are multiple types of indicators, the indicators with the similar

degrees can be clustered together and classified, and then the index group can be classified [8].

2.2. Classification Function

There are 4 national demonstration schools and 15 provincial demonstrations (backbone) colleges in Hb Province. With the strong support of relevant policies, the four national demonstration schools have fully developed their actions in the construction plan, professional construction service, industrial upgrading, teaching practice and other aspects, which has led to the reform and development of Higher Vocational Education in Hb Province [9]. The 15 provincial demonstrations (backbone) colleges and universities have enhanced the vitality of running schools, expanded the high-quality education resources, and formed a development system of higher vocational education with HB characteristics, including coordinated development, reform and innovation, the combination of production and teaching, managing the university by law and strengthening morality education, which serves the development of economic and social of Hb Province.

Therefore, the national and provincial demonstrations colleges divide Higher Vocational Colleges into two types: demonstration colleges and non-demonstrations colleges, which can make Higher Vocational Colleges in Hb Province form benign competition, drive the overall development of Higher Vocational Colleges in Hb Province, and thus promote the development of Higher Vocational Education in Hb Province. If we can scientifically and reasonably classify all the Higher Vocational Colleges in Hb Province, and assist different development policies for different types of Higher

Vocational Colleges, then the Higher Vocational Colleges in Hb Province will also get further development.

3. DATA DESCRIPTION AND CLUSTER ANALYSIS

3.1. Data Description

The college data for cluster analysis come from the Data Monitoring Center of China Higher Vocational Colleges (hereinafter referred to as the "monitoring center"), which is used as the empirical data for the classification research of Higher Vocational Colleges in Hb Province. In 2019, there are 61 Higher Vocational Colleges in the province 58 Higher Vocational Colleges in the monitoring center, and 58 colleges with data. The data shows that the total number of full-time students is 450 245. After analyzing the data modules of fund input, education condition, specialty construction, the teachers, the students and employment quality of HB Vocational Colleges in 2019, 36 valid data items of 58 Higher Vocational Colleges can be obtained.

3.2. Cluster Analysis

3.2.1. Cluster index system

Figure 1 Shows the icicle plot, obtained by the SPSS cluster method

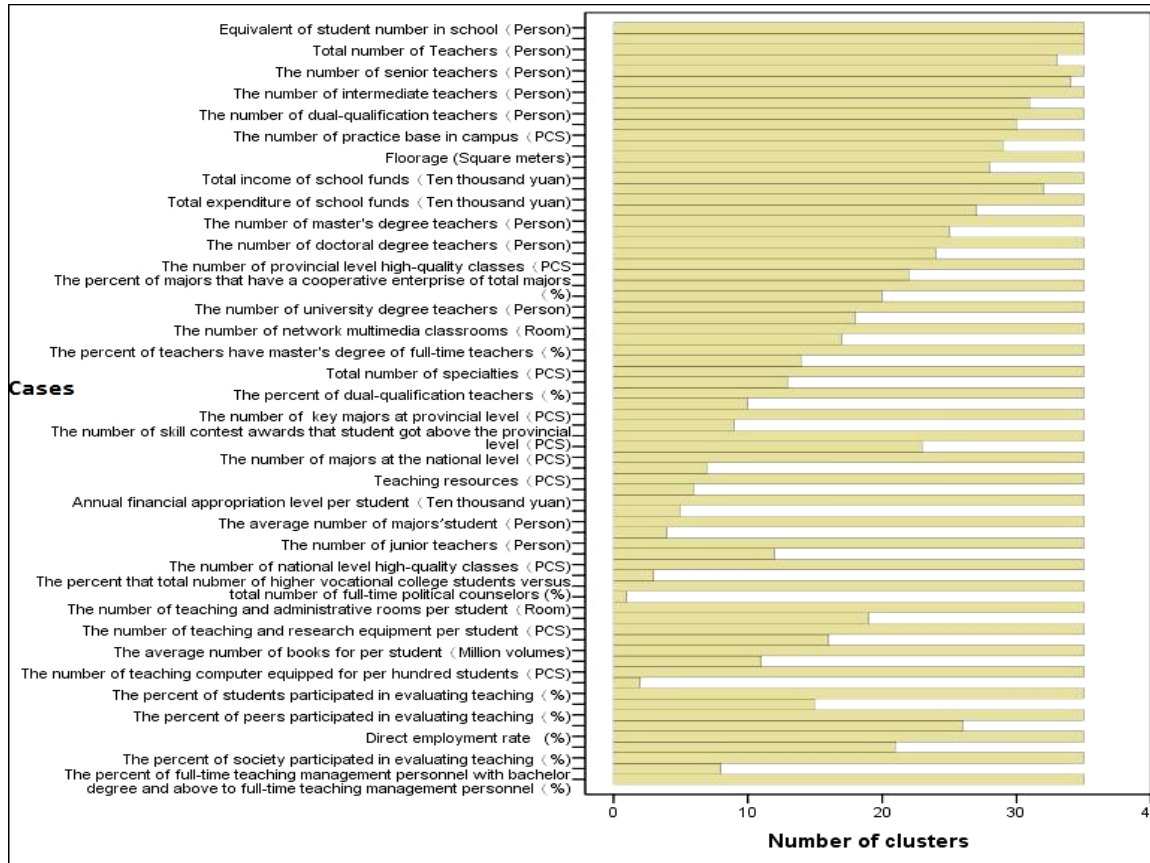


Figure 1 Cluster analysis icicle plot.

According to the similarity degree of each index in the icicle chart, the 36 indexes are divided into the following three categories:

(1) Basic Index System: It includes the number of provincial key majors, the number of national excellent courses, the proportion of social participation in teaching evaluation, the number of teaching resources, the average annual financial allocation level of students, the average number of professional students, the number of teaching computers for 100 students, the total number of full-time vocational students (equivalent to the total number of students in school), the proportion of double qualified teachers, the average number of books per student, and the proportion of full-time teaching management personnel with undergraduate or above in full-time teaching and the number of national key specialties are 12 indicators.

(2) Development Index System: It includes the number of students who have won the skills competition at or above the provincial level, the number of teachers with a university degree or above, the proportion of majors with cooperative enterprises in the total number of specialties, the number of excellent courses at the provincial level, the number of network multimedia class classrooms, the proportion of teachers with a graduate degree in the number of full-time teachers, the total number of specialty equipment, the number of junior teachers, the ratio of

students participating in teaching evaluation, the direct employment rate, the average number of teaching administration per student and the average number of teaching and scientific research equipment per student are 12 indicators..

(3) The expansibility index system includes 12 indexes: the total number of students converted into the total number of students, the total number of teachers, the number of senior teachers, the number of intermediate teachers, the number of double qualified teachers, the number of practice bases in the school, the construction area, the total amount of school funding, the total amount of school expenditure, the number of master graduate teachers, the number of doctoral teachers and the proportion of peer participation in teaching evaluation.

3.2.2. Clustering results

Through the K-means clustering analysis of the non-system clustering of SPSS, the classification result of 5 is selected and converges after 4 system iterations, and the best classification result can be output [10-11]. The results are shown in Table 1-5. (the indexes in Tables 1, 3 and 4 are the indexes of the above indexes in the output results of SPSS).

Table 1 shows the five types of initial clustering centers automatically determined by SPSS according to the selected data.

Table 2 is the iteration record which was repeated for 4 times until the final convergence was completed. The convergence criterion is 0.

Table 3 shows the final clustering center after iteration, which is the matrix distance between different types after clustering. The data of the clustering center is the average

Table 1 Initial cluster center

frequency of each type of Vocational College with a certain characteristic index. For example, the first data in the first row of Table 3 represents the average number of students converted into the total number of students in Hb Province of the first category, which is 1.46990.

Table 4 is the variance analysis of the clustering process.

Table 5 shows the final classification results of five types of Higher Vocational Colleges.

	clustering				
	1	2	3	4	5
Equivalent of students number in school	2.32006	.62130	2.14552	-1.37262	-1.88411
Total number of specialties	2.05129	.84007	-.97676	-1.36214	-2.02281
The average number of majors' student	-.09504	-.48575	3.14995	-.35640	-1.28967
The number of skill contest awards that student got above the provincial level	2.92291	-.38346	-.69269	.16364	-.76405
The percent of teachers have master's degree of full-time teachers	.36798	.45304	-.94620	.23610	-3.10815
The number of teaching and administrative rooms per student	-.10308	-.63025	.84163	3.71342	-2.04012
The number of taching and research equipment per student	.27638	-.41478	.04169	6.72269	-1.15740
The average number of books for per student	-.74430	-.45878	.93138	2.99606	-3.16297
The number of teaching computer equipped for per hundred students	.34351	-.42764	-.77677	2.25885	-1.48185
The number of network multimedia classrooms	3.53034	-.37020	1.21478	-.82836	.18702
Floorage	1.57613	-.23459	3.24653	-.55011	.07512
Teaching resources	.21888	-.27208	-.39735	.28839	-.42066
The number of practice base in campus	3.06101	-.17463	.47909	-.28475	-1.21781
The percent of students participated in evaluating teaching	.50672	.41592	.52811	.26139	-3.83734
The percent of peers participated in evaluating teaching	.38992	.27619	.50946	.11776	-3.12414
The percent of society participated in evaluating teaching	.56533	.57106	.82564	-.60621	-2.03806
The percent of full-time teaching management administrators personnel with bachelor degree and above to full-time teaching management personnel	-.25258	-.11875	.39840	.39840	-6.32662
Total income of school funds	2.11020	-.22991	.45417	.78115	-1.54081
Total expenditure of school funds	2.14320	-.21813	2.48708	.84961	-1.37432
The percent that total nubmer of higher vocational college students versus total number of full-time political counselors	-.09919	-1.01232	-.58892	-.15916	-1.01232
Annual financial appropriation level per student	.43472	.30033	-1.08493	.05222	-1.08493
The percent of dual-qualification teachers	.72486	.26533	-.59088	.74990	-2.53257
Direct employment rate	.55344	-.01743	.26561	.58010	-2.81124
Total number of teachers	2.45909	.49577	1.43084	-1.18471	-1.79700
The number of senior teachers	2.08827	.44871	1.89684	-.91621	-1.48215
The number of intermediate teachers	1.92854	.73292	1.49846	-.82398	-1.63253
The number of junior teachers	3.29769	2.96649	-.84227	-.51107	-.84227
The number of doctoral degree teachers	1.90051	-.52339	1.09255	-.17712	-.63881
The number of master's degree teachers	.69556	-.29930	.58021	-.54441	-1.59695

Table 1, cont

The number of university degree teachers	1.36406	1.24920	1.86176	-1.00002	-1.85185
The number of dual-qualification teachers	2.08403	.41920	.20205	-.63760	-1.47001
The percent of majors that have a cooperative enterprise of total majors	.87427	1.13570	.58653	.35600	-1.83644
The number of majors at the national level	3.81795	.13285	-.53717	-.53717	-.53717
The number of key majors at provincial level	.45445	.45445	-.90889	-.90889	-.90889
The number of national level high-quality classes	1.89524	5.67270	-.29568	-.29568	-.29568
The number of provincial level high-quality classes	5.554403	1.009891	-.589103	.673261	-.589103

Table 2 Iteration history

Iteration	Changes within cluster centers				
	1	2	3	4	5
1	5.130	7.336	5.758	6.424	4.779
2	0.000	1.116	1.320	0.000	0.000
3	0.000	0.406	0.527	0.000	0.000
4	0.000	0.000	0.000	0.000	0.000

Table 3 Final cluster center

	clustering				
	1	2	3	4	5
Equivalent of students number in school	1.65638	-.41412	.75856	-1.30794	-1.49656
Total number of specialties	1.04653	-.17210	.49322	-1.09788	-1.36214
The average number of majors' student	.08394	-.04261	.21289	-.16576	-.88559
The number of skill contest awards that student got above the provincial level	2.30445	-.31210	.20289	-.57375	-.76405
The percent of teachers have master's degree of full-time teachers	1.08244	-.44815	.58448	.05159	-1.54183
The number of teaching and administrative rooms per student	.04284	-.22269	.01421	1.98082	-1.52328
The number of taching and research equipment per student	.32515	-.28743	.04502	1.70473	-1.08380
The average number of books for per student	-.40511	-.04241	.05812	1.56290	-2.08465
The number of teaching computer equipped for per hundred students	.71328	-.37616	.11202	1.77315	-1.39300
The number of network multimedia classrooms	1.37885	-.39877	.48730	-.68967	-.48164
Floorage	1.39442	-.56804	.75424	-.75946	-.69873
Teaching resources	-.03209	-.33959	.57329	-.24042	-.43533
The number of practice base in campus	2.45790	-.39270	.39898	-.84080	-1.13232
The percent of students participated in evaluating teaching	.40294	.22715	.16617	.13418	-3.83734
The percent of peers participated in evaluating teaching	-.16203	.17865	.38657	-.47117	-3.12414
The percent of society participated in evaluating teaching	.35327	.12552	.44716	-1.50112	-2.03806
The percent of full-time teaching management administrators personnel with bachelor degree and above to full-time teaching management personnel	.09561	.09280	.16323	.39840	-2.68390
Total income of school funds	1.77607	-.65095	.79976	-.45552	-1.29904
Total expenditure of school funds	1.46990	-.58591	.77534	-.52822	-1.17056
The percent that total nubmer of higher vocational college students versus total number of full-time political counselors	-.21287	.30951	-.15423	-.60267	-.36591

Table 3, cont

Annual financial appropriation level per student	.66473	-.15692	.23003	.01501	-1.08493
The percent of dual-qualification teachers	.96456	-.45932	.65531	-.32763	-1.12797
Direct employment rate	.49455	-.04099	.45188	-.30327	-2.81124
Total number of teachers	1.79938	-.45761	.74268	-1.20068	-1.38326
The number of senior teachers	1.60763	-.53913	.82780	-1.01109	-1.30460
The number of intermediate teachers	1.77371	-.56163	.83141	-.93924	-1.47483
The number of junior teachers	1.51751	-.10344	.06024	-.41171	-.84227
The number of doctoral degree teachers	2.33335	-.38133	.26149	-.54647	-.63881
The number of master's degree teachers	1.85262	-.43073	.53840	-.80394	-.98657
The number of university degree teachers	.71082	-.23175	.61224	-1.12827	-1.14040
The number of dual-qualification teachers	2.10936	-.59027	.76158	-.97201	-1.15394
The percent of majors that have a cooperative enterprise of total majors	1.19975	-.39092	.67777	-.78682	-1.41880
The number of majors at the national level	2.64542	-.45986	.28360	-.53717	-.53717
The number of key majors at provincial level	.45445	-.41949	.74984	-.63623	-.90889
The number of national level high-quality classes	1.78192	-.28987	.13872	-.29568	-.29568
The number of provincial level high-quality classes	2.377453	-.456393	.286136	-.319799	-.589103

Table 4 ANOVA

	clustering		error		F	Sig.
	mean square	df	mean square	df		
Equivalent of students number in school	10.554	4	.279	53	37.829	.000
Total number of specialties	5.402	4	.668	53	8.090	.000
The average number of majors' student	.868	4	1.010	53	.859	.494
The number of skill contest awards that student got above the provincial level	6.999	4	.547	53	12.789	.000
The percent of teachers have master's degree of full-time teachers	5.971	4	.625	53	9.558	.000
The number of teaching and administrative rooms per student	6.970	4	.549	53	12.686	.000
The number of taching and research equipment per student	5.166	4	.686	53	7.536	.000
The average number of books for per student	6.505	4	.585	53	11.130	.000
The number of teaching computer equipped for per hundred students	6.877	4	.556	53	12.358	.000
The number of network multimedia classrooms	4.891	4	.706	53	6.924	.000
Floorage	7.973	4	.474	53	16.832	.000
Teaching resources	2.608	4	.879	53	2.969	.028
The number of practice base in campus	9.685	4	.345	53	28.110	.000
The percent of students participated in evaluating teaching	11.702	4	.192	53	60.858	.000
The percent of peers participated in evaluating teaching	8.579	4	.428	53	20.042	.000
The percent of society participated in evaluating teaching	7.159	4	.535	53	13.377	.000
The percent of full-time teaching management administrators personnel with bachelo degree and above to full-time teaching management personnel	5.799	4	.638	53	9.093	.000
Total income of school funds	10.632	4	.273	53	38.935	.000

Table 4, cont

Total expenditure of school funds	8.774	4	.413	53	21.231	.000
The percent that total number of higher vocational college students versus total number of full-time political counselors	1.341	4	.974	53	1.377	.254
Annual financial appropriation level per student	1.750	4	.943	53	1.854	.132
The percent of dual-qualification teachers	5.537	4	.658	53	8.421	.000
Direct employment rate	7.319	4	.523	53	13.991	.000
Total number of teachers	10.594	4	.276	53	38.393	.000
The number of senior teachers	10.454	4	.286	53	36.495	.000
The number of intermediate teachers	11.387	4	.216	53	52.689	.000
The number of junior teachers	3.134	4	.839	53	3.736	.009
The number of doctoral degree teachers	7.411	4	.516	53	14.358	.000
The number of master's degree teachers	7.625	4	.500	53	15.252	.000
The number of university degree teachers	5.295	4	.676	53	7.835	.000
The number of dual-qualification teachers	11.794	4	.185	53	63.623	.000
The percent of majors that have a cooperative enterprise of total majors	7.013	4	.546	53	12.840	.000
The number of majors at the national level	9.352	4	.370	53	25.299	.000
The number of key majors at provincial level	5.287	4	.676	53	7.816	.000
The number of national level high-quality classes	3.992	4	.774	53	5.157	.001
The number of provincial level high-quality classes	7.804	4	.487	53	16.040	.000

Table 5 Number of cases in each cluster

Clustering	Cases/PCS	Effective number /PCS	Missing number /PCS
1	4.000	58.000	0.000
2	26.000		
3	20.000		
4	5.000		
5	3.000		

Higher Vocational Colleges are ultimately divided into five categories according to Table 5. The first category includes 4 cases, the second one includes 26 cases, the third one includes 20 cases, the fourth one includes 5 cases, and the fifth one includes 3 cases. The 58 cases are all effective values.

On the basis of Table 3 and Table 5, the following conclusions can be got:

The first category is the high-level Higher Vocational Colleges, with 4 in total, accounting for 7% of the total, including Hebei College of Industry and Technology, etc. In such institutions, the proportion of graduate degree teachers to full-time teachers, the number of books per student, the number of network multimedia classrooms,

the building area, the average financial allocation level of students, the proportion of double qualified teachers, the number of intermediate teachers, the number of Master graduate teachers, the number of double qualified teachers, and the proportion of the number of specialties with cooperative enterprises in the number of specialty settings are the highest, which is the cultivation of technical skills talents provide a solid foundation, but also for the development of colleges and universities into the continuous power, with a large campus building area and high direct employment rate of students, which shows that high-level vocational colleges export a large number of available talents for the society.

The second type is the relatively high-level vocational colleges, a total of 26, accounting for 45% of the total number, including HS vocational and technical college. The proportion of graduate degree teachers in the number of full-time teachers, the number of books per student, the number of network multimedia classrooms, the construction area, the average financial allocation level of students, the proportion of double qualified teachers, the number of intermediate teachers, the number of master's degree teachers, the number of double qualified teachers, and the proportion of the number of specialties with cooperative enterprises in the number of specialty settings in these colleges and universities are lower than those in the first type of colleges. This kind of Higher Vocational Colleges have higher basic conditions for college development, but the direct employment rate is obviously lower than the first type of colleges, indicating that the

development index of colleges and universities needs to be improved.

The third category is the medium-level vocational colleges, a total of 20, accounting for 34% of the total number, including HD vocational and technical college. From the proportion of graduate degree teachers to full-time teachers, the average number of books per student, the average financial allocation level of students, the number of master degree teachers and the number of teachers with double qualification, it can be seen that these colleges and universities have certain development conditions, and the direct employment rate of students is lower than that of the second type.

The fourth category is the general-level vocational colleges, a total of 5, accounting for 9% of the total, including BD electric power vocational and technical college. From the proportion of graduate degree teachers to full-time teachers, the average number of books per student, the average financial allocation level of students, the number of master graduate teachers and the number of teachers with double qualification, we can see that the employment rate and the comprehensive level of colleges and universities are obviously lower than those of the third type.

The fifth category is the lower-level vocational colleges, a total of 3, accounting for 5% of the total number, including HB arts and Crafts Vocational College. It can be seen from various indicators that the basic conditions for the development of such institutions are general, which leads to the low employment rate and other basic indicators.

4. RESULT ANALYSIS

The results of cluster analysis can make the relevant government departments accurately locate the Higher Vocational Colleges in Hb Province, and formulate more targeted policies according to the classification of five different levels of colleges. (1) For high-level Higher Vocational Colleges, we should continue to maintain their high-level levels in the expansibility index system, such as the number of double qualified teachers, financial investment, building area and other indicators, and formulate more suitable programs for such colleges in terms of high-tech personnel training. (2) For higher-level Higher Vocational Colleges, we should strengthen the construction of the expansibility index system, such as the number of senior teachers, funding investment. Meanwhile, the development index system including the number of provincial excellent courses, the number of specialty settings and other indicators should also increase construction power, to promote the development of higher-level vocational colleges. In terms of higher technical personnel training, we should formulate training programs in line with such colleges and improve the direct employment rate. (3) For the medium level Higher Vocational Colleges, we should continue to build the development index system, such as the number of teachers with a university degree or above, the number of teachers with a graduate degree, the number of teaching and

administrative rooms per student, the number of teaching and scientific research instruments and equipment per student, etc., and continue to maintain the level of medium level, and make more efforts in the direct employment rate and the cultivation of secondary technical personnel. (4) For general level Higher Vocational Colleges and lower level Higher Vocational Colleges, we should focus on the construction of basic indicators, such as the number of national excellent courses, the number of national key majors, the number of provincial key majors and other specific indicators, to strive to develop to higher-level colleges and ensure their basic employment rate.

5. CONCLUSION

The results of cluster analysis show that the 58 Higher Vocational Colleges in Hb Province are divided into five categories. First of all, each type of college has different characteristics and classification indicators, which provides new ideas and methods for the classification of Higher Vocational Colleges in Hb Province in the future. Secondly, the classification index reveals that the index system of Higher Vocational Colleges is composed of a basic index system, development index systems and expansibility index systems. Thus, colleges and universities can make full use of subject characteristics, specialty characteristics and college characteristics. Thirdly, the classification process can reveal the actual situation of Higher Vocational Colleges at the level of statistical analysis, objectively reflect its shortcomings and development potential, and dynamically reflect its development law and employment rate. Finally, the classification results can enable relevant government departments to accurately locate colleges and formulate more targeted policies to promote the development of Higher Vocational Colleges in Hb Province and the reform of personnel educating policy, give full play to the advantages of human resources of Higher Vocational Education in Hb Province and contribute to the development and modernization of higher education

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