
Guidance on Students' Geography Course Selection Under the Background of New College Entrance Examination System Based on Principal Component Analysis

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Abstract

Under the new system of college entrance examination, students in senior high school can choose 3 subjects independently. Under the circumstance of choosing geographical subjects without considering the influence of other factors on the course selection, using SPSS statistical analysis software, the End-of-Semester results of all first-year students in the Fifth Middle School of Shimenn County, Changde, is analyzed by the method of Principal Component Analysis to provide scientific and reasonable methods and references for students to choose suitable examination subjects. The results show that students may give priority to the selection of biology, physics and chemistry under the first selection of geographical subjects. This may be more conducive to students to build a knowledge system and achieve better results in the college entrance examination.

Keywords

New System of College Entrance Examination, Geography, Principal Component Analysis.

1. Introduction

In September 4, 2014, the China's State Council issued the "Implementation Opinions on deepening the reform of examination and enrollment system" (hereinafter referred to as "opinion") [1], and decided to take Zhejiang and Shanghai as the comprehensive reform experiment provinces of the college entrance examination. In the new period, the educational training objective in China is to train the talents, who serve the socialist modernization and development in an all-round way. The new college entrance examination reformed the form of Arts and Sciences Division in the past nearly 40 years, and it is an innovation and development on the basis of inheriting the previous branch examination. Selecting subjects independently by students conform to the educational goal, emphasizes on giving full play to students' autonomy, and respects the student's main body status.

With the reform of the college entrance examination, the traditional pattern of the division of Arts and sciences will be changed into the mode of choosing 3 subjects from 6 subjects or choosing 3 subjects from 7 subjects, which has 20 combination modes and 35 combination modes respectively. At present, under the background of the new college entrance examination reform, much research on the status, significance and countermeasures of subject selection for senior high school students appeared [2-8]. However, it is very rare to study how to choose reasonable subjects based on optimization theory. In this paper, under the assumption that students select geographical subjects firstly, the paper studied how to reasonably and effectively select other subjects to provide theoretical and methodological reference for such research. Based on the examination results, this paper takes the mode of choosing 3

subjects from 6 subjects as an example to analyze and study. The study involves a total of 10 kinds of combinations, including geography, physics, chemistry; geography, physics and biology; geography, physics and history; geography, physics and politics; geography, chemistry, biology; geography, chemistry, history; geography, chemistry, politics; geography, biology, history; geography, biology, politics; geography, history, politics. It is very important for students to choose the most suitable examination subjects in these 10 combinations, which will play a vital role in getting their favorite university in the future.

2. Data and Methods

2.1 Data Sources

The data used in this paper come from the End-of-Semester results of all first-year students in the Fifth Middle School of Shimenn County, Changde. Fifth Middle School in Shimen is a Full-time Ordinary Senior Middle School, which teaching quality and enrollment rate is in the middle level of Hunan province. At the same time, because of no Arts and Sciences Division between the first-year students, the status of all subjects is the same ones. Therefore, the data utilized in this study are representative.

2.2 Standardization of the Data [9]

Due to the difference of the score criterion, total score and the level of difficulty of each subject, the original data are normalized by the Z - score standardization to improve the accuracy. This method normalizes the data based on the mean value and standard deviation of the original data. After treatment, the results are as follows:

$$z = (x - \mu) / \delta$$

In the above formula, x is an original data, and μ is the average value, μ is the average value, and δ is the standard deviation.

2.3 Principal Component Analysis and test

Principal Component Analysis (PCA) is a simplified analysis method for the interrelated complex relations among variables [10]. PCA is to replace the original variables with a new set of uncorrelated comprehensive variable by combining a very large number of variables with a certain correlation according to certain rules [11,12]. In this paper, spss22.0 is used as a statistical analysis software to perform PCA

2.4 KMO Test and Bartlett Test

KMO Test and Bartlett Test can judge whether the variables are fit for the Principal Component Analysis, and is an index to compare the simple correlation coefficient and the partial correlation coefficient between variables [11,12]. Bartlett Test assumes the original variables are independent with each other, while the probability value of the significance level is less than 0.01, it is a significant correlation, which is suitable for principal component analysis [13-15]. Measurement standard of KMO Test is given in Table 1.

Table 1. Measurement standard of KMO Test [16]

KMO	<0.5	0.6-0.7	0.7-0.8	0.8-0.9	>0.9
Criterion	Extremely unsuitable	Not suitable	General	Suitable	Very suitable

3. Course selection analysis

3.1 Correlation analysis

The correlation matrix table of each subject is obtained by importing the standardized data into the software to calculate the correlation between each subject. The correlation coefficient is expressed by

r, and the absolute value of r is closer to 1, the greater the correlation is [17]. Based on Table 2, it can be seen that the score of all subjects showed different degrees of positive correlation. However, according to the traditional concept of the Division of Arts and Sciences, although geography, politics and history are both subjects of Arts, the correlation between geographical score and the score of politics and history was low, 0.327 and 0.270 respectively. Conversely, the greatest correlation with geography is biology (0.635), followed by Physics (0.563) and Chemistry (0.524).

In Table 2, in terms of "Sig. (Unilateral)", the correlation coefficient in the table is the p value of significance level test probability. Except for the p value between English and history is big, the p value between the other subjects is less than or equal to 0.01, which shows significant correlation coefficient between the various subjects. Therefore, the data are suitable for carrying out Principal Component Analysis.

Table 2. Correlation Matrix Table between Subjects

		GEOG	HST	POL	BIOL	CHEM	PHYS	ENGL	MATH	CHN
Correlation Coefficient	GEOG	1.000	.270	.327	.635	.524	.563	.202	.519	.280
	HST	.270	1.000	.247	.342	.203	.232	.080	.189	.199
	POL	.327	.247	1.000	.428	.343	.338	.315	.281	.390
	BIOL	.635	.342	.428	1.000	.612	.575	.294	.482	.375
	CHEM	.524	.203	.343	.612	1.000	.626	.259	.596	.257
	PHYS	.563	.232	.338	.575	.626	1.000	.151	.631	.246
	ENGL	.202	.080	.315	.294	.259	.151	1.000	.160	.429
	MATH	.519	.189	.281	.482	.596	.631	.160	1.000	.167
	CHN	.280	.199	.390	.375	.257	.246	.429	.167	1.000
Sig. (Unilateral)	GEOG		.000	.000	.000	.000	.000	.000	.000	.000
	HST	.000		.000	.000	.000	.000	.042	.000	.000
	POL	.000	.000		.000	.000	.000	.000	.000	.000
	BIOL	.000	.000	.000		.000	.000	.000	.000	.000
	CHEM	.000	.000	.000	.000		.000	.000	.000	.000
	PHYS	.000	.000	.000	.000	.000		.001	.000	.000
	ENGL	.000	.042	.000	.000	.000	.001		.000	.000
	MATH	.000	.000	.000	.000	.000	.000	.000		.000
	CHN	.000	.000	.000	.000	.000	.000	.000	.000	

Note 1: Geography=GEOG; History=HST; Politics=POL; Biology=BIOL; Chemistry=CHEM; Physics=PHYS; English=ENGL; Mathematics=MATH; Chinese=CHN.

3.2 KMO Test and Bartlett Test

The results of KMO Test and Bartlett Test of the processed data are presented in table 3. KMO (=0.868) is greater than 0.8, which indicates that the sum of simple correlation coefficient squares is greater than that of the partial correlation coefficient square. And it showed that the correlation between data is strong. From Bartlett Test, the approximate chi-square value (χ^2) is 1484.984; freedom (df) is 36; the probability value of the significance level was 0.000, which is far less than the significance level of 0.01. This proves that there is a significant correlation between the variables of each subject and reject the original hypothesis, so the data are fit for the Principal Component Analysis.

Table 3. KMO Test and Bartlett Test **

Kaiser-Meyer-Olkin measured the appropriateness of sampling		.868
Bartlett Test	1484.984	22.692
	36	147.603
	.000	170.295

Note 2: Selection method: Main Element Analysis; **: select 2 elements

3.3 Results of Principal Component Analysis

After rotation, the factor load matrix is obtained, and then, two main factors are obtained by reducing the dimension of 9 factors (Chinese, Mathematics, English, Physics, Chemistry, Biology, History, Geography, Politics) that affect students' scores (Table 4). The loads of Biology, Chemistry, Physics, Geography and Mathematics on element 1 are greater than 0.7, which proves that Geography, Biology, Chemistry and Physics are the main factors affecting element 1.

Table 4. Element matrix ^a

	GEOG	HST	POL	BIOL	CHEM	PHYS	ENGL	MATH	CHN
Element 1	.764	.418	.594	.828	.788	.782	.426	.721	.513
Element 2	-.185	.078	.376	-.019	-.217	-.322	.645	-.379	.629

Through the Principal Component Analysis of the students' scores, it is found that the subjects of geography are not only strongly correlated to the subjects of biology, chemistry and physics, but also the main factor that affects the element 1 of student achievement. Therefore, under the new college entrance examination system, when students choose exam subjects, they can give priority to geography and biology, chemistry, physics as a matching subject.

4. Conclusions and Suggestions

According to the investigation by Du Fangfang et al., 50.33% of the students said they would take the elective subjects based on their own learning achievement. However, 41.32% of the students are confused on how to select subjects under the new college entrance examination system [2]. For students just entering high school, It's not reasonable to choose the subject of college entrance examination merely on the assertion by virtue of their own learning performance of one or two exams. Therefore, under the new college entrance examination system, it is necessary to provide some scientific and reasonable suggestions for students' elective course.

Based on the End-of-Semester results of all first-year students in the Fifth Middle School of Shimenn County, Changde, the statistical analysis showed that students may give priority to the selection of biology, physics and chemistry under the initial selection of geographical subjects. This may be more conducive to students to build a knowledge system and achieve better results in the college entrance examination. Wilhelm Windelband, German philosopher, divided knowledge into two categories: "natural science" and "historical science" [18]. The former pays attention to the law, and the latter describes the features. The knowledge of geography is a regular knowledge, just like biology, physics and chemistry. Therefore, from the point of view of knowledge classification, It might be more appropriate to divide geography and biology, physics, and chemistry into one. In fact, there are also examples in education and teaching. In the high school education in the United States, the earth / environmental science, biology and chemistry are classified as science [19].

Of course, in the course of discussing the course selection, this paper does not consider the influence of other factors on the course selection of students, such as family factors, school advantages, college enrollment conditions, which are the inadequacies of this paper. Therefore, the author hopes to consider the influence of more factors on the course selection of students in subsequent research to provide more reasonable suggestions and guidance for students' course selection.

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