Rationality Evaluation of Curriculum System of Groundwater Science and Engineering

Zhou YAHONG
Hebei GEO University, School of Water Resources and Enviroment, Shijiazhuang, China
Hebei Province Key Laboratory of Sustained Utilization and Development of Water Resources, Shijiazhuang, China
Hebei Province Collaborative Innovation Center for Sustainable Utilization of Water Resources and Optimization of Industrial Structure, Shijiazhuang, China
zhyh327@163.com

Wang RUI
Hebei GEO University, School of Water Resources and Enviroment, Shijiazhuang, China
245768983@qq.com

Wei AIHUA
Hebei GEO University, School of Water Resources and Enviroment, Shijiazhuang, China
274503529@qq.com

ABSTRACT
The research object of this paper is the 66 students of Groundwater science and engineering in Hebei GEO University. Their 11 courses’ exam scores in grade 3 were analyzed by principal component analysis (PCA). The results show that the course system is basically reasonable, because most of the score of the curriculums in PC1 are consistent with each other. What’s more, the results show that the professional basic courses laid a good foundation for the development of other courses. At the same time, the weakness of the curriculums has been reflected during the study. The content of the professional practice may need to be adjusted because it failed to transform the theoretical knowledge to practical application.

Keywords: PCA, groundwater science and engineering, correlation, professional practice

INTRODUCTION
The learning aim of groundwater science and engineering specialty in Hebei University of geology is to cultivate advanced applied talents. Graduated students with a solid ground basic theory and skill, can be engaged in the related research of groundwater science and engineering in many companies, such as groundwater resources survey, evaluation, planning, management, technical and economic analysis of groundwater resources and other aspects of the work. According to the training objectives and learning content of the course, the professional courses system were established, which including professional basic courses, professional courses, practice, graduation design and so on. The principal component analysis method was used to analyze the exam scores of groundwater science and engineering students in grade three, and the relationship between the courses was also discussed which would provide basis for the reasonable arrangement of the courses.

METHOD AND MATERIALS
Method
PCA is used to reduce the dimension of correlated coefficients in an optimal way (HU Shuai, 2015). The calculation method of PCA is already very mature, and has been widely applied in many fields.
SPSS software was used on PCA algorithm and the calculation method could be found in the manual of SPSS learning.

**Materials**

The research object of this paper is the 66 students of Groundwater science and engineering in Hebei GEO University. Their 11 courses’ exam scores in grade three were analyzed. The courses of groundwater science and engineering specialty in grade three mainly includes Mao Zedong Thought and the theoretical system of socialism with Chinese characteristics (Mao Zedong thought for short, MZDT), hydro-geochemistry (HG), groundwater dynamics (GD), rock mechanics and engineering (RME), engineering surveying (ES), hydrological statistics (HS), hydrology and water conservancy calculation (HWCC), water resources survey (WRS), soil mechanics (SM), Hydrogeological geophysical (HG) and professional practice (PP).

**RESULTS AND DISCUSSION**

**Correlational analyses**

Groundwater science and engineering courses system's reasonable degree impact on the quality of the graduates. The status and features of every course makes them intrinsically connected with each other involved. The connectional extent is discussed in this paper. Based on the statistics of the 66 students’ exam scores, the courses with larger standard deviation (S) are hydrology water resources calculation, groundwater dynamics and hydro-geochemistry. The three courses in this semester are important and difficult relatively, especially the hydro-geochemistry and groundwater dynamics. What’s more, the average exam scores of the three courses were between 69 and 74, which were mired in the middle, far from good. It is noteworthy that Mao Zedong thought as the guide to college students' ideological curriculum, and achieved excellent grade, suggests that most of the students’ ideology and moral character is good or even excellent.

**Table 1: results of Descriptive statistics**

| Course   | Average | S     | NO. |
|----------|---------|-------|-----|
| MZT      | 90.73   | 6.956 | 66  |
| HG       | 71.68   | 16.650| 66  |
| GD       | 74.05   | 14.966| 66  |
| RME      | 71.58   | 13.541| 66  |
| ES       | 80.09   | 11.879| 66  |
| HS       | 71.21   | 9.962 | 66  |
| HWCC     | 69.83   | 21.129| 66  |
| WRS      | 82.70   | 8.606 | 66  |
| SM       | 69.36   | 8.414 | 66  |
| HG       | 88.96   | 4.787 | 66  |
| PP       | 80.15   | 6.904 | 66  |

Based on 66 students of 11 courses for statistical correlation analysis. Statistical results show the strong links of some courses (including the rock mechanics and engineering, engineering surveying and water resources survey) with others. Three of the correlations are larger than 0.6.

The three courses are professional basic course of the semester, and the closely links to other courses showed their base performance precisely. What’s more, Mao Zedong thought, hydrogeological exploration and professional practice showed smaller contact with other course. The purpose of the hydrogeological exploration is service for the professional practice. But the results showed no link between the two courses, which proved the intercommunity on content from them, is less. Theoretical knowledge learned by the students is failed to transform to practical application to some extent. In the future, the contact between the practice content with the theoretical courses must be strengthened by adjusting the curriculum content.
Table 2  Correlation coefficient matrix

|       | MZT  | HG   | GD   | RME  | ES   | HS   | HWCC | WRS  | SM   | HG   | PP   |
|-------|------|------|------|------|------|------|------|------|------|------|------|
| MZT   | 1.00 | 0.43 | 0.16 | 0.48 | 0.45 | 0.49 | 0.47 | 0.51 | 0.53 | 0.47 | 0.24 |
| HG    | 0.43 | 1.00 | 0.28 | 0.41 | 0.51 | 0.54 | 0.67 | 0.56 | 0.39 | 0.31 | 0.13 |
| GD    | 0.16 | 0.28 | 1.00 | 0.35 | 0.44 | 0.33 | 0.41 | 0.46 | 0.31 | 0.19 | 0.13 |
| RME   | 0.48 | 0.41 | 0.35 | 1.00 | 0.67 | 0.70 | 0.54 | 0.67 | 0.54 | 0.41 | 0.03 |
| ES    | 0.45 | 0.51 | 0.44 | 0.67 | 1.00 | 0.66 | 0.54 | 0.63 | 0.76 | 0.34 | 0.17 |
| HS    | 0.49 | 0.54 | 0.33 | 0.70 | 0.66 | 1.00 | 0.53 | 0.50 | 0.55 | 0.31 | 0.01 |
| HWCC  | 0.47 | 0.67 | 0.41 | 0.54 | 0.54 | 0.53 | 1.00 | 0.60 | 0.47 | 0.36 | 0.01 |
| WRS   | 0.51 | 0.56 | 0.46 | 0.67 | 0.63 | 0.50 | 0.60 | 1.00 | 0.47 | 0.50 | 0.19 |
| SM    | 0.53 | 0.39 | 0.31 | 0.54 | 0.76 | 0.55 | 0.47 | 0.47 | 1.00 | 0.27 | 0.21 |
| HG    | 0.47 | 0.31 | 0.19 | 0.41 | 0.34 | 0.31 | 0.36 | 0.50 | 0.27 | 1.00 | 0.06 |
| PP    | 0.24 | 0.13 | 0.13 | 0.03 | 0.17 | 0.01 | 0.01 | 0.19 | 0.21 | 0.06 | 1.00 |

Table. 3 The cumulative reliability of the first five principal components

|        | PCS  | PC1  | PC2  | PC3  | PC4  | PC5  |
|--------|------|------|------|------|------|------|
| Eigenvalues | 5.365 | 1.091 | 0.964 | 0.856 | 0.754 |
| Contribute (%) | 48.771 | 9.92  | 8.761 | 7.783 | 6.855 |
| Cumulative percent (%) | 48.771 | 58.691 | 67.452 | 75.235 | 82.091 |

Through the principal component analysis, the results are shown in table 3, table 4 and figure 1. Results show that the PC1 have its reliability of 48.771%, which indicates the dominated position in the system. In addition to Mao Zedong thought and groundwater dynamics, other factor score absolute value is greater than 0.1 (Table 4). Obviously, PC1 explained the unity of the whole system and each course is an important part of the whole system. Only professional practice in PC1 score is negative, but it is also the only scored higher in PC2. A distance was shown in Fig.1 between professional practice and other courses, once again prove less connection between the practice and theory courses. To some sense, the contents of the professional practice should strengthen the application of theoretical knowledge and promote learning theoretical knowledge into practical application.
Table 4 results of PCA calculation

|                                | PC1   | PC2   |
|--------------------------------|-------|-------|
| Mao Zedong thought (X1)        | 0.085 | 0.245 |
| Hydro-geochemistry(X2)         | 0.141 | -0.037|
| groundwater dynamics(X3)       | 0.094 | 0.021 |
| rock mechanics and engineering(X4) | 0.178 | -0.131|
| engineering surveying(X5)      | 0.150 | 0.054 |
| hydrological statistics(X6)    | 0.179 | -0.164|
| hydrology and water conservancy calculation(X7) | 0.177 | -0.166|
| water resources survey(X8)     | 0.146 | 0.052 |
| soil mechanics(X9)             | 0.107 | 0.180 |
| Hydrogeological geophysical(X10)| 0.101 | 0.015 |
| professional practice(X11)     | -0.123| 0.848 |

CONCLUSIONS
PCA was used to analyze the relationship between the courses of the Groundwater science and engineering. The results show that the method is feasible and get the following conclusion:

(1) The course system is basically reasonable, because most of the score of the curriculums in PC1 are consistent with each other;

(2) Professional basic courses including engineering surveying, hydrology and water conservancy calculation and water resources survey laid a good foundation for the development of other courses;

(3) The content of the professional practice may need to be adjusted because it failed to transform the theoretical knowledge to practical application.

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REFERENCES
HU Shuai, GU Yan, QU Wei-wei (2015). Study of classroom teaching quality assessment model based on PCA. Electronic Design Engineering, 23(23):9-11. (in Chinese)

Helena B, Pardo R, Vega M, et al. (2000). Temporal evolution of groundwater composition in an alluvial aquifer (Pisuerga River, Spain) by principal component analysis. Water Research, 34(3):807–816.

Mohammadi Z. (2009). Assessing hydrochemical evolution of groundwater in limestone terrain via principal component analysis. Environmental Earth Sciences, 59(2):429-439.

Zhang ZB (2013). Optimum selection method of audio sample based on PCA and BP neural network, Computer Engineering and Applications, 49(19):108-111. (in Chinese)