

Comprehensive Assessment of Mathematics Self-learning Ability and Its Influence Factors of University Students Based on Factor Analysis

Fang Hong

Institute of Basic Science, Tianjin Agricultural University, Tianjin, China

fanghong681019@126.com

Keywords: Mathematics self-learning ability, Factor analysis, Comprehensive evaluation

Abstract. Based on the questionnaire survey data of 343 students, this study employed factor analysis to investigate undergraduates' mathematics self-learning ability, gave a comprehensive evaluation and made a classification of the results. Combining each factor, we offered an effective way to improve self-learning ability.

Introduction

The theme of the social development today is how to learn. It has become an important research topic for education researchers to cultivate students' innovative consciousness and ability, to guide students to learn how to learn and to help students develop self-learning ability. Mathematics is an integral part of our lives. And its teaching purpose is to promote student comprehensive, sustainable and harmonious development. Mathematician Polya said: "If students want to firmly grasp math, you must learn math with creating and experience". It is an important responsibility of teachers to train students' mathematics self-learning ability in the teaching process, so that students can master the mathematical knowledge independently, and apply mathematics and scientific knowledge to solve mathematical problems. This paper aims at analyzing the survey data of self-learning ability in mathematics, and fully understanding the students' self-learning ability and the variables related with mathematics self-learning to explore the "teaching" and "learning" model.

Methodology

Research subject. An extract from the 2010-2013 class of 343 students at Tianjin agricultural university as the sample of the study, among whom 153 boys (44.6%), 190 girls (55.4%), including Polytechnic students (54.5%), agriculture and forestry, economics and humanities majors (45.5%).

Research contents. The questionnaire includes 19 questions about self-learning ability in mathematics, which mainly relate to four aspects of self-learning (self-directed ability, self-control ability, self-reflection and evaluation ability, mathematics learning ability). Questionnaire questions are primarily from: (1) The definition and description of autonomous learning from domestic and foreign scholars (Holec, 1981; Higgs, 1988; Dickson, 1992; Wenden, 1991; Pang Weiguo, 2001; etc.) (2) Domestic and overseas investigation and research on self-learning ability (Xu Jinfen, etc., 2004; Hua Weifen, 2001; etc.) [1,2,3,4]. In this study, each category includes five items presented in a five-point Likert mode, namely Strongly disagree, Disagree, Slightly agree, Agree, Strongly agree. Scoring was accomplished by assigning a score of 1 to items receiving a "Strongly disagree" response, a score of 2 to "Disagree", and so on through the five response categories.

Data survey. 380 copies of questionnaires were distributed, but only 343 questionnaires returned were effective. The effective rate was 90.5%. Survey data were analyzed by SPSS 19.0.

The Result, Interpretation and Discussion

Comprehensive evaluation of students' mathematics self-learning ability

Reliability analysis of samples. In order to further explore the reliability and validity of the questionnaire, we used statistical software SPSS19.0 to further explore the reliability analysis of 19

variables samples about mathematics self-learning. By Cronbach test, the overall alpha was 0.842, indicating that these factors had highly consistency and sufficient reliability.

Exploratory factor analysis of samples. This paper utilized the statistical software SPSS19.0 to test sample KMO and conduct Bartlett’s sphericity test of the related survey data. The results showed that the KMO measure of sampling adequacy index was found to be 0.878, which was more than the critical value of 0.7, indicating that the common factor existed among the variables and the sample was appropriate for such an analysis. Besides, Bartlett’s test of sphericity, $\chi^2 = 1874.609$, $df = 170$, $p < 0.001$, indicating that the common factor among the overall correlation matrix existed and the sample was appropriate for such an analysis.

The comprehensive score of math self-learning ability is calculated. Factor analysis studies the dependence of the correlation matrix of the internal study variables. A number of related variables are integrated into a few integrated variable indexes, with the sum of the less linear function of the few common factors and the special factors to describe very variable observed originally. It is an important feature extraction method of the multivariate statistical analysis. Specific steps are as follows:

Step1: Use the statistical software SPSS19.0 to normalize the original data to calculate the eigenvalues, contribution rate and cumulative variance contribution rate of the main factors. As can be seen from Table 1, in terms of the 19 items of the survey scale, the former six principal factors accounted for 61.906 % of the cumulative variance contribution rate, which is considered to be good and can be used to replace the original indicators.

Table1. the eigenvalues and the variance contribution rate of the principal factors

Principal Factors	Extraction Sums of Squared Loading			Rotation Sums of Squared Loading		
	Total	% of Variance	Cumulative%	Total	% of Variance	Cumulative%
1	5.724	30.124	30.124	2.395	12.603	12.603
2	1.901	10.007	40.131	2.325	12.238	24.841
3	1.238	6.517	46.648	2.231	11.741	36.582
4	1.039	5.466	52.114	2.008	10.571	47.153
5	1.002	5.274	57.388	1.707	8.982	56.135
6	0.858	4.518	61.906	1.097	5.771	61.906

Step2: In order to make the factor variables’ meanings clearer, factor loading matrix was handled through varimax orthogonal rotation. The absolute value of variables in column i of the rotated factor loading matrix A_m were classified into Class Z_i , and thus named Z_i . The principal factors in Table 1 represent the students’ learning motivation, self control, self reflection and evaluation, learning attitude, learning ability and other aspects of mathematics.

Step3: Calculate the comprehensive score F according to the coefficient matrix of the scoring and contribution rate.

The factor scores:

$$F_j = \sum_{i=1}^{19} B_{ji} X_i \quad (j = 1, 2, \dots, 6) \quad (1)$$

Comprehensive score:

$$F = \sum_{j=1}^6 F_j \sqrt{C_j} \quad (2)$$

(B_{ji} is the factor score coefficients, X_i is the value of the normalized sample data, C_j is the rate of contribution to the variance of each main factor)[5,6].

Randomly selected 20 students' comprehensive score values and they were listed in table 2.

Table 2. student score value

1	2	3	4	5	6	7	8	9	10
0.428	0.626	-0.088	-1.999	-0.607	-0.750	0.296	0.029	0.720	-1.117
11	12	13	14	15	16	17	18	19	20
0.216	-0.665	0.315	-0.666	-1.133	0.257	0.824	0.194	0.702	-1.852

Maximum score of 343 students' comprehensive scores is 2.403, the minimum value is -2.878. The comprehensive scores of students' results in an isometric are divided into four categories, the equidistant $d = (2.403 + 2.787) / 4 = 1.2975$.

Table3. the student mathematics independent learning capability classification (%)

Category	Value range	first grade	second grade	third grade	boys	girls	All
1	[1.105, 2.403]	7.08	6.32	4.55	8.55	5.24	6.71
2	[-0.1925, 1.105]	56.64	57.89	63.64	51.97	61.78	57.43
3	[-1.49, -0.1925]	33.63	29.47	31.81	35.53	29.84	32.37
4	[-2.787, -1.49]	2.65	6.32	0	3.95	3.14	3.49

From the table we can see, from either the overall situation of students, the grade, or gender perspective, students' autonomous learning ability obeys the normal distribution, and more than 60% of them have a certain ability of mathematics autonomous learning.

Detailed analysis of students' autonomous learning ability of mathematics

Table 4. student autonomous learning ability scores

The ability of autonomous learning	The average	Standard deviation
Ego orientation	3.317	0.6771
Self regulation	3.324	0.7112
Self evaluation and reflection	3.276	0.7392
The ability of mathematics study	3.522	0.7137

As can be seen from the table, an average of four aspects of students' autonomous learning ability of mathematics are more than 3 points, indicating that at the early stage of learning, students have a certain learning goal, will make some study plan, and have the ability of learning preparation. In the middle of learning, they can monitor their learning process, they can transform learning strategies to some extent and they have the ability to adjust learning objectives. In the later period of the study, they can reflect on the learning process, summarize the study experience, and have a certain degree of

ability to evaluate their learning results. But the average autonomous learning ability is not too high, which indicates that the students' autonomous learning ability needs to be further improved. All of the standard deviation is less than 1, indicating little difference between the students [7,8,9].

Conclusion

This study shows: (1)The students have certain mathematical self-learning ability, but it needs to be further improved. (2) There is a significant positive correlation between the ability of self-learning and self orientation, self control, self evaluation and reflection, mathematics learning ability. The correlation coefficients between them are respectively (0.816, 0.771, 0.711 and 0.409 ($p < 0.001$)).

Mathematics has its own characteristics (mathematical deduction and experiment) which determine the importance of mathematics autonomous learning ability. The process of mathematics autonomous learning is a learning process with students' own leaning process as the conscious object. For students, they are successful learners if they can determine their own learning goals, formulate a suitable study plan, know what learning strategies to be selected according to learning tasks under different circumstances, timely monitor their learning process, and effectively evaluate their own learning process and make appropriate self adjustment, and have the certain ability of mathematics learning. For teachers, in the teaching process, they should take the student as the center, adopt flexible teaching methods to stimulate student strong learning interest and the intellectual curiosity, from a good learning atmosphere, and guide the teaching on the basis of autonomous learning theories, to enhance student motivation of autonomous learning from outside.

Acknowledgment

This work was financially supported by the Tianjin twelfth five year plan project of Education Science: "Mathematics learning formative assessment and experimental study of the correlation between college students self-learning ability" (HE3026).

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