

Simulation Study of the Reliability and Validity of Vocational Mental Quality Questionnaire Based on Big Data Statistical Analysis Techniques

Guanli Huang¹, Jiangyi Lv², Hongli Zhou¹, Shenggang Wu^{1*}, Feifei Xing³

¹Office of Quality Management, Beijing Polytechnic, Beijing, P.R.C.

²School of Automotive Engineering, Beijing Polytechnic, Beijing, P.R.C.

³School of Basic Education, Beijing Polytechnic, Beijing, P.R.C.

*Corresponding Author

Abstract:

Need a scale for the psychological quality of teachers in vocational colleges was developed to test its reliability and validity. In this study, vocational college teachers were selected as subjects. Subjects were retested at an interval of two weeks to investigate the test-retest reliability and homogeneity reliability of the questionnaire. Subjects were used to test the content and criterion validity. The test-retest reliability of the scale was Less than 0.7, Cronbach's of 6 factors α the coefficients are greater than 0.7; The total split half reliability coefficient was between 0.85 and 0.90. More than 90% of the items had a CVR above 0.6, which had good content validity. College Teachers' psychological quality scale (DTPA) and middle school teachers' professional identity (MTCA) as the standard questionnaires, except that the correlation between operational demonstration and the two scales did not reach a significant level ($P < 0.01$).

Keywords: Vocational mental quality questionnaire, Psychological quality, reliability and validity, Big data statistical analysis

I. INTRODUCTION

The current domestic research results on Teachers' psychological quality can not be fully applicable to the evaluation and research of teachers' psychological quality in vocational colleges ^[1]. The commonly used vocational aptitude test 16PF does not show teachers' professional identity and lacks teachers' professional pertinence. The psychological quality table of excellent university teachers emphasizes the scientific research spirit that teachers should have, as well as the intelligence quality and integrity attitude related to the scientific research spirits ^[2]. The main job of teachers in vocational colleges is not to engage in scientific research, but to cultivate technology producers with front-line operation ability. According to the working characteristics of middle school teachers, the psychological quality table of middle school teachers is also not fully applicable to the evaluation of teachers' psychological quality in vocational colleges ^[3]. It lacks the operation demonstration ability emphasized by teachers' teaching ability in vocational colleges. This ability also has quality characteristics ^[4].

At present, there are only theoretical studies on the evaluation of teachers' psychological quality in Vocational Colleges^[5], which is lack of operability. Some scholars have put forward the psychological quality characteristics of teachers in higher vocational education, which are as follows: (1) practical teaching ability and quality; (2) operation demonstration ability; (3) research ability and quality of vocational education; (4) professional research ability and quality; (5) ability and quality of employment guidance; (6) organizational coordination and interpersonal communication skills.

II. OBJECT AND METHOD

2.1 Scale Preparation

An expert team composed of vocational education, psychology experts, senior teachers of Vocational Colleges and the teachers of the supervision office confirms the universality and importance of the items involved in the questionnaire, so as to ensure that the selected items are universal and important in the real "psychological quality structure of excellent vocational college teachers", The final pre-test questionnaire of "psychological quality structure of teachers in Vocational Colleges" contains 76 items. Each item of all questionnaires was scored with 5 points. Then 25 teachers were tested in a small sample. The sentences with improper words, unclear meaning, difficult to understand or easy to cause ambiguity were modified, and the inappropriate items were deleted. Finally, an initial scale of 76 items was formed. There are 57 positive scoring items and 19 negative scoring items. The scale adopts self-rated questions, and the item score is 5 points, 1 = totally disagree, 2 = partially disagree, 3 = uncertain, 4 = partially agree, 5 = fully agree. Use statistical software to generate random numbers and arrange all items randomly. The higher the score, the more the subjects have this psychological quality.

2.2 Object

630 teachers were conveniently selected from Beijing Institute of electronic technology, Shenzhen Institute of technology, Lanzhou Institute of technology and Henan Jiaozuo Normal University. 600 samples were recovered, and the effective recovery rate was 95.2%. There are 322 engineering teachers, 74 management teachers and 204 liberal arts teachers; Female teachers accounted for 56.8% and male teachers accounted for 43.2%; The proportion of teachers under 35 years old, 35 ~ 50 years old and over 50 years old were 22.5%, 46.1% and 21.4% respectively; The proportions of teaching assistants, lecturers, associate professors and professors were 14.6%, 38.0%, 29.8% and 17.6% respectively.

2.3 Tools

2.3.1 College excellent teachers' psychological quality scale (DTPA). It contains 7 factors and 45 items. The internal consistency reliability coefficient is 0.9265. The content validity ratio (CVR) of 90.2% items is more than 0.6.

2.3.2 Psychological quality scale for secondary school teachers

(MTCA) Including 7 factors and 36 items, the internal consistency reliability was 0.865 and the split half reliability was 0.821.

2.4 Measurement of Scale

The main test of this study was conducted by the researcher himself and the graduate students of the clinical psychology research center of Peking University. Unified training was conducted before the test. 630 initial scales were distributed, filled in and recovered on the spot, and 87 of them were retested at an interval of two weeks to calculate the test-retest reliability. DTPA and MTCA scales were selected as the criterion validity questionnaire, and 64 subjects in the sample were used to test the criterion validity.

2.5 Big Data Statistical Methods

SPSS13.0 statistical software for item analysis, reliability and validity analysis of all data. The statistical analysis used was selected $\alpha = 0.01$ as the test level, the probability values represent the bilateral probability.

III. RESULTS

3.1 Project Analysis

3.1.1 Use the correlation coefficient method to screen items

Correlation analysis was conducted between each item and the total score of the initial scale, and 18 items with correlation coefficient less than 0.4 (x1, x13, x14, x15, X25, x26, X29, X32, x33, X36, x39, x44, x48, X51, x57, x59, X63, X70) were deleted. The correlation coefficient between the remaining 58 items and the total score of the scale was 0.416 ~ 0.725, which was statistically significant ($P < 0.01$).

3.1.2 Calculate discrimination filter entries

The "critical ratio" was calculated to evaluate the ability of the scale items to distinguish the differences of subjects' psychological quality level. The total scores of the scale were arranged from high to low, and the highest 27% and the lowest 27% of the total scores were divided into high and low groups. The significance of the average scores of 58 items in the two groups was tested. The results showed that 58 items reached the significance level ($P < 0.01$).

3.2 Structural Analysis of the Scale

3.2.1 Exploratory factor analysis

Exploratory factor analysis was conducted on the items after item analysis. The kmo value was 0.935 and Bartlett spherical test $\chi^2 = 5221.957$, $P < 0.000$, indicating that it is suitable for factor analysis.

Principal component analysis was used to analyze the initial factors according to the maximum variance orthogonal rotation method. Extract factors with feature root greater than 1 and factor load greater than 0.4, and delete items with similar load in more than two factors. Then, according to the actual needs and expert opinions, we make careful choices and attribution, and finally get 32 items (of which 8 items are reverse scoring), which belong to 6 factors, and the cumulative contribution rate is 55.540%; These six factors are named: (1) communication and expressiveness (like to communicate and express with others. Strong ability to get along with others, cooperate and adapt); (2) innovation (like to test the existing theory and practice, give new evaluation, and like to understand avant-garde ideas and behaviors); (3) demonstration of hand operation (like to do some activities requiring hands-on operation, like to use both hands and brain); (4) stability (able to cope with various environments and problems with a calm attitude and maintain team spirit); (5) intelligence (quick thinking, high educational and cultural level, and personal mental and physical health); (6) teacher identity (reflecting the individual's interest, identity and confidence in the work of teachers in vocational colleges, and the preference for communicating with students in Vocational Colleges of that age). See Table I.

Table I. Results of exploratory factor analysis

entry	Communication and expression	Innovation	Operational demonstratio	stability	Intelligence	Professional identity
X56	0.766					
X55	0.764					
X50	0.761					
X28	0.649					
X58	0.646					
X8	0.597					
X76		0.721				
X68		0.702				
X3		0.677				
X45		0.674				
X52		0.546				
X74			0.689			
X60			0.688			
X54			0.628			
X46			0.581			
X37			0.570			
X71			0.542			

X20	0.648		
X61	0.617		
X75	0.576		
X34	0.562		
X43	0.541		
X24		0.695	
X49		0.683	
X66		0.637	
X30		0.615	
X21			0.684
X22			0.673
X12			0.592
X11			0.551
X5			0.544
X10			0.501

3.2.2 Correlation between factors and between factors and total score. The correlation between each factor was 0.422 ~ 0.668, and the correlation between each factor and the total score was 0.723 ~ 0.852. See Table II.

Table II. Correlation between factors and between factors and total score

Project	Communication and expression	Innovation	Operational demonstration	stability	Intelligence	Professional identity	Total score
Project	Communication and expression	Innovation	Operational demonstration	stability	Intelligence	Professional identity	Total score
Communication and expression	1						
Innovation	0.532**	1					
Operational demonstration	0.561**	0.668**	1				
stability	0.485**	0.650**	0.652**	1			
Intelligence	0.442**	0.654**	0.553**	0.502**	1		
Professional identity	0.422**	0.661**	0.621**	0.511**	0.582**	1	
Total score	0.825**	0.852**	0.822**	0.772**	0.723**	0.755**	1

Note: ** $P < 0.01$ (2-tailed)

3.3 Reliability Test

3.3.1 homogeneity reliability total Cronbach's α the coefficient is 0.941, Total Cronbach's α Cronbach's with a coefficient of 0.941 and 6 factors α The coefficient is 0.765 ~ 0.873. See Table III.

3.3.2 87 teachers were retested every two weeks, and 87 valid questionnaires were collected. The test-retest reliability coefficient of the total scale was 0.654, and the test-retest reliability coefficient of each factor was 0.462 ~ 0.709, which reached statistical significance ($P < 0.01$). See Table III.

Table III. Reliability analysis results

factor	Cronbach's α Cronbach's α coefficient	Test-retest reliability
Communication and expression	0.868	0.531**
Innovation	0.874	0.613**
Operational demonstration	0.832	0.709**
stability	0.765	0.462**
Intelligence	0.770	0.638**
Professional identity	0.758	0.642
Total amount table	0.941	0.654**

** $P < 0.01$ (2-tailed)

3.4 Validity Test

3.4.1 Content validity

The content validity ratio (CVR) was used to evaluate the content validity of the scale. The results showed that among the 32 entries, 17 entries had CVR = 1, 12 entries had CVR = 0.6, 3 entries had CVR = 0.2, and 90.6% of the entries had CVR above 0.6.

3.4.2 Effective calibration

The results showed that the total score and factor scores of the teaching quality evaluation scale for teachers in vocational colleges were positively correlated with DTPA and MTCA. Except that the correlation between the operational demonstration and the two scales did not reach a significant level, they were statistically significant ($P < 0.05$, $P < 0.01$). See Table IV.

Table IV. Results of criterion validity analysis

factor	DTPA	MTCA
Communication and expression	0.352*	0.398*
Innovation	0.436**	0.351**
Operational demonstration	0.132	0.179
stability	0.424**	0.381**
Intelligence	0.365**	0.339**

Professional identity	0.675**	0.651**
Total score of scale	0.450**	0.328**

* $P < 0.05$, ** $P < 0.01$ (2-tailed)

IV. DISCUSSION

4.1 Structure of the Scale

In terms of teachers' psychological quality, it is generally believed that being good at expressing and communicating with others is the basic element of teachers' psychological quality, which is reflected in factor 1 communication and expressiveness [6]. Another characteristic of vocational college education is that due to the continuous development of various industries, the knowledge renewal and change speed of vocational education is significantly faster than that of ordinary middle school education [7]. The teaching innovation of factor 2 and the intelligence of factor 5 reflect the teachers' continuous pursuit of innovation and development in imparting knowledge to students, keeping up with the trend of the times, and organizing classroom teaching with flexible wisdom. While emphasizing that teachers should be good at expressing and communicating in classroom teaching and updating knowledge, some scholars put forward the stability characteristics of teachers' Teaching [8]. As the fourth factor, stability emphasizes another quality that teachers should have in classroom teaching, that is, they can face the complex and changeable classroom teaching environment with a stable attitude, not be disturbed by various adverse factors such as students or environment, and always maintain systematic teaching and the systematicness and integrity of knowledge. It has also been recognized by the majority of teachers and students. As for the quality characteristics of teachers in vocational colleges, in addition to covering some quality contents of the above general teachers, it also has particularity, that is, the on-site operation demonstration, which requires teachers to be able to effectively operate hand-in-hand and guide students to master the front-line production technology ability [9]. This ability also has quality characteristics. Educators attribute this preference for doing things and communicating to one of people's multiple intelligences, which is a part of physical kinesthetic intelligence, and plays a great role in these people. A large part of the teaching tasks of Vocational Colleges belong to the cultivation of students' hand operation skills. As teachers of vocational colleges, if they have good physical kinesthetic intelligence ability and preference in terms of psychological and behavioral quality, they will better complete the cultivation of students' hand operation skills. This leads to a teacher's attitude towards the profession-teacher professional identity [10]. Therefore, the third factor, hand operation demonstration and the sixth factor, teachers' professional identity, reflect a kind of psychological quality unique to vocational college teachers and their self feeling and recognition of vocational teaching courses. Finally, six factors were selected as the framework of the psychological quality evaluation scale for teachers in vocational colleges.

4.2 Item Analysis of the Scale

Item analysis is an important step in the preparation of standardized evaluation tools. The purpose is to screen out suitable items and ensure the reliability and validity of the scale.

The item analysis of this scale mainly uses three methods to screen items: the first is the correlation between items and the total score of the scale, the second is the discrimination of items for high and low groups, and the third is factor analysis. Some scholars have proposed that the correlation coefficient between items and total score is between 0.3-0.8^[11], which can produce good reliability and validity. The items of this study are positively correlated with the total score, and the correlation coefficients are greater than 0.4, indicating that the items of this scale are representative and sensitive. The results of discrimination show that the differences between high and low groups of each item are significant at the level of 0.001, indicating that the items of this scale have good discrimination. Factor analysis retains the items with factor load > 0.4, and also screens the items from the perspective of representativeness and independence to ensure that the items have both representativeness and independence. The correlation analysis between each factor and between each factor and the total score shows that there is a moderate positive correlation between each factor and the total score, and the correlation between each factor and the total score is significantly higher than that between each factor, indicating that each factor contributes and has a certain independence.

4.3 Reliability Analysis

This study mainly investigates the reliability of the scale from two aspects: test-retest reliability and homogeneity reliability. The reliability of the evaluation tool with good reliability is better than 0.8 for the total scale and 0.6 for the subscale^[12]. Test-retest reliability, also known as stability coefficient, mainly examines the cross time stability of the scale. According to the test results of teachers after 2 weeks, the test-retest reliability is 0.654, indicating that the scale has high cross time stability and good test-retest reliability. These reliability coefficients are within the acceptable range of measurement, indicating that the scale has good external and internal reliability, and the scale is stable and reliable.

4.4 Validity Analysis

Content validity refers to whether the items constituting the scale can reflect the whole content or the whole domain. The prepared items should represent all relevant results^[13]. Expert evaluation is a typical procedure to determine the content validity. In this study, the content validity ratio (CVR) is used to evaluate the content validity of the scale. The closer the value of CVR is to 1, the better the content validity of the items of the scale. Among the 32 items in the scale, the CVR of 17 items is 1 (that is, 5 experts think the item content is important), the CVR of 12 items is 0.6 (that is, 4 of 5 experts think the item content is important), and the CVR of 3 items is 0.2 (that is, 3 of 5 experts think the item content is important). 90.6% of the entries had a CVR above 0.6. Therefore, it can be considered that this scale has good content validity.

Criterion validity is the external standard to measure whether an evaluation scale is effective. According to the theory of psychometrics, the closer the structure and content of the scale, the higher the correlation between the measurement results, and vice versa. At the same time, it is considered that the

correlation coefficient between the calibration scale and the evaluation scale used in the study is only 0.30-0.50, Because the validity of the scale will be affected by other factors^[14]. According to the standards of psychometrics, this evaluation scale has good criterion validity.

In short, the professional psychological quality scale of Vocational College Teachers compiled in this study has a comprehensive structure, good homogeneity reliability and test-retest reliability, high content validity, and the calibration validity meets the psychometric standards. It can be used as a measuring tool for the professional psychological quality of vocational college teachers.

ACKNOWLEDGEMENTS

This work was supported by National Social Science Foundation of China Pedagogy National Major Project ‘Research on vocational education type characteristics and its relationship with general education ‘dual track system’ and ‘dual access system’ system construction”, Host: Sun Shanxue, (Grant NO. : VJA200003).

REFERENCE

- [1] Mehl MR, Gosling SD, Penndbaker JW. Personality in its natural habitat: Manifestations and implicit folk theories of personality in daily life. *J Pers Soc Psychol*, 2006, 90(5): 862-877
- [2] Lin Chongde, Shen Jiliang, Xin Tao. The Composition of Teacher Quality and Its Training Approach. *Chinese journal of education*, 1996, 16(6): 16-22
- [3] Xu Xuejun, LV Li. Theoretical Construction and Scale Compilation of Psychological Quality Structure of Excellent College Teachers. *Journal of hubei university (philosophy and social sciences)*, 2011, 6(36): 119-124
- [4] Sun Xiaoyuan, Wang Xihua. The Development of Psychological Quality Questionnaire for Middle School Teachers. *Journal of neijiang normal university*, 2011, 2(26): 49-54
- [5] Guo Lina. Discussion on the Shaping of Vocational Teachers' Psychological Quality. *Journal of liaoning higher vocational college*, 2009, 11(5): 78-79
- [6] Wei Jianguo, Zhang Haizhu. *Theory and Practice of Classroom Teaching Skills*. Beijing: Beijing Normal University Press, 2008:147-150
- [7] Zhang Riheng. A study on the influence of teachers' enterprise Practice on the construction of double-qualified team. *China vocational and technical education*, 2011, 19(35): 71-74
- [8] Zhu Xiaoping. Research on Teaching Team Construction in Higher Vocational Colleges under the Mode of Combination of Work and Study. *Journal of Harbin university*, 2013, 34(4) 216-219
- [9] Asher. J: *Learning Another Language through action*. New York: Holt, Yinehart & Winston, 2000: 205-208;
- [10] Qin Man. On teacher Training of Vocational Education in Japan. *Science theory*, 2009, 51(10): 144-145
- [11] Dai Haiqi, Zhang Feng, Chen Xuefeng. *Psychological and Educational Measurement*. Guangzhou: Jinan University Press, 1999:201-203
- [12] Luo Fang, Sun Xiaomin. *Psychological measurement*. Beijing: China Light Industry Press, 2009:191-194
- [13] Huang Guangyang. *The Theory and Application of psychological measurement*. Nanjing: Jiangsu Education Press, 1987: 142-145
- [14] Xie Xiaoqing. *Handout on psychometrics*. Wuhan: Central China Normal University Press, 1988: 87-89