

## **A study on the comprehensive evaluation method of teachers' teaching quality based on Z-score**

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### **Abstract.**

The comprehensive evaluation of the quality of the teacher's teaching is an important part of the teaching quality evaluation in which the scientific rationality of the method is very important. Based on the four quartile method and the students' score of the teachers obtain Z-score of teachers and judge the position of the teacher in the whole teaching quality evaluation. This is also the purpose of the evaluation method. The conclusion via the evaluation method can objectively reflect the teacher's individual teaching quality of teacher groups. It is helpful to understand the whole structure of the teaching staff.

### **Introduction**

In order to compare the skill level of a number of people who have the same kind of professional skills, sometimes it is necessary to carry out the same kind of vocational skill experiment by several tests and evaluate by comparing results of vocational skill of experimenters.

A general evaluating standard constitutes the following terms:

- (1) The expert's common opinions, such as criteria which are determined by trade experts;
- (2) The standards confirmed by authoritative departments, such as the national standard;
- (3) By establishing evaluation criteria for evaluation models, such as the minimal influence of extreme values.

In the teaching profession, the evaluation of teachers' teaching skill, that is to say, the evaluation of teaching quality, is an important part of the teaching quality evaluation. This evaluation is based on the school's educational objectives and teachers' teaching tasks. According to the scientific index system and evaluation criteria, we can take teachers' teaching effectiveness evaluation. In addition, this evaluation includes the evaluation of peer experts, teaching management staff and students and the students' evaluation of teaching is an important basis for the evaluation of teachers' teaching quality. Because of students as the direct object of classroom instruction, they owned the whole teaching process and the amount of information can objectively reflect the teaching quality of teachers. In order to scientifically and accurately reflect the position of every teacher in the teaching quality, it is very vital to evaluate the teaching quality.

In the evaluation of teachers' teaching skill, people have carried on the discussion to the method and the means. The most simple way is to implement percentile scoring system. In accordance with the score, this is divided into five levels, such as "excellent, good, medium, qualified and poor". This division often appear much "excellent" and no "poor" phenomenon in the actual operation process. In addition, use some of the weight sorting method, such as Zhen Yang. She, introducing AHP and fuzzy comprehensive evaluation method and combining with the teaching work of teachers in all aspects of the content, utilize teaching quality of university teachers into a comprehensive evaluation[1]. Yuexia Gao, using factor analysis method, has evaluated teaching quality of preventive medicine professional teachers[2]. Yuntao Yang, using the information entropy theory to determine the weight

of evaluation index objectively, makes use of fuzzy comprehensive evaluation method to estimate classroom teaching quality of teachers[3]. Qingtian Wu make cloud model introduced to the uncertain linguistic multi-criteria decision and the knowledge of the qualitative and quantitative transformation and language value aggregation. They establish the model of university teachers' teaching quality evaluation of multi-criteria decision making based on cloud model[4]. In the above mentioned methods, the method of ranking weights are based on many factors that affect the teaching effect. These evaluation is obviously a lack of hierarchy. According to the proportion of the implementation of the bottom out of teaching skill evaluation mechanism, it has defects.

In this paper, we propose a method for evaluating the quality of teachers' teaching quality based on the normal distribution of Z-score. This method can judge the relative position of every teacher evaluated in the overall evaluation and can also judge in which evaluation criteria. The decision makers, achieving the benchmark for the evaluation of modification, can control the number of rating as "excellent" and "poor" in the evaluation. It is advantageous for the implementation of the bottom out of teaching skill evaluation mechanism.

In this paper, assume evaluation results are rated as five levels, i.e. excellent, good, medium, qualified and poor. The concrete evaluating criterion is as follows:

$$\left\{ \begin{array}{ll} 1.645 \leq Z, & \text{excellent} \\ 0.675 \leq Z < 1.645, & \text{good} \\ -0.675 \leq Z < 0.675, & \text{medium} \\ -1.645 \leq Z < -0.675, & \text{qualified} \\ Z < -1.645, & \text{poor} \end{array} \right. \quad (1)$$

Given parameters in the formular (1) are determined in accordance with the normal distribution method. According to the subjective needs of the decision makers, the parameters can be revised.

Several definitions involved in this paper are as follows[5,6,7]:

(1)  $p\%$  quantile: A set of  $N$  measurements, which are arranged in size, constitute a collection. The collection has at least  $p\%$  measurement values that is smaller than it and at least  $(100 - p)\%$  measurement values that is larger than it. 25% quantile, 50% quantile, 75% quantile are respectively called 1/4 quantile, 2/4 quantile, 3/4 quantile, i.e.  $Q_{25\%}$ ,  $Q_{50\%}$ ,  $Q_{75\%}$ .

(2) Inter quartile range (IQR): the difference between 3/4 quantile and 1/4 quantile.

(3) Z-score: let  $x$  be a continuous random variable,  $\mu$  and  $\sigma$  are respectively the mean and standard deviation of the overall value, the result of calculating  $Z = (x - \mu) / \sigma$  is called Z-score of  $x$  value.

### **Z-score Calculated Based on Quartile Method**

In a comprehensive ranking of the teaching quality of a number of teachers, students' evaluation score to many teachers should be normal distribution. Assume that a number of teachers' teaching effect score  $X$  are subject to normal distribution. The concrete steps of using quartile method to calculate Z-score are as follows:

(1) Rank the obtained  $X$  by ascending sort, respectively.

(2) Compute a quarter of quantile  $Q_{25\%} = N/4 + 0.5$ , two-quarter of quantile  $Q_{50\%} = 2N/4 + 0.5$ , and three-quarter of quantile  $Q_{75\%} = 3N/4 + 0.5$  of the set  $X$ , respectively. The  $N$  is the total numbers of the measurement value of each sample.

(3) Z-score calculation. Calculate Z-score  $z_i$  of measurement value  $x_i \in X$  according to the following formula:

$$z_i = (x_i - \mu) / \sigma, \quad (2)$$

where  $\mu$  is criterion value,  $\sigma$  is standard deviation. According to relation of standard deviation  $\sigma$  on the normal distribution, quartile, and IQR (inter quartile range), there is

$$IQR = (Q_{75\%} - Q_{25\%}) = 2 \times 0.6745\sigma = 1.349\sigma . \quad (3)$$

Thus,

$$\sigma = 0.7413 \times IQR = 0.7413 \times (Q_{75\%} - Q_{25\%}) . \quad (4)$$

In the formula (2), if  $\mu = Q_{50\%}$ , the Z-score  $z_i$  of the experimental data  $x_i$  of the teacher  $i$  is as follows:

$$z_i = (x_i - Q_{50\%}) / (0.7413 \times (Q_{75\%} - Q_{25\%})) . \quad (5)$$

### Computational Examples

The 40 teachers participated a comprehensive teaching quality evaluation. Students' score to teachers and the ascending sort show in Table 1. If according to previous evaluation criteria, i.e. 100-90 rated excellent, 89-80 rated good, 79-70 rated medium, 69-60 rated qualified and 50 below rated poor, then the number are respectively 3, 14, 16, 6, 1 in the 40 evaluated teachers. If according to propose the normal distribution method based on Z-score in this paper and utilize formular (1) to evaluate, the results are shown in Table 1, where the number of excellent, good, medium, qualified and poor are respectively 2, 9, 19, 7, 3.

TABLE 1 COMPREHENSIVE EVALUATION OF TEACHING QUALITY BASED ON Z-SCORE

number	Student scoring	Z-score	Evaluation result	number	Student scoring	Z-score	Evaluation result
1	55.0	-2.619	poor	21	79.1	0.090	medium
2	60.0	-2.057	poor	22	79.1	0.090	medium
3	61.0	-1.945	poor	23	79.8	0.169	medium
4	65.7	-1.416	qualified	24	80.2	0.214	medium
5	66.0	-1.383	qualified	25	80.7	0.270	medium
6	67.5	-1.214	qualified	26	81.0	0.304	medium
7	69.4	-1.000	qualified	27	83.0	0.528	medium
8	70.6	-0.866	qualified	28	83.3	0.562	medium
9	71.0	-0.821	qualified	29	83.5	0.585	medium
10	71.2	-0.798	qualified	30	84.6	0.708	good
11	<b>73.0</b>	-0.596	medium	31	<b>85.0</b>	0.753	good
12	73.5	-0.540	medium	32	85.8	0.843	good
13	74.0	-0.483	medium	33	86.6	0.933	good
14	74.8	-0.393	medium	34	87.4	1.023	good
15	75.5	-0.315	medium	35	88.1	1.102	good

16	76.0	-0.259	medium	36	88.5	1.147	good
17	77.3	-0.112	medium	37	89.0	1.203	good
18	77.5	-0.090	medium	38	91.2	1.450	good
19	78.0	-0.034	medium	39	94.8	1.855	excellent
20	<b>78.3</b>	0.000	medium	40	<b>95.0</b>	1.877	excellent

From the result, it can be seen the results of these both methods, the normal distribution based on Z-score and previous evaluation method, are different. The thirty-eighth excellent teacher of original score 91.2 becomes good in the new method. Though 60 score is qualified, two teachers, i.e. the second teacher and the third teacher, are not qualified with the new method. The new method is not in accordance with their own students score as the evaluation criteria, but in accordance with the overall calculation of the teachers. Compared with the previous evaluation, the new method makes more scientific.

### Conclusions

This paper presents a new method for the comprehensive evaluation of teachers' teaching quality. This evaluation method is not a single evaluation of teachers, but teachers as a system to deal with the status of each teacher in the whole system. The advantage is no longer to teacher's personal absolute scores to determine the results, but to the relative fraction as the evaluation standard. It can make every teacher understand their position in teacher groups evaluated well and find out the differences between oneself and other teachers. It can also promote the continuous improvement of teaching quality.

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