



Research on the Construction of Scientific Research Evaluation System for Teachers in Higher Vocational Colleges Based on Computer PCA and ANP

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Abstract. With the rapid development of Higher Vocational Education in China, a series of problems need to be solved, especially the performance appraisal of teachers. At present, the scientific research assessment system of teachers in higher vocational colleges is not perfect, which restricts the development of higher vocational colleges to a certain extent. Establishing a scientific performance appraisal system is the key to improve the teaching quality and highlight the characteristics of higher vocational colleges. This is also the premise of the healthy development of higher vocational education, which has strong theoretical and practical significance for the sustainable development of higher vocational education. According to the working characteristics of teachers in higher vocational colleges, this paper establishes the performance evaluation index system of teachers in Higher Vocational Colleges from five aspects of teaching, scientific research, social service and discipline construction, and studies and grows through investigation and principal component analysis (PCA). On this basis, the use of network analytic hierarchy process (ANP) to determine the construction of Higher Vocational College Teachers' performance evaluation model.

Keywords: Higher vocational colleges · Performance appraisal · Appraisal system

1 Introduction

Talent competition is the main content of today's international competition, people are more and more deeply aware of the strategic importance of talent. In the current situation, only by vigorously developing all kinds of education can we be invincible in the future international competition. Higher vocational education is the inevitable product of economic development and the development of modern social science and technology. The rise of new technological revolution after World War II has promoted the rapid development of economy in the world, and the economic structure and labor employment structure have also changed significantly, thus promoting the great development of higher vocational education. All countries in the world recognize that the development of higher vocational education plays an important role in promoting economic

and social development and employment growth. Therefore, they regard the reform and development of higher vocational education as an important part of planning the education system in the 21st century. In 1999, the decision of the CPC Central Committee and the State Council on deepening education reform and comprehensively promoting quality education put forward: “higher vocational education is an important part of higher education, and we should vigorously develop higher vocational education. Since then, higher vocational education began to expand on a large scale, and its development has been widely concerned by all sectors of the society. It has provided great support for the rapid leap of China’s higher education from the elite stage to the popular stage.

2 Summary of Performance Appraisal

2.1 The Meaning of Performance Appraisal

From the perspective of human resource management, performance is efficiency, which refers to the input-output ratio of an organization or individual in a certain period of time. There are various forms of performance, generally speaking, mainly reflected in the work efficiency, the quality and quantity of work tasks and work efficiency. From the perspective of management, it is the expected work behavior, performance and results of an organization, including organizational performance and individual performance [2]. The realization of organizational performance is based on the realization of individual performance, but the realization of individual performance does not necessarily guarantee the realization of organizational performance, it is not a simple superposition. However, if the organizational performance can be decomposed to everyone according to a certain logical relationship, as long as everyone realizes the requirements of the organization, the organizational performance can be achieved. If higher vocational colleges want to achieve the goal of running a school, they should first decompose the development goal of the college to each teacher. As long as the performance of each teacher is achieved, then the performance of the college can be achieved.

2.2 Main Methods of Performance Appraisal

Key performance indicators (KPI) is a mode of performance appraisal based on the analysis of the characteristics of work performance and the selection of a series of indicators that are the most critical for a job. It is a tool to decompose the strategic objectives of an organization into operational long-term objectives and the basis of the organizational performance management system. The specific steps of establishing key performance indicators are as follows: first, clarify the strategic objectives of the organization, and the top management of the organization will reach a consensus on the key points of the future development objectives of the organization, that is, the key points of the organization value evaluation, and then analyze each key business focus and relevant performance standards and their proportion through the “fishbone chart”, Finally, according to the qualification requirements of the post, the corresponding performance standards are re decomposed to determine the KPI indicators corresponding to the post, which are the elements of employee evaluation. All KPI indicators point to the key points of organizational success, and can play the guiding role of indicators themselves.

3 Design of Higher Vocational College Teachers' Performance Appraisal Model Based on ANP

3.1 ANP Overview

ANP and AHP are both faced with unstructured and semi-structured decision-making problems. AHP is a multi project decision-making method combining qualitative and quantitative analysis [3]. In the 30 years since its birth, Saaty and many other scholars have done a lot of work in the development and application of the theory. At present, AHP has been widely used in the world, especially in the field of economy. AHP is a multi criteria evaluation and decision-making method, which quantifies people's subjective judgment objectively through relative scale, and reasonably combines qualitative and quantitative decision-making. As shown in Fig. 1. To analyze a relatively complex problem, first of all, the problem to be analyzed is hierarchically divided into several groups with the same or similar attributes. It divides the system into different elements by analyzing the relationship between various factors and their subordination, and divides these elements into different levels, thus forming a multi-level analysis structure model.

Let W be the hypermatrix of the system, and let the k -th power of W be:

$$W_k = (W_{ij}^{(k)}) \tag{1}$$

$$W_{ij}^{(k)} = \sum_{m=1}^N W_{im}^{(1)} W_{mj}^{(k-1)} \tag{2}$$

Therefore, the matrix reflects the relative ranking of index I for the cumulative K steps of index J .

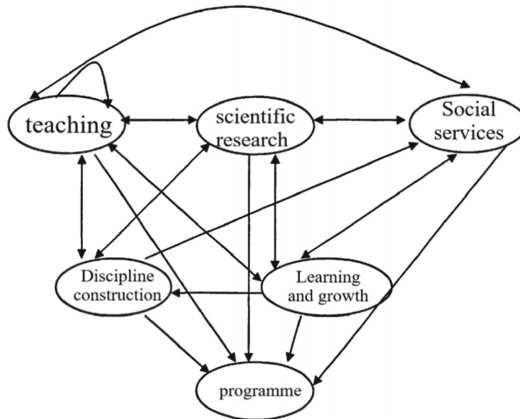


Fig. 1. ANP based teacher performance appraisal index system of higher vocational and technical college

3.2 Analysis of Performance Appraisal Index System

The purpose of teachers' performance appraisal in this higher vocational and technical college is clear, and appraisal is only a means, and the ultimate goal is to promote the teaching and scientific research level of teachers. Through the way of performance appraisal, it can form certain pressure and motivation for all teachers, and promote each teacher to constantly dig out his own strengths in the work. But in the actual implementation of the performance appraisal work, it has not played too much effect, mainly because the current performance appraisal ignores the development of teachers, which has greatly hit the enthusiasm of teachers. In order to manage, there is a lack of communication and feedback, and the performance appraisal index system is not perfect.

The orientation of teachers' assessment is vague, which fails to combine with the orientation, development strategy and purpose of the college, and lacks a clear purpose. In order to assess, the assessment becomes a mere formality, which costs a lot of time, manpower and material resources. In the process of formulating and designing the indicators, the college does not widely solicit teachers' opinions and carry out in-depth research, which will inevitably lead to the low or high level of indicators, and the assessment standards can not reflect the actual working conditions. The orientation of performance appraisal is the core of performance appraisal. Unreasonable positioning will lead to the inconsistency between the assessment process, the application of key points and the assessment objectives. The fundamental purpose of teachers' teaching performance appraisal is to reward advanced teachers and enhance their sense of responsibility for teaching quality. On the other hand, it is to make some teachers realize their shortcomings, improve teaching methods and improve teaching quality. But at present, teachers' teaching performance evaluation has become the focus of teachers' professional title evaluation. Performance evaluation is only for rating, selecting excellent teachers and granting subsidies, rather than focusing on improving teachers' quality and enhancing the future competitiveness of the college through performance evaluation [4].

If the teaching workload is set at 380 class hours, teachers are busy completing the workload, and it is difficult to pay attention to the improvement of teaching quality, let alone improve themselves. As mentioned above, the requirement of scientific research workload leads to the lack of academic spirit. Most of teachers' scientific research focuses on publishing papers and compiling teaching materials, while topics are just embellishments. Even in the papers, there are many opportunistic behaviors. Many papers have changed their faces or registered with each other. Although the number is large, there is no new idea. In the project selection, tend to "short, fast" project. Moreover, for college teachers, most of them have heavy teaching tasks. Many teachers have 16 class hours a week, among which most full-time teachers are also class teachers, so they have no time to write papers, and there are conflicts between teaching and scientific research [5–7]. The time of engaging in scientific research is not guaranteed, which is not conducive to mobilizing teachers' enthusiasm for scientific research, let alone the quality of scientific research. Therefore, the effectiveness of this assessment policy is very poor, which is not conducive to the long-term development of scientific research.

3.3 System Simulation Analysis

PCA (principal components analysis) is principal component analysis technology, also known as principal component analysis. Principal component analysis, also known as principal component analysis, aims to transform multiple indicators into a few comprehensive indicators by using the idea of dimension reduction.

In statistics, PCA is a technique to simplify data sets. It's a linear transformation. This transformation transforms the data into a new coordinate system, so that the first major variance of any data projection is on the first coordinate (called the first principal component), the second major variance is on the second coordinate (the second principal component), and so on. Principal component analysis (PCA) is often used to reduce the dimension of data sets, while maintaining the features of data sets that make the largest contribution to the square error [8–11]. This is achieved by retaining the lower order principal components and ignoring the higher order principal components. In this way, low-order components can often retain the most important aspects of the data. However, this is not necessarily, it depends on the specific application.

We use PCA and ANP technology to evaluate teachers, and the evaluation results are shown in Fig. 2 and Fig. 3. Figure 2 shows the results of using PCA technology to evaluate teachers, and Fig. 3 shows the results of ANP technology to evaluate teachers.

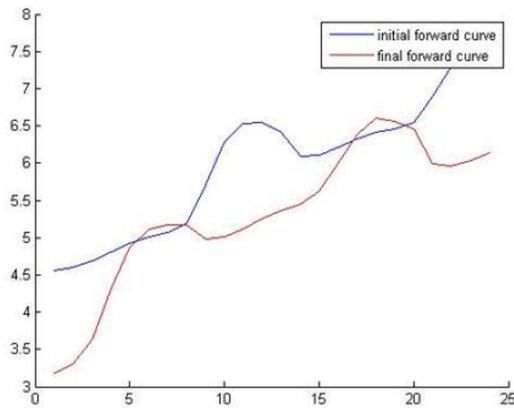


Fig. 2. PCA technology to evaluate teachers

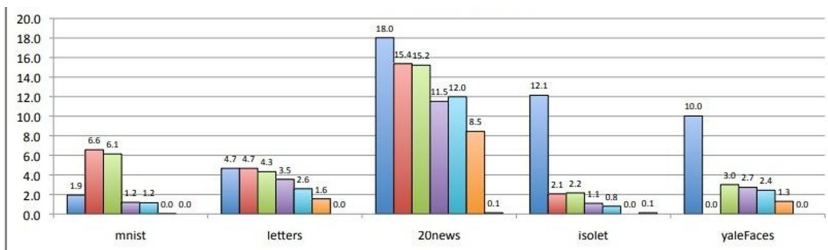


Fig. 3. ANP technology to evaluate teachers

4 The Main Problems in the Evaluation System of the Achievements of Scientific Research of University Teachers

4.1 Research Performance Evaluation of Digital Quantity

The quantitative evaluation index of teachers' scientific research performance can avoid the interference of human factors to a great extent, which is relatively fair. However, there are some problems in the performance evaluation system of scientific research of teachers in some colleges and universities, such as over quantification and standardization. For example, the scientific research situation of teachers in the past year, whether the research projects they presided over or participated in were national, provincial, municipal or school level; whether they were vertical or horizontal projects, and how much funds they had. How many papers are published in authoritative journals, core journals or general journals? How many papers are included in SC and E? How many monographs are published? Implement digital management, simply pursue quantity, and ignore the weight of quality in evaluation. Since the amount of remuneration for teachers' scientific research work is calculated and paid according to the amount of scientific research work completed by the teachers themselves in that year [12–14]. Therefore, teachers will only focus on the number of academic papers, and ignore the quality of papers, which is not conducive to the improvement of the level of scientific research.

4.2 Scientific Research Performance Evaluation Ignores Discipline Differences

Because different disciplines and their academic research have their own special regularity, the ways and methods of research exploration, the length of research cycle, and the form of achievements are all different. It is impossible to use a unified scientific research quantitative evaluation system and standard to evaluate the research of all disciplines. For example, the evaluation of liberal arts research involves value judgment, historical judgment and nature judgment, which needs time precipitation and historical evaluation. The scientific research of science and engineering is mostly applied technology research, with high conversion rate of scientific research achievements, obvious direct economic benefits, more invention patents, and easy to quantify the evaluation index. According to the classification of university scientific research, university scientific research can be divided into three categories: basic research, applied research and technology industrialization. Due to the emphasis of disciplines and the conditions of scientific research, the workload of scientific research varies greatly between basic disciplines and professional disciplines, between liberal arts and science and engineering. As shown in Fig. 4. In order to facilitate the assessment, most colleges and universities usually use the same evaluation standard to evaluate the research results of different disciplines. It is difficult to achieve the objective, fair and just evaluation, which affects the enthusiasm of some teachers in scientific research.

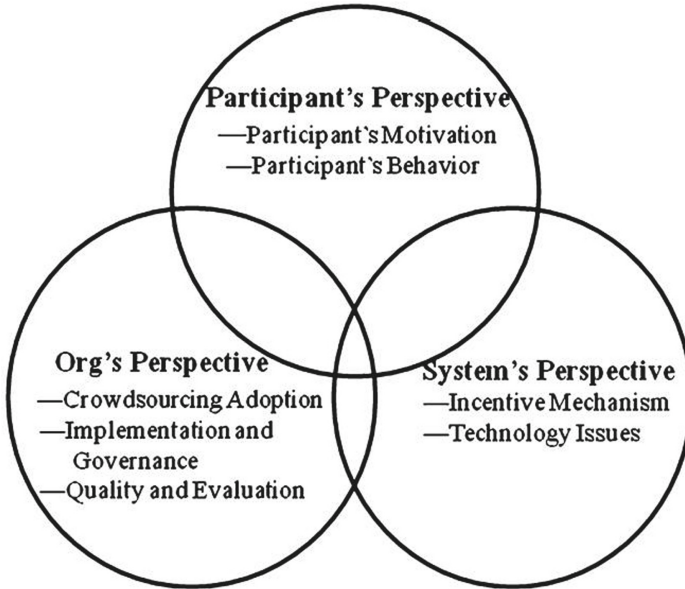


Fig. 4. Scientific research performance evaluation ignores discipline difference

4.3 Excessive Quantification Is Easy to Make Teachers Eager for Quick Success and Instant Benefit and Academic Misconduct

At present, there are some problems in the performance evaluation system of scientific research in Colleges and universities, such as ignoring the process and paying attention to the results. Scientific research performance evaluation is mainly based on the level of published articles, the level of scientific research projects and the amount of funds. The assessment results are directly linked with each person's year-end remuneration and professional title promotion [6, 9, 12]. Under the guidance of this policy, in order to meet the requirements of assessment scores, some teachers lack of academic innovation and are willing to engage in the research and development of short and quick small projects, resulting in few influential high-level scientific research achievements and low level of scientific research achievements. Some teachers even divided a high-quality article into several articles to publish, or pieced together to cope with the assessment. From the academic research achievements of colleges and universities in recent years, there are more tracking projects and less original articles. Although the number of papers is rising sharply, the number of papers cited by the international academic community is very few. Even academic misconduct such as "plagiarizing and plagiarizing other people's scientific research achievements" occurred.

5 Measures to Improve the Performance Evaluation System of University Teachers

5.1 Scientific Research Activities of Different Disciplines and Types

Different evaluation index systems and methods should be adopted, and the evaluation objectives and contents should be different. Because different disciplines have different ways of research and forms of achievements. For example, teachers engaged in science and engineering research should evaluate their scientific research achievements from the aspects of scientific research projects, scientific research funds and the economic benefits generated by the transfer of achievements. For teachers engaged in Humanities and social sciences research, the representative papers published in domestic influential academic journals and their citation should be taken as the important reference index for evaluation. In addition, there are obvious differences in each teacher's age, research experience, professional expertise and career goals. In the design of teachers' scientific research performance evaluation index system, we must analyze the bairite situation, determine the reasonable weight of each evaluation index, and refine the evaluation standard. Only in this way can we objectively and positively reflect teachers' achievements in scientific research and improve their enthusiasm in scientific research.

5.2 Implement the Organic Combination of Quantitative Assessment and Qualitative Assessment

The advantages of quantitative method of scientific research performance evaluation system lie in its high degree of standardization and accuracy, strong operability and little influence by subjective factors. However, scientific research performance evaluation system, not only quantitative analysis, but also qualitative analysis, to achieve the organic combination of qualitative and quantitative. We should accord with the law of academic development, put innovation in the first place, and gradually change from "quantity centered evaluation" to "quality centered evaluation". For example, to measure the level of academic papers, we should not only see whether they are published in authoritative and core journals, but also make a more scientific evaluation by comprehensively examining the cited times, online download rate and other indicators of papers. We should not only see how many scientific research projects teachers have, how many patents they have applied for and how many awards they have won, but also see the potential social benefits, so as to achieve the organic combination of quantitative assessment and qualitative assessment [10, 13]. We should pay attention to the quality of scientific research while evaluating the quantity of scientific research, so as to make the evaluation of teachers' scientific research performance more fair and equitable.

6 Conclusion

To vigorously develop higher vocational education, we must fully mobilize the enthusiasm of teachers. Only by establishing a performance appraisal system suitable for higher vocational colleges, can we give full play to the guiding role of appraisal, promote the

independent development of teachers, and finally promote the development of higher vocational colleges. On the basis of expounding the relevant theories of performance appraisal, this paper compares and analyzes the performance appraisal of teachers in Higher Vocational Colleges with that of colleges and secondary vocational and technical schools. Combined with the working characteristics of teachers in higher vocational colleges, this paper analyzes the problems existing in the performance appraisal of teachers in Higher Vocational colleges, and conducts research in some higher vocational colleges in Suzhou, Wuxi and Changzhou to obtain relevant index data, And try to use principal component analysis (PCA), combined with spss8 statistical software, finally, from the teaching, scientific research, social services, discipline construction, learning and growth five dimensions to build a higher vocational college teacher performance appraisal index system.

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References

1. Yuqin, X., Yonghong, J.: Enterprise Salary and Performance Management System Design, 1st edn. China Machine Press, Beijing (2004)
2. Zhaofeng, L.: The construction of teachers' performance management system in higher vocational colleges. *J. Hunan First Normal Univ.* **3**, 143–145 (2008)
3. Wu, J., Yue, N.: Does interest relevance affect the objectivity of evaluation results: a study on the selection of performance evaluation subjects based on simulation experiments. *Manage. Rev.* **58**–62 (2007)
4. Li, C.: American university teacher performance evaluation. *J. Nat. School Educ. Admin.* (5), 91–95 (2007)
5. Xu, Y.G., Yu, G.R.: Guidance and rationality of scientific research evaluation system for university teachers in China. *J. Sichuan Normal Univ. (Soc. Sci. Edition)* (3), 119–123 (2011)
6. Junjie, L.: Problems and improvement of scientific research performance evaluation of university teachers. *Educ. Dev. Res.* **7**, 74–76 (2011)
7. Chunyan, Z.: Evaluation and suggestions on scientific research performance of university teachers. *Sci. Technol. Progress Countermeasure*. **11**, 210–212 (2008)
8. Weijin, D.: Analysis on the current situation and improvement of scientific research evaluation in Colleges and universities. *High. Educ. Res.* **4**, 61–64 (2004)
9. Yu, J., Zhou, L.: Problems and thinking in the evaluation system of scientific research performance in Colleges and universities. *Res. Sci. Technol. Manage.* (18), 73–75 (2010)
10. Xing, L.: Research on the scientific research performance evaluation of university teachers. *Sci. Technol. Industrializat. Chin. Univ.* **5**, 40–41 (2010)
11. Xi, Z., Xiaofeng, S.: On the thinking of the non material incentive of university scientific research teachers. *Res. Sci. Technol. Manage.* **4**, 185–186 (2010)
12. Tian Zai, L.A.N.: Research on optimizing the scientific research performance evaluation system of university teachers in China. *J. Econ. Res.* **18**, 238–239 (2009)
13. Wenyan, Z.: Problems and countermeasures of scientific research evaluation in Chinese universities. *J. Jishou Univ. (Nat. Sci. Edition)* **7**, 119–121 (2006)
14. Ping, J., Tingting, Y., Song, L.: Research on discipline construction of open university. *Modern Dist. Educ.* **2**, 28–33 (2012)