# Construction and Empirical Research on Teaching Quality Evaluation System of Java Programming in the Context of New Engineering Science

Donghai Peng[a*], Huanjie Yu[b], Huajin Jiang[c]

School of Information Engineering, Shaoguan University, Shaoguan, China

[a*]469946899@qq.com, [b]2990280345@qq.com,[c]2661000291@qq.com

**Abstract.** The construction of new engineering disciplines has put forward new requirements for teaching evaluation in applied undergraduate colleges. The traditional teaching evaluation methods are generally subjective in determining the weights of indicators, which can no longer meet the current needs of engineering education[1]. The article comprehensively considers the construction needs of the new engineering discipline, introduces the comprehensive assignment method to calculate the index weights, combines the fuzzy comprehensive evaluation method, and puts forward the fuzzy evaluation system of teaching quality based on comprehensive assignment. Taking the Java Programming course as an example, the research finds that the evaluation results calculated by the institute based on subjective weights are on the high side, while the results calculated based on objective weights are consistent with the results of the comprehensive assignment, which is more in line with the reality. The research results can provide a reference for the teaching evaluation of applied undergraduate colleges and universities under the background of the new engineering discipline.

**Keywords:** teaching evaluation system; hierarchical analysis; entropy weight method; fuzzy evaluation model; new engineering science.

## 1 Introduction

### 1.1 Background

The Ministry of Education of China has launched a series of seminars since February 2017, the contents of which are centered on the construction of "new engineering disciplines", and it is easy to see that the construction of "new engineering disciplines" is increasingly becoming a new hotspot for university reforms from the "Fudan Consensus", "Tianda Action" and "Beijing Guidelines"[2]. From the trilogy of "Fudan Consensus", "Tianda Action" and "Beijing Guidelines", it is easy to see that the construction of "New Engineering" has become a new hotspot of university reform. The innovative


M. Yu et al. (eds.), *Proceedings of the 2024 5th International Conference on Big Data and Informatization Education (ICBDIE 2024)*, Advances in Intelligent Systems Research 182,
https://doi.org/10.2991/978-94-6463-417-4_33

engineering disciplines" in colleges and universities have new ideas and new directions after these seminars[3]. Under the mode of "New Engineering", the way of talent cultivation will be changed, which requires the reform of higher education. The construction of "new engineering" has become a "new wind direction" in the research of colleges and universities, but most of the first-class colleges and universities are more extensive and in-depth in the research of "new engineering" than local undergraduate colleges and universities, and as the main force of undergraduate education, local undergraduate colleges and universities should not be able to do so. As the main force of undergraduate education, local undergraduate colleges and universities should not lag behind, and they should adapt to local conditions and put forward a set of more scientific and reasonable teaching quality evaluation system according to the new requirements for teaching evaluation of new engineering disciplines, which is of great significance to the construction and development of new engineering disciplines in China[4].

The current research on teaching evaluation system mostly adopts hierarchical analysis method, fuzzy comprehensive evaluation method, etc. Most of the evaluation methods use hierarchical analysis method to determine the weights of the indicators, i.e., they are calculated through the subjective scoring of experts, which is subjective to a certain extent. Based on the characteristics of teaching evaluation of applied undergraduate colleges and universities in the context of the new engineering discipline, and in response to the problem of subjectivity in the weights of indicators in the traditional teaching evaluation system, the article, through a comprehensive analysis of the existing teaching evaluation plans, selects the teaching evaluation indicators applicable to the new engineering disciplines and adopts the comprehensive assignment method to determine the weights of indicators, which avoids, to a certain extent, the subjectivity brought about by the use of AHP alone, and is combined with the fuzzy evaluation method to construct the teaching evaluation system[5]. The teaching evaluation system is constructed, and the research results can provide reference for the teaching evaluation work of applied undergraduate colleges under the background of new engineering disciplines.

### 1.2 A brief review of the method of use

In this paper, considering the construction needs of new engineering disciplines comprehensively, the comprehensive assignment method is introduced to calculate the weights of indicators, combined with the fuzzy comprehensive evaluation method, and the fuzzy evaluation system of teaching quality based on comprehensive assignment is proposed. Among them, the comprehensive assignment method is a multi-attribute decision-making method for dealing with the problem of assessing and ranking a set of alternatives by multiple evaluation indicators or attributes. The goal of this method is to help decision makers make the best choice by considering the weights of different indicators and assigning a composite score to each alternative. The origins of the combined assignment method can be traced back to the fields of decision science and operations research, and the method was developed and shaped in the mid-20th century by Howard Raiffa and Ronald A. Howard, who conducted in-depth research on multi-attribute decision-making problems in the 1950s and 1960s, particularly in the context of

risk analysis and decision-making. Their work laid the theoretical foundations of the integrated assignment method. Howard Raiffa then collaborated with Duncan Luce on a book on decision analysis, Games and Decisions: Introduction and Critical Survey, which provides a detailed account of the mathematical and conceptual foundations of multi-attribute decision making.

The fuzzy integrated evaluation method has also influenced the development of the integrated assignment method. Fuzzy integrated evaluation allows to deal with uncertainty and ambiguity, which is very useful in some decision-making problems.

Hierarchical analysis in the integrated assignment method was introduced and developed in the 1970s by the American mathematician and operations researcher Thomas L. Saaty[6]. AHP is designed to solve the problem of weight assignment and preferred solution selection in multi-attribute decision problems, providing a systematic approach to the complex choices faced by decision makers. Thomas L. Saaty is a professor at the University of Pittsburgh at the Pittsburgh Professor at the University of Pittsburgh, where his early research focused on operations research, mathematical modelling, and decision science. His research on decision problems and complexity led him to develop the AHP methodology to help address complexity and uncertainty in real-world decision making. The key idea of the AHP is to decompose the decision problem into multiple levels, starting at the goal level and descending to the criterion level and the alternatives level, and then to use a comparison matrix to determine the relative importance of the elements between the different levels. Subsequently, weight assignments are determined by calculating eigenvectors and maximum eigenvalues, and consistency tests are performed to ensure the consistency of the comparison matrix. Ultimately, the AHP synthesises the weights of each level into a composite score, which is used to make the best choice. The introduction of the AHP method enriches the toolbox of the composite assignment method, enabling decision makers to analyze and deal with complex multi-attribute decision problems in a more systematic way. The AHP method has been widely used in various fields, including engineering, economics, environmental science, marketing and project management, amongst others. Its contribution is to provide decision makers with a structured approach to help them better understand and weigh the importance of different factors and thus make more informed decisions. The fuzzy evaluation model based on comprehensive assignment takes into account both subjective and objective situations when calculating the weights, i.e. the AHP method is used to calculate the subjective weights, the entropy weight method is used to calculate the objective weights, and finally the comprehensive weight value is calculated by taking into account both subjective and objective weights, which takes into account the subjective experience of the experts, and at the same time, respects the objective facts of the data and avoids the limitation of completely subjective judgement.

### 1.3 The motivations of this paper

In writing the paper "Construction and Empirical Research on Teaching Quality Evaluation System of Java Programming in the Context of New Engineering Education", there are four aspects that constitute our motivation.

(1) Trend of New Engineering Education: In recent years, higher education institutions around the world have been actively responding to the trend of New Engineering Education (NEE), which emphasizes practice, interdisciplinarity and innovation. In this context, programming education has become a core component of engineering education. One of the motivations of this paper is to explore how to improve the quality of education through the teaching of Java Programming course in the context of New Engineering Education.

(2) Importance of Java: Java has a wide range of applications and importance as a programming language widely used in the field of software development. Understanding how to effectively teach and learn Java programming is crucial for students' career development. Therefore, establishing and studying a teaching quality evaluation system for the Java Programming course is crucial for developing students' programming skills.

(3) The Need for Teaching Quality Improvement: There is a growing need in the higher education community to improve the quality of education. Schools and educational institutions need more effective ways to assess and improve the quality of teaching to ensure that students can better master what they have learnt. The aim of this paper is to provide powerful methods and tools to improve the quality of teaching and learning in the Java Programming course.

(4) The importance of empirical research: in order to ensure the feasibility and effectiveness of the proposed teaching quality evaluation system, empirical research is needed. By collecting and analyzing actual teaching data, it is possible to assess the effectiveness of the system in real educational settings. Such empirical research can help provide guidelines that can be applied to other educational plans to further improve the quality of education.

Based on the above four motives and the characteristics of project teaching evaluation, this paper introduces the comprehensive assignment method to calculate the weights of the indicators, combines the fuzzy comprehensive evaluation method, and proposes a fuzzy evaluation system of teaching quality based on comprehensive assignment.

## 2 Constructing a teaching evaluation index system

In order to cope with the new round of industrial revolution and scientific and technological changes, the Ministry of Education put forward the concept of new engineering discipline, which not only has certain significance of the times, but also has significant new features such as leading, intermingling, innovation, cross-border and development. Facing the new concept, new situation, new features and new challenges of the new engineering discipline, the traditional teaching quality evaluation methods can no longer meet the current needs of engineering education. For applied undergraduate colleges and universities, how to cultivate compound and high-level technical talents with international competitiveness to meet the needs of social development and how to build a teaching evaluation system in the context of the new engineering disciplines has become an urgent problem for applied undergraduate colleges and universities to solve[7].

Comprehensive assignment method is a comprehensive assignment method that combines subjective weights and objective weights. AHP constructs a hierarchical model and calculates the subjective weights, and the entropy weight method is used to calculate the objective weights, which to a certain extent avoids the subjectivity brought by AHP alone[8].AHP is to take the complex multi-objective decision-making problem as a system, decompose the objectives into different constituent factors, and then decompose them into a number of levels of multi-indicators in accordance with the correlation and affiliation between the factors, to form a structural model with multi-levels. Structural model. Experts can calculate the subjective weight of each factor at each level by constructing a judgement matrix for each factor at each level according to their experience[9]. The entropy weight method is based on the data itself and determines the objective weight of an indicator according to the degree of dispersion of the data of the indicator. Oriented by the reform of engineering education in new engineering disciplines, combining the new features of the construction of new engineering disciplines and the practical experience of teaching work, based on multi-party evaluation, multi-party feedback and diversified evaluation, introducing the AHP method to construct a hierarchical structure model, and calculating the comprehensive weight by the comprehensive assignment method, the designed teaching evaluation index system is divided into three layers, i.e., the target layer, the criterion layer, and the index layer. The target layer is teaching evaluation, which is the general goal of JAVA classroom teaching evaluation model; the criterion layer contains six items: B1 Teaching attitude, B2 Teaching content, B3 Teaching process, B4 Teaching methodology, B5 Teaching practice, B6 Teaching effect, etc.; and the indicator layer contains 24 items in total. The detailed content is shown in Table 1.

**Table 1.** Indicator system for teaching evaluation

| Target layer | Criterion layer | Index layer | Evaluation body |
|---|---|---|---|
| Evaluation of Teaching Java Programming A | B1 Teaching attitude | C11 Enthusiasm and motivation | Teaching management |
| | | C12 Respect and care | Teaching management |
| | | C13 Patient Answers | Teaching management |
| | | C14 Motivation and stimulation of interest | Teaching management |
| | B2 Teaching content | C21 Core concept coverage | Teaching management |
| | | C22 Example richness | Teaching management |
| | | C23 Up-to-date and practical | Teaching management |
| | | C24 Depth and breadth | Teaching management |
| | B3 Teaching process | C31 Classroom interaction | Student |
| | | C32 Content organisation | Student |
| | | C33 Classroom atmosphere | Student |
| | | C34 Innovative stimulation | Student |
| | B4 Teaching methodology | C41 Diversity and personalisation | Student |
| | | C42 Opportunities for practice | Student |
| | | C43 Case studies | Student |
| | | C44 Cooperative learning | Student |

| | | | |
|---|---|---|---|
| | B5 Teaching practice | C51 Actual projects | Industry |
| | | C52 Programming practice | Industry |
| | | C53 Problem solving | Industry |
| | | C54 Code review and feedback | Industry |
| | B6 Teaching effect | C61 Level of knowledge acquisition | Teacher |
| | | C62 Practical application skills | Teacher |
| | | C63 Learning motivation | Teacher |
| | | C64 Employment and development | Teacher |

# 3 Fuzzy evaluation system based on comprehensive empowerment

The fuzzy evaluation model based on comprehensive assignment considers subjective and objective situations comprehensively when calculating the weights, i.e. the AHP method is used to calculate the subjective weights, the entropy weight method is used to calculate the objective weights, and finally the comprehensive weight values are calculated by considering subjective and objective weights comprehensively, which not only takes into account the subjective experience of the experts, but also respects the objective facts of the data, and avoids the limitation of completely subjective judgement.

## 3.1 Comprehensive Empowerment Approach

AHP is used to calculate the subjective weights, firstly, to determine the target layer, factor layer and sub-factor layer, so as to construct the hierarchical structure model; according to the constructed hierarchical structure model, the judgement matrix of each layer is constructed by comparing the relative importance of the factors based on the 9-level labelling method. Next, the square root and eigenvector methods were used to calculate the weights of the factors in the corresponding factor layer from the judgement matrix. Since the construction of the judgement matrix is a two-by-two comparison made by experts based on their experience, it is difficult to achieve complete consistency in judgement when there are many elements, which may easily lead to estimation errors. Therefore, the constructed judgement matrix should be tested for consistency, and when the consistency test index CI meets the requirements, it is considered to meet the consistency test[10]. Finally, the combination weights, i.e. subjective weights $w_{js}$, are calculated according to the results of hierarchical single sorting. The calculation process of AHP is shown in Figure 1.

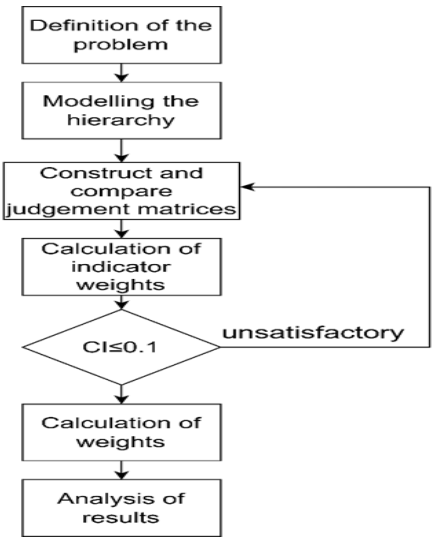



**Fig. 1.** Calculation process of the AHP

After calculating the subjective weight $w_{js}$, then use the entropy weight method to calculate the objective weight $w_{jo}$. entropy is a way to measure uncertainty, the larger the amount of information, the smaller the uncertainty, so the smaller the entropy; conversely, the larger the entropy, the larger the uncertainty. Entropy method to calculate the objective weights first need to forward the indicator value $x_{ij}$ processing, calculate the jth indicator in the ith evaluation project characteristic weight $p_{ij}$ for:

$$p_{ij} = \frac{x_{ij}}{\sum_{i=1}^{m} x_{ij}}, i = 1,2,\ldots,n$$

Then calculate the size of the information entropy value $e_j$ for the ith indicator as:

$$e_j = -\frac{k}{\sum_{i=1}^{m} p_{ij} \ln p_{ij}}$$

Where: the constant k can be taken as $k = \frac{1}{\ln m}$.

Normalization determines the evaluation indicator weights $w_{jo}$ as:

$$w_{jo} = \frac{1 - e_j}{\sum_{j=1}^{n} (1 - e_j)}$$

Finally, the combined assignment method is introduced to determine the combined weights, which is expressed as:

$$w_j = aw_{js} + bw_{jo}$$

Where: $w_j$ denotes the combination weight, $w_{js}$ denotes the subjective weight, $w_{jo}$ denotes the objective weight, and $a$ and $b$ denote the coefficients to be determined for the subjective and objective weights, respectively.

### 3.2 Fuzzy evaluation model

Let the object of teaching quality evaluation be $P$, its factor set $U = \{u_1, u_2, \cdots, u_m\}$, and the evaluation level set $V = \{v_1, v_2, \cdots, v_m\}$. Fuzzy judgement is made on each factor in $U$ according to the grade index in the evaluation set[11], and the judgement matrix $R$ can be obtained:

$$R = \begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1m} \\ r_{21} & r_{22} & \cdots & r_{2m} \\ r_{n1} & r_{n2} & \cdots & r_{nm} \end{bmatrix}$$

Where $r_{ij}$ is the affiliation degree of $u_i$ about $v_j$, and $(U, V, R)$ is the fuzzy comprehensive judgement model of teaching quality evaluation. Combined with the weights of each index calculated by comprehensive assignment, the fuzzy evaluation matrix B can be obtained as:

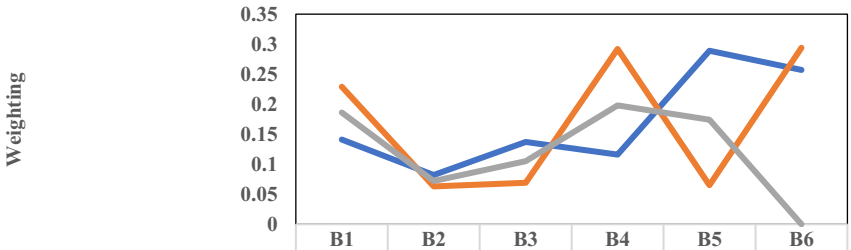
$$\bar{B} = W_J^T \times R = (W_1, W_2, \ldots, W_n) \times \begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1m} \\ r_{21} & r_{22} & \cdots & r_{2m} \\ r_{n1} & r_{n2} & \cdots & r_{nm} \end{bmatrix} = (\overline{b_1}, \overline{b_2}, \ldots, \overline{b_m})$$

After normalization, the evaluation result vector $B = \{b_1, b_2, \cdots, b_m\}$ can be obtained, and the teaching evaluation result can be finalised based on the principle of maximum affiliation.

## 4 Practical Application of Fuzzy Evaluation System Based on Comprehensive Empowerment

Taking the Java programming course in the author's school as an example, the students of computer science and technology majoring in the class of 2021 were selected as the research object, and in order to evaluate the teaching quality of the Java programming course, 76 teaching administrators, teachers, enterprise personnel and students were organized to carry out a practical application research on the fuzzy evaluation system based on the comprehensive empowerment. The teaching quality evaluation criteria used in this evaluation are divided into five grades, i.e. excellent, good, moderate, qualified and unqualified.

According to the scores of teaching managers, teachers, enterprises and students and the scoring results of experts, taking the coefficients to be determined, a and b, both of which are 0.5, we can get the subjective, objective and comprehensive weights of six dimensions, namely, attitude towards teaching, teaching content, teaching process, teaching methods, teaching practice and teaching effect[12], as shown in Fig. 2.




| | B1 | B2 | B3 | B4 | B5 | B6 |
|---|---|---|---|---|---|---|
| Subjective Weighting | 0.141 | 0.082 | 0.137 | 0.116 | 0.289 | 0.257 |
| Objective Weighting | 0.229 | 0.063 | 0.069 | 0.292 | 0.065 | 0.294 |
| Combined Weighting | 0.186 | 0.072 | 0.105 | 0.198 | 0.174 | 0 |

**Fig. 2.** Subjective, objective and composite weighting values at the guideline level

As can be seen from Fig. 2, there is a large difference between the subjective and objective weights of B4 and B5, with a difference of about 3 to 4 times. If subjective or objective weights are used separately for evaluation, both may cause the evaluation results to be inconsistent with the actual situation. Therefore, the comprehensive weighting method can reduce the subjectivity of human judgement to a certain extent, and also take into account the intrinsic nature of the data itself, which can more truly reflect the weights of the impact indicators. Based on the results of comprehensive assignment, the evaluation results of each indicator in the guideline layer (B1, B2, B3, B4, B5, B6) are obtained as [0.000 0.000 0.282 0.599 0.119], [0.0000.132 0.208 0.405 0.256], [0.000 0.000 0.057 0.1780.765], [ 0.003 0.004 0.049 0.164 0.781], [0.000 0.0000.443 0.163 0.394], [0.000 0.156 0.333 0.511 0.000].

According to the evaluation results of the indicators of each guideline layer, it can be seen that the evaluation results of Java programming course in teaching practice in this academic year are medium, and there is still room for improvement. Combined with the calculated comprehensive weight value, the final teaching quality evaluation result of Java programming course can be obtained as [0.001 0.052 0.248 0.357 0.343]. Based on the principle of maximum affiliation, it can be determined that the teaching quality evaluation result of Java programming course in 2022 is good.

If subjective and objective weights are used separately for calculation, the evaluation results of teaching quality can be obtained as [0.000 0.0500.276 0.336 0.339] and [0.001 0.054 0.221 0.378 0.347], and according to the principle of maximum affiliation, the evaluation results can be obtained as excellent and good, respectively. It can be seen that the calculation based on subjective weights has a high final evaluation result. The calculation results based on objective weights are consistent with the results of comprehensive weighting and more in line with reality.

## 5 Conclusion

The teaching quality evaluation system based on comprehensive empowerment in the context of new engineering disciplines can comprehensively consider the subjective and objective weights of each evaluation index, adopt hierarchical analysis model to

decompose the teaching quality evaluation problem into two levels, i.e., criterion level and index level, and introduce fuzzy mathematics method to construct the teaching quality evaluation system based on comprehensive empowerment. Aiming at the cultivation needs of high-quality, cross-composite outstanding scientific and technological talents in applied undergraduate colleges under the background of new engineering disciplines, the proposed evaluation system takes into account the assessment of cross-curricular integration and innovation ability aspects at the same time, and has good operability and credibility, which provides a feasible solution for the evaluation and improvement of the teaching quality under the background of new engineering disciplines.

## References

1. Zhong D (2017) Connotation and Action of New Engineering Construction. Research on Higher Engineering Education (03),1-6.
2. Zhong D (2017). Connotation and Action of New Engineering Construction. Research on Higher Engineering Education (03),1-6.
3. Zhang H, Ren Y (2009) Countermeasures to Optimise Teachers' Evaluation of Teaching Quality. Party building and ideological education in schools (36),56-57.
4. Lin J (2017) Building new engineering disciplines to lead the reform of higher education. China Higher Education (Z2),40-43.
5. Jaichandran, R., Krishna, S. H., Madhavi, G. M., Mohammed, S., Raj, K. B., & Manoharan, G. (2023, January). Fuzzy Evaluation Method on the Financing Efficiency of Small and Medium-Sized Enterprises. In 2023 International Conference on Artificial Intelligence and Knowledge Discovery in Concurrent Engineering (ICECONF) (pp. 1-7). IEEE.
6. Govender, P., & Sivakumar, V. (2020). Application of k-means and hierarchical clustering techniques for analysis of air pollution: A review (1980–2019). Atmospheric pollution research, 11(1), 40-56.
7. Zhang X (2019) Constructing a Classroom Teaching Evaluation System for Local Colleges and Universities. China Higher Education (19),43-45.
8. Zhou X, Yu X (2011) Constructing Practice Teaching Quality Evaluation Model Based on Hierarchical Analysis Approach. Journal of Inner Mongolia Agricultural University (Social Science Edition) (04),163-165.
9. Zhang L, Han Y, Zhang H (2022) Constructing the evaluation system of classroom teaching quality in colleges and universities by focusing on "assessment of learning". University education (03),237-240.
10. Bai J, Qu R, Li H (2019) Evaluation of the Effectiveness of Practical Teaching in New Engineering Based on Fuzzy Hierarchical Analysis Method. Journal of Higher Education (21),6-9.
11. Nie, H. (2020, August). Fuzzy Evaluation Model of the Teaching Quality in Colleges and Universities Based on Analytic Hierarchy Process. In Basic & Clinical Pharmacology & Toxicology (Vol. 127, pp. 189-189). 111 RIVER ST, HOBOKEN 07030-5774, NJ USA: WILEY.
12. Yu Z (2022) Research and Practice of Project Curriculum Evaluation. Automotive maintenance and repair (12),17-21.