Evaluation mechanism research based on the scientific research innovation ability for the College science and engineering students

ZHANG Xiao-bo[1, a]，JIN Li[2,b]，HU Wen-bin[3,c]
[123] School of Science,Zhejiang Sci-Tech University,Xia sha 928 2nd road , HangzhouZhejiang Province, China
[a]zzxiaobo@sina.com, [b]565427681@qq.com, [c]hwb0202@zstu.edu.cn

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Abstract. According to the characteristic of the undergraduate students in university, Using questionnaire survey method to analyze the results, the scientific research innovation ability evaluation criterion system is constructing by the AHP method ，then calculating the weight of each indictor, on this basis through the instance we achieve the fuzzy comprehensive evaluation on it . The method will provide a scientific basis for the cultivation of the innovative ability of undergraduate students, based on the weak link of the innovation ability training some reasonable suggestions and corresponding measures are put forward .

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Introduction

The ability of scientific research and innovation of undergraduate students is the combination of the innovative spirit and the practical ability, which epitomizes the overall quality of undergraduate students[1].The undergraduates are required to possess not only a solid theoretical knowledge, but also innovation and creativity. Concentration on developing the capability of scientific research and innovation of undergraduate students has become one of the most important parts for strengthening the quality education and deepening education reform[2-3]**.**

This article established the fuzzy comprehensive evaluation of the scientific research innovative ability, which used a questionnaire method focusing on the research innovation ability of part of the undergraduate students in Zhejiang Sci-Tech University majored in science and engineering, an AHP(Analytic Hierarchy Process) method focusing on the structural model of the research innovation ability of undergraduates, calculating the weight of each indicator and an instance of a certain undergraduates majoring in applied physics.

1. Design of hierarchical structure of the evaluation

AHP method is a hierarchical weight analysis method, which was raised by American operational research expertise, Professor T. L. Saaty from University of Pittsburgh, in 1970s[4]. The method, which combines quantitative analysis and qualitative analysis, resolves complicated problems into several levels of factors and combines them according to their correlative influence and member ship function, analyzing at simpler levels.

This article introduces the research using part of third-year undergraduate students of Zhejiang Sci-Tech University majoring in science and engineering as research objects, defining the hierarchical structure of the evaluation of scientific research and innovative ability. It is resolved into four levels, second of which includes six principle factors. They are shown in Figure 1, which are: innovation education platform, innovation activity participation, scientific innovation achievement, academic innovation awards, innovation program establishment and innovation education profit.

Members of the evaluation committee: 331 undergraduate students of Zhejiang Sci-Tech University (majored in mechatronic engineering, packaging, measure and control, electronic and information technology, textiles, computer science, light chemical engineering, digital media technology, information and computation science, applied physics, etc.). In the survey, a total of 331 questionnaires were sent out, 306 valid questionnaires were recovered.

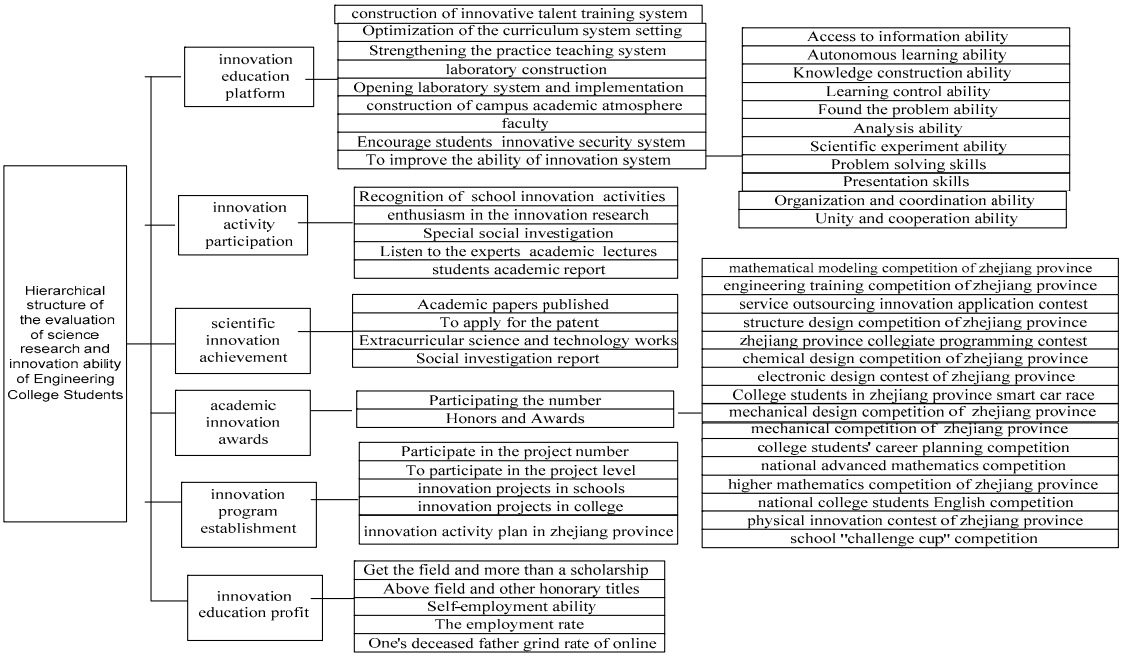

Fig.1 Hierarchical structure of the evaluation of science research and innovation ability of Engineering College Students

2. Design of the weight of the evaluation system

There are three steps in building the hierarchical structure of the evaluation of the scientific research and innovation capacity of undergraduate students majored in science and engineering:

a. Resolve and combine the problems, and build up hierarchical structure, according to the one-to-nine measurement raised by Saaty. Firstly, order the levels by single factors and check for consistency, calculating corresponding ordering vector.

b. Apply expert evaluation method. For the six principle factors in the second level, such as innovation education platform, innovation activity participation, scientific innovation achievement, academic innovation awards, innovation program establishment and innovation education profit, compare pairwise in certain weights and build up the matrix of the comparison, calculating corresponding weight and checking for the compatibility. The six primary index of judgement matrix and the calculation results are shown in Table 1, and the corresponding program calculation results are shown in Figure 2.

c.Expand the result and make the average of the result from the students the evidence to establish the evaluation matrix with reasonable estimation. Calculate each matrix of levels and normalize the feature vectors, finally expand until the bottom level. The steps above leads to the coincident indicator that concluded from the whole structure. The data to calculate the weight vector can be guidance for experts to estimate the indicator reasonably, which help calculate the data of fuzzy comprehensive evaluation.

Corresponding layer 2,weight as follows：W （0.376, 0.242, 0.185, 0.106, 0.059, 0.032）.

Corresponding layer 3,weight as follows：W_1（0.091, 0.091, 0.156, 0.156, 0.078, 0.078, 0.078, 0.156, 0.115）, W_2（0.222, 0.111, 0.222, 0.222, 0.222）, W_3（0.25, 0.25,0.25,0.25）, W_4（0.50, 0.50）, W_5（0.20, 0.20, 0.20, 0.20, ,0.20）,W_6（0.222, 0.111, 0.222, 0.222, ,0.222）.

Corresponding layer 4, weight as follows：W_{19}（0.251, 0.088, 0.045, 0.088, 0.045, 0.088, 0.045, 0.088, 0.088, 0.088, 0.088）, W_{42}（0.0625, 0.0625, 0.0625, 0.0625, 0.0625, 0.0625, 0.0625, 0.0625, 0.0625, 0.0625, 0.0625, 0.0625, 0.0625, 0.0625, 0.0625, 0.0625）.

Table1 Judgment matrix A → B

A	B_1	B_2	B_3	B_4	B_5	B_6	Weight vector W
B_1	1	2	3	4	5	7	0.376
B_2	1/2	1	2	3	4	5	0.242
B_3	1/3	1/2	1	3	4	6	0.185
B_4	1/4	1/3	1/3	1	3	5	0.106
B_5	1/5	1/4	1/5	1/3	1	3	0.059
B_6	1/7	1/5	1/6	1/5	1/3	1	0.032

Fig.2 the calculated results graph matrix index

3. Fuzzy comprehensive evaluation of the scientific research and innovation capability

According to the structure built up in Figure 1, we adopt weighted average model of fuzzy mathematics to evaluate[5]. Formulation is known as:

$$\widetilde{B} = \sum_{i=1}^{n} \widetilde{W}_i \widetilde{R}_i \tag{1}$$

$\widetilde{B}$ —innovation ability evaluation score, n — the number of factors

$\widetilde{W}_i$ —Various factors affecting the normalized weights

$\widetilde{R}_i$ —the consequences of fuzzy evaluation values, shown in table 2.

Table2 The student status evaluation hierarchy evaluation

State class	$\widetilde{R}_1$ （Optimal）	$\widetilde{R}_2$ (Good)	$\widetilde{R}_3$ (General)	$\widetilde{R}_4$ (Poor)	$\widetilde{R}_5$ (Very poor)
score	0.9	0.8	0.7	0.6	0.5

Use the comments for reference, the evaluation of the scientific research and innovation ability of undergraduate students can be made. By scoring the indicator in Figure 1, different evaluation matrix was got. The calculation is bottom-up level by level and end up with the final score. Take the example of a certain student who is in his third year and majored in applied physics to emphasize the thought, he has won an award in Challenge Cup 13th the Students' Extracurricular Scientific and Technological Works Competition of zhejiang province and established paper as first author in SCI journal articles with scientific research interest, strong ability of problem solution and handling and doing excellent in practical activity.

Following five experts score results calculation for innovation education platform, first we calculate the underlying factors:

U_{19} The role of innovation education system to improve the ability to:

Evaluation results ： $B_{19} = W_{19} \circ R_{19} = [0.8267, 0.8016, 0.7720, 0.8445, 0.7795]$,

Weight： $W_{19} = (0.251, 0.088, 0.045, 0.088, 0.045, 0.088, 0.045, 0.088, 0.088, 0.088, 0.088)$,

$$R_{19} = \begin{bmatrix} 0.9 & 0.8 & 0.7 & 0.9 & 0.9 \\ 0.8 & 0.8 & 0.7 & 0.9 & 0.8 \\ 0.7 & 0.7 & 0.7 & 0.9 & 0.8 \\ 0.8 & 0.8 & 0.9 & 0.9 & 0.8 \\ 0.9 & 0.9 & 0.8 & 0.9 & 0.9 \\ 0.9 & 0.8 & 0.7 & 0.8 & 0.7 \\ 0.8 & 0.8 & 0.8 & 0.8 & 0.7 \\ 0.7 & 0.7 & 0.8 & 0.8 & 0.7 \\ 0.9 & 0.9 & 0.9 & 0.7 & 0.8 \\ 0.8 & 0.8 & 0.8 & 0.9 & 0.8 \\ 0.7 & 0.8 & 0.8 & 0.7 & 0.8 \end{bmatrix}$$

The above results in the upper matrix, B_1 innovation education platform，

Weight：$W_1 = (0.091,0.091,0.156,0.156,0.078,0.078,0.078,0.156,0.115)$，

$$R_1 = \begin{bmatrix} 0.9 & 0.8 & 0.7 & 0.9 & 0.8 \\ 0.9 & 0.8 & 0.7 & 0.9 & 0.8 \\ 0.8 & 0.9 & 0.7 & 0.9 & 0.8 \\ 0.8 & 0.8 & 0.7 & 0.9 & 0.8 \\ 0.9 & 0.9 & 0.8 & 0.8 & 0.8 \\ 0.8 & 0.7 & 0.9 & 0.9 & 0.8 \\ 0.9 & 0.8 & 0.8 & 0.8 & 0.8 \\ 0.8 & 0.7 & 0.7 & 0.9 & 0.8 \\ 0.8267 & 0.8016 & 0.7720 & 0.8445 & 0.7795 \end{bmatrix}$$

Evaluation results ： $B_1 = W_1 \circ R_1 = [0.8361,0.7994,0.7388,0.8771,0.7978]$

the average score of the five experts is 0.8096, which is the total score of the students in innovative education platform.

innovation activity participation ：

$B_2 = W_2 \circ R_2 = [0.222,0.111,0.222,0.222,0.222] \circ [0.8,0.9,0.9,0.9,0.9]^T = 0.8769$

scientific innovation achievement：

$B_3 = W_3 \circ R_3 = [0.25,0.25,0.25,0.25] \circ [0.9,0.9,0.9,0.9,0.9]^T = 0.900$

academic innovation awards：

$B_4 = W_4 \circ R_4 = [0.50,0.50] \circ [0.90,0.98125]^T = 0.9406$

innovation program establishment：

$B_5 = W_5 \circ R_5 = [0.20,0.20,0.20,0.20,0.20] \circ [0.9,0.8,0.9,0.9,0.9]^T = 0.88$

innovation education profit：

$B_6 = W_6 \circ R_6 = [0.222,0.111,0.222,0.222,0.222] \circ [0.8,0.8,0.8,0.7,0.9]^T = 0.8769$

The evaluation results ： $B = W \circ R$

$= [0.376,0.242,0.185,0.106,0.059,0.032] \circ [0.8096,0.8769,0.90,0.9406,0.88,0.8769]^T = 0.8660$

Finally, the result of the student of his scientific research and innovation evaluation is score 0.8660, which does not fit the pre-expectation. However, his grade is looked forward to improving, which is the weakness of the academic experience.

Calculation based on the fuzzy comprehensive evaluation can be applied to calculate the students' scientific research and innovation ability in different majors. What's more, the calculation done in MATLAB and Visual Basic program, with the various arrangement in different program module, should be specified.

Summary

The reasonable assessment of the undergraduate students scientific research innovation ability is a very important work, from the result of evaluation we can understand the actual level of the scientific research ability of undergraduates, thus to put forward some reasonable training way to provide a theoretical reference and training mode.

According to the evaluation results, the reasonable training mode of cultivation of innovative ability of college students and scientific research and a number of ways, can actively and effectively carry out of College Students' scientific research innovation, improving training for college students' innovative spirit and practical ability, to train high-quality talents of social need.

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