Innovation and Practical Ability Evaluation for College Student under Multi-subject Integration Background

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Abstract. Multi-subject integration has become a common phenomenon in university talent training. According to the characteristics of innovation and practical ability of different talent output types such as research type, industrial application type and management type, the indicator system of innovation and practical ability evaluation is established based on activities and achievements, then the evaluation method is designed based on the fuzzy mathematics theory. A case study of college student majoring in mechanical engineering is given to illustrate the feasibility of the proposed method which can provide the guidance basis for the university talent training under multi-subject integration background.

Introduction

Multi-subject integration is helpful to improve the innovation and practical ability of college students [1-5]. However, the innovation and practical ability of college students in the university talent training process has the characteristics of complexity and fuzziness. By the existing qualitative methods, it cannot be evaluated objectively and appropriately [6]. Therefore, it is meaningful to establish an evaluation indicator system of innovation and practical ability of college students under multi-subject integration background and design the specific evaluation method.

Classification of Innovative Talents of Multi-Subject College Students

After summarizing the output situation of the current university talents training in China [3-6], we divide the multi-subject integration college students into 3 types: research type, industry application type and management type. The emphases of the innovation and practical ability, which different output types of multi-subject integration college students need to have, are absolutely different. It includes the following types: the innovation and practical ability of research type, the innovation and practical ability of industrial application type, and the innovation and practical ability of management type.

Evaluation Indicator System

According to the above different construction factors of innovation ability evaluation indicator system, this research, which is mainly based on the evaluation factors characterized by the concrete results of learning ability, preliminary discusses and constructs the evaluation indicator system of the innovation and practical ability of multi-subject integration college student as shown in Figure 1.

Evaluation Method

Based on the aforementioned analysis of the innovation and practical ability of multi-subject integration college student and the construction of the evaluation indicator system, the evaluation
Figure 1. Evaluation indicator system of the innovation and practical ability of multi-subject integration college student.

Modeling of the Characterization of Innovative Activities And Achievement

For the characterization of innovative activities and achievement, the specific assessment models include two kinds: one is the accurate assessment value using the common centesimal system; the other is multi-grade fuzzy assessment such as five-grade fuzzy assessment \{'excellent', 'good', 'general', 'bad', 'poor'} or seven-grade fuzzy assessment value \{'best', 'better', 'good', 'middle', 'bad', 'worse', 'worst'}.

(1) The characterization with the accurate assessment value \((I_1, I_2)\)

Here, the accurate assessment value of the accurate characterization \(I_k\) \((I_1, I_2)\) is:

\[V(I_k)=S(I_k)/100\]  
(1)

where \(S(I_k)\) is the score using centesimal system. Foreign language and computer level can be converted into the original centesimal score according to the corresponding calculation way.

(2) The characterization with the fuzzy assessment value \((I_3, \ldots, I_9)\)

We use five-grade fuzzy assessment \{'excellent', 'good', 'general', 'bad', 'poor'} in this paper. The assessment comment set is \(AC=\{ac_1, ac_2, ac_3, ac_4, ac_5\}\) where \(ac_1='excellent', ac_2='good', ac_3='general', ac_4='bad', ac_5='poor'\). The assessment comment set of the fuzzy characterization \(I_k\) \((I_3, \ldots, I_9)\) is:

\[AC(Ih)=\{ac_1(Ih), ac_2(Ih), \ldots, ac_5(Ih)\}\]  
(2)

where \(ac_i(Ih)\in AC\) is the assessment comment made by the expert \(i (i=1, 2, \ldots, n)\).

For the fuzzy characterization \(I_k\), the membership degree set of the five assessment comment grades is:

\[MD(Ih)=\{md(Ih, ac_1), md(Ih, ac_2), \ldots, md(Ih, ac_5)\}\]  
(3)

where \(md(Ih, ac_j)\) is the membership degree of the characterization \(I_k\) to the fuzzy assessment grade \(ac_j\) \((j=1, 2, \ldots, 5)\). The specific calculation way of membership degree can be determined according to certain algorithms and experiences in practical application.
Here, we adopt the common calculation method as follows:

\[ \text{md}(I_h, acj) = \frac{N(I_h, acj)}{n} \] \quad (4)

where \( N(I_h, acj) \) is the number of assessment experts who choose the assessment comment grade \( ac_j \) on the characterization \( I_h \).

The grade value set of five-grade fuzzy assessment \( AC=\{ac_1, ac_2, ac_3, ac_4, ac_5\} \) is \( GV=\{0.9, 0.7, 0.5, 0.3, 0.1\} \), so the comprehensive assessment value of the fuzzy characterization \( I_h \) is:

\[ V(I_h) = \sum_{j=1}^{5} \text{md}(I_h, ac_j) \cdot \text{gv}(ac_j) \] \quad (5)

where \( \text{gv}(ac_j) \in \{0.9, 0.7, 0.5, 0.3, 0.1\} \) is the grade value of the fuzzy assessment comment \( ac_j \).

Modeling of the Rule and Indicator of Innovation and Practical Ability

As shown in Figure 1, the indicators of the rule \( C_p \) (\( p=1,2,3 \)) are \( C_{pq} \) (if \( p=1, q=1,2,3,4; \) if \( p=2 \) or \( p=3, q=1,2,3,4,5 \)), and the indicator \( C_{pq} \) has \( N_{ch_{pq}} \) \( (N_{ch_{pq}} \leq 9) \) characterizations which can be determined by the evaluation indicator system shown in Figure 1. It is assumed that the weight of the characterization \( I_r \) (\( r=1,2,...,N_{ch_{pq}} \)) to the indicator \( C_{pq} \) is \( w_{chin_{r,pq}} \). Then the comprehensive assessment value of the indicator \( C_{pq} \) is:

\[ V(C_{pq}) = \sum_{r=1}^{9} w_{chin_{r,pq}} \cdot V(I_r) \] \quad (6)

where \( \sum_{r=1}^{9} w_{chin_{r,pq}} = 1 \).

Similarly, it is assumed that the weight of the indicator \( C_{pq} \) to the rule \( C_p \) is \( w_{inr_{pq,q}} \). Then the comprehensive assessment value of the rule \( C_p \) is:

\[ V(C_p) = \sum_{q=1}^{N_{in_p}} w_{inr_{pq,q}} \cdot V(C_{pq}) \] \quad (7)

where \( N_{in_p} \) is the number of indicators which the rule \( C_p \) has. Here, \( \sum_{q=1}^{N_{in_p}} w_{inr_{pq,q}} = 1 \).

Evaluation of Innovation and Practical Ability

It is assumed that the weight of the rule \( C_p \) to the target \( C \) is \( w_{rt_{p}} \). Then the comprehensive assessment value of the target \( C \) is:

\[ V(C) = \sum_{p=1}^{3} w_{rt_{p}} \cdot V(C_p) \] \quad (8)

where \( \sum_{p=1}^{3} w_{rt_{p}} = 1 \).

Case Study

How to evaluate their innovation and practical ability has become a key problem in the university talent training. Due to space limitations, we only take the research type student majoring in mechanical engineering for example to illustrate the feasibility of the proposed method.

(1) The value of the characterization of innovative activities and achievement

If the scores of basic courses and practice training using centesimal system (\( I_1 \)) is 88.2 and the foreign language and computer level converted to centesimal system score (\( I_2 \)) is 92.3, the accurate assessment value are 0.882 and 0.923.
For the characterization with the fuzzy assessment value \((I_3, \ldots, I_9)\), ten assessment experts including the curriculum teachers, the supervisor or assistant-supervisor, the enterprise cooperation supervisor, the educational administration management personnel, the cooperation student are selected. The specific assessment result using five-grade fuzzy assessment is shown in Table 1.

Table 1. Assessment result using five-grade fuzzy assessment.

<table>
<thead>
<tr>
<th>Characterizations</th>
<th>(a_{c1})</th>
<th>(a_{c2})</th>
<th>(a_{c3})</th>
<th>(a_{c4})</th>
<th>(a_{c5})</th>
</tr>
</thead>
<tbody>
<tr>
<td>(I_1)</td>
<td>7</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>(I_2)</td>
<td>8</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>(I_3)</td>
<td>0</td>
<td>9</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>(I_4)</td>
<td>2</td>
<td>6</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>(I_5)</td>
<td>4</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>(I_6)</td>
<td>1</td>
<td>7</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>(I_7)</td>
<td>3</td>
<td>6</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Therefore, the membership degree matrix is:

\[
MD = \begin{bmatrix}
0.7 & 0.3 & 0 & 0 & 0 \\
0.8 & 0.1 & 0.1 & 0 & 0 \\
0 & 0.9 & 0.1 & 0 & 0 \\
0.2 & 0.6 & 0.2 & 0 & 0 \\
0.4 & 0.4 & 0.1 & 0.1 & 0 \\
0.1 & 0.7 & 0.2 & 0 & 0 \\
0.3 & 0.6 & 0.1 & 0 & 0
\end{bmatrix}
\]

According to Formula (5), the comprehensive assessment values of the fuzzy characterization \(I_3, \ldots, I_9\) are 0.84, 0.84, 0.68, 0.70, 0.72, 0.68, 0.80.

(2) The weight enactment

In the whole evaluation process, the weight enactment has three levels: the weight of the characterization layer to the indicator layer, the weight of the indicator layer to the rule layer and the weight of the rule layer to the target layer.

Based on the characteristics of the university talent training under multi-subject integration background, we set the weight of the above three levels according to Figure 2, Table 2 and Table 3.

Table 2. The weight of the characterization layer to the indicator layer \((C_{11} \text{ to } C_{23})\).

<table>
<thead>
<tr>
<th>Characterizations</th>
<th>(C_{11})</th>
<th>(C_{12})</th>
<th>(C_{13})</th>
<th>(C_{14})</th>
<th>(C_{21})</th>
<th>(C_{22})</th>
<th>(C_{23})</th>
</tr>
</thead>
<tbody>
<tr>
<td>(I_1)</td>
<td>0.8</td>
<td>0.6</td>
<td>0</td>
<td>0</td>
<td>0.2</td>
<td>0.3</td>
<td>0</td>
</tr>
<tr>
<td>(I_2)</td>
<td>0</td>
<td>0</td>
<td>0.3</td>
<td>0</td>
<td>0.2</td>
<td>0.3</td>
<td>0</td>
</tr>
<tr>
<td>(I_3)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.3</td>
<td>0.4</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>(I_4)</td>
<td>0</td>
<td>0.7</td>
<td>0.3</td>
<td>0</td>
<td>0.6</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>(I_5)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>(I_6)</td>
<td>0.2</td>
<td>0.4</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.5</td>
</tr>
<tr>
<td>(I_7)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.4</td>
<td>0.5</td>
</tr>
<tr>
<td>(I_8)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>(I_9)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Table 3. Assessment result using five-grade fuzzy assessment.

<table>
<thead>
<tr>
<th>Characterizations</th>
<th>(C_{24})</th>
<th>(C_{25})</th>
<th>(C_{26})</th>
<th>(C_{27})</th>
<th>(C_{28})</th>
<th>(C_{29})</th>
<th>(C_{30})</th>
</tr>
</thead>
<tbody>
<tr>
<td>(I_1)</td>
<td>0</td>
<td>0</td>
<td>0.2</td>
<td>0</td>
<td>0</td>
<td>0.2</td>
<td>0.2</td>
</tr>
<tr>
<td>(I_2)</td>
<td>0.6</td>
<td>0</td>
<td>0.3</td>
<td>0</td>
<td>0</td>
<td>0.2</td>
<td>0.2</td>
</tr>
<tr>
<td>(I_3)</td>
<td>0</td>
<td>0</td>
<td>0.3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.3</td>
</tr>
<tr>
<td>(I_4)</td>
<td>0</td>
<td>0</td>
<td>0.2</td>
<td>0.3</td>
<td>0.7</td>
<td>0.2</td>
<td>0.3</td>
</tr>
<tr>
<td>(I_5)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.2</td>
<td>0</td>
<td>0</td>
<td>0.2</td>
</tr>
<tr>
<td>(I_6)</td>
<td>0</td>
<td>0.3</td>
<td>0</td>
<td>0.2</td>
<td>0.3</td>
<td>0.2</td>
<td>0</td>
</tr>
<tr>
<td>(I_7)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>(I_8)</td>
<td>0</td>
<td>0.2</td>
<td>0</td>
<td>0.1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>(I_9)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
According to the weight values shown in Table II, Table III and Formula (6), the comprehensive assessment values of the indicators $C_{11}, C_{12}, C_{13}, C_{14}$ are 0.8464, 0.8098, 0.8643, 0.8648; the comprehensive assessment values of the indicators $C_{21}, C_{22}, C_{23}, C_{24}, C_{25}$ are 0.8772, 0.7920, 0.7100, 0.8726, 0.7220; the comprehensive assessment values of the indicators $C_{31}, C_{32}, C_{33}, C_{34}, C_{35}$ are 0.8729, 0.7400, 0.8040, 0.8128, 0.8488. Then, according to the weight values shown in Figure 2 and Formula (7), the comprehensive assessment values of the rules $C_1, C_2, C_3$ are 0.8355, 0.8018, 0.8039. Lastly, according to the weight values shown in Figure 2 and Formula (8), the comprehensive assessment value of the target $C$ is 0.8128. So the innovation and practical ability of this student belongs to a good level which should be maintained and carried out some corresponding improving measures.

Conclusions

The key to the university talent training under multi-subject integration background lies in the evaluation and improvement of the innovation and practical ability of college students. The indicator system and method for innovation and practical ability evaluation proposed in this paper, which can get a more objective and reasonable evaluation result, has the characteristics of intuitive result, simple calculating. So it has a strong operability. At the same time, the proposed method also has a certain commonality. The assessment function based on the proposed method can be more easily implemented in the general student information management system.

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References


