Research on the Leadership Prediction Model and Error Evaluation of Engineering Undergraduates

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ABSTRACT

The basic task of higher education is to cultivate talents, to strengthen undergraduate leadership education is an important way to achieve this task, especially in the field of engineering. Through the analysis of the components and influencing factors of college students' leadership, based on five variables of social participation, family function, personal temperament, organizational factors and professional knowledge, a multiple linear regression model and the method of evaluating the error of the prediction results is proposed. The questionnaire of the factors influencing the leadership constitution of engineering undergraduates and its influencing factors were designed, the practical application of the proposed method is realized by an engineering College of the local comprehensive university as an example.

INTRODUCTION

With the deepening of economic globalization and increasingly complex organizational management system, the comprehensive quality of personnel requirements are getting higher and higher. Facing the complicated and changeable social environment, the leadership is regarded as a quality which the current enterprises and institutions pay much attention to in the higher education. Some studies have shown that more than 600 colleges and universities in the United States have carried out the education of undergraduate leadership in varying degrees [1]. At present, foreign-related research focused on the need for leadership education [2-3], leadership availability [4], design of education curriculum [5], teaching methods [6] and other issues. Although these studies have a certain reference value, but conditions and education system of china had big difference with other countries, it is necessary to study and explore the training method of undergraduate leadership under China's national conditions. Xu et al. (2004) [7] and Li et al. (2010) [8] have conducted empirical research on the leadership education of college students in China and put forward their own problems on the cultivation of university leadership, but their research lacks quantification of the actual level of leadership and different types of undergraduate leadership differentiation. These studies should follow national
conditions and the background of China's colleges in China. Through constructed composition model, influencing factors and prediction analysis of university students in China Leadership, these studies could have a profound understanding of the status of university students’ leadership. Through an empirical study conducted in a local general and engineering college, this paper is characterized by not only improving the composition of the undergraduate leadership on the basis of predecessors, but also analyzing the corresponding influencing factors, and building on this basis The prediction model of student leadership in our country and the corresponding evaluation method of prediction error, so as to achieve the objective quantification of the actual level of leadership.

COMPOSITION AND INFLUENCING FACTORS OF UNDERGRADUATES' LEADERSHIP

Leadership refers to the ability to work with others and achieve the desired goals with minimal cost and maximum efficiency through the work of others [9]. From this level, as long as the leadership activities to play a leadership, there are strengths and weaknesses of leadership. The undergraduate objectives of the university mainly focus on the function of university education, including the goal of curriculum study, the goal of scientific research, the goal of student community and the social affairs. Therefore, the undergraduate students in the existing professional knowledge and related skills, its leadership and leadership to enhance their mental state, character improvement, interpersonal communication, communication and coordination have a great help. It is the prerequisite and basis for predicting the leadership of the undergraduates by means of analyzing the constituent elements of university undergraduates' leadership.

Elements of Undergraduate Leadership

Domestic and foreign scholars focused on student cadres in the leadership of undergraduate research, but pay less attention on the entire undergraduate research groups. As the undergraduate group mainly focuses on the function of university education and the decision-making affairs are relatively weakened. From the aspect of the interaction and coordination of the group and taking into account the career planning of the whole undergraduate group, this paper divided the undergraduate leadership of the elements of communication into elements of coordination, cooperation and win-win capabilities, information processing capabilities and the ability to perform tasks in four areas.

COMMUNICATION AND COORDINATION ABILITY

The ability to effectively deal with relationship between the students, teachers, friends and members of organizations in daily life are the reflection of undergraduate students’ communication and coordination ability. In the daily study and life, students' communication and coordination ability is particularly important, good coordination, effective communication will make college students early in learning, opening up the situation, obtaining a relaxed development space, and getting a high sense of accomplishment in their daily lives. On the other hand, students with lower communication ability often feel depressed and even get difficultly in study life. During the university life, each person more or less will encounter some communication problems, communication and coordination capacity of the size of the undergraduate
college students reflect the ability to effectively deal with an important indicator of the problem.

COOPERATION AND WIN-WIN CAPABILITY

Cooperation and win-win capability refers to the university students in team cooperation in the sense of cooperation, cooperation and the ability to accommodate the size of different views, is the overall consciousness, spirit of cooperation and service of the concentrated expression. Teamwork is the only way for university undergraduates to pursue personal success. Effective teamwork can mobilize all the resources of team members, which can reduce discord and unfairness to a large extent, and maximize the team members' potential. Cooperation and win-win capability is an important indicator of the ability of university undergraduates to solve complex problems with others.

INFORMATION PROCESSING CAPABILITY

Undergraduates are faced with the exchange of information with the outside world at all times. Information processing is the process of extracting the information from the collected information and refining the valuable information from the table and in the process. Undergraduates with good information processing ability can effectively shield the wrong information, the formation of unique insights, to convey accurate thinking, to lead the right direction, and then complete the task efficiently. The size of the information processing ability is the undergraduate students can effectively receive and convey the accurate embodiment of the accurate information.

TASK EXECUTION CAPABILITY

Task execution capability is the ability to plan tasks, set goals, and schedule tasks in a planned time. Task execution ability is of great practical significance to the daily affairs and future career development of university undergraduates. Rich human and material resources require a task execution ability of people to dominate; not performing or improper executing the resource is a waste. Task execution capability is a measure of the size of a university undergraduate action.

Analysis of Influencing Factors of Undergraduate Leadership

At present, the domestic study shows that the main factors that affect the leadership of college students in the performance of social factors, family factors, personal disposition and organizational factors four levels [10]. The study is based on the undergraduate students as a whole object of study, and did not conduct the analysis of differences in subject classification. In order to compare the undergraduates of management disciplines, the process of undergraduates majoring in engineering is not involved in the compulsory course of leadership-related courses, and the lack of practical training, the background of professional knowledge of leadership is generally weak. Of the professional background of the leadership, the article introduces the expertise and the above four aspects for the merger of five for the Three Gorges University School of Electrical and New Energy undergraduate influence factors in the study.

The main way to enhance the leadership of university undergraduates is social
practice, which is the most direct way to enhance the communication ability of university undergraduates and show their own specialty. Social factors can be refined into four dimensions: information acquisition, participation in activities, expression of opinions and public affairs. The family factor is the important foundation environment which the undergraduate student studies the life, the family environment condition directly or indirectly affects the university undergraduate's growth. Family factors can be measured by family affection, family intimacy, family communication, family conflict. Personality is in the face of unexpected events when the characteristics shown, this trait can affect their own value, but also can affect the state of people around, and personal leadership has a certain relationship. And the personal characteristics of university undergraduates can be divided into two levels: personal characteristics and personal charm. Organizational factors and organizational culture can affect the enthusiasm of individuals to influence their ability to play, which also affects the level of students' leadership in a large extent. The professional knowledge of undergraduates in engineering major is to accumulate the knowledge of management science according to their interest in management.

**Relationship model of undergraduate leadership influential factors and constituent elements**

Based on the above analysis, the "influencing factors" and "constituent elements" of university undergraduates' leadership are taken as the research frame, that is, the influencing factors are regarded as independent variables and the constituent elements are taken as independent variables. That is to say, the model of individual leadership is quantitatively predicted according to the difference of individual leadership's influence factors. The relationship model is shown in Figure 1.

![Figure 1. Relationship model of undergraduates' leadership influencing factors and their constitution.](image)

**PREDICTIVE MODEL AND ERROR CALCULATION OF UNDERGRADUATE LEADERSHIP**

From the above analysis, it is found that undergraduates' leadership is mainly affected by social participation, family function, personal disposition, organizational factors and professional knowledge, according to the above five variables in Figure 1, using the multivariate random variable regression theory to establish the regression linear model of the variables to predict the actual leadership of undergraduates. Assuming that the undergraduate leadership as a dependent variable and five independent variables meet the linear regression prediction model:

\[ y_i = a_1x_{i1} + a_2x_{i2} + a_3x_{i3} + a_4x_{i4} + a_5x_{i5} \]  \hspace{1cm} (1)
Which \( Y_i \) refers to undergraduate leadership; \( X_{1i} \) refers to undergraduate social participation; \( X_{2i} \) refers to undergraduate family function; \( X_{3i} \) refers to undergraduate students' personal disposition; \( X_{4i} \) refers to undergraduate students of organizational factors measurement; \( X_{5i} \) refers to undergraduates of the degree of leadership; 
\[
(a_1, a_2, a_3, a_4, a_5)^T = (B^T B) (y_1, y_2, \cdots, y_n)^T
\]
Which, 
\[
B = \begin{bmatrix}
1 & x_{11} & x_{21} & x_{31} & x_{41} & x_{51} \\
1 & x_{12} & x_{22} & x_{32} & x_{42} & x_{52} \\
\vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\
1 & x_{1n} & x_{2n} & x_{3n} & x_{4n} & x_{5n}
\end{bmatrix}
\]
If the parameter variables \( Y_i, X_{1i}, X_{2i}, X_{3i}, X_{4i} \) and \( X_{5i} \) can minimize the sum of the quadratic sums of the deviations in the vertical direction for each sample point and the corresponding point on the regression line, that is to 
\[
Q = \sum_{i=1}^{n} [y_i - (a_1 x_{1i} + a_2 x_{2i} + a_3 x_{3i} + a_4 x_{4i} + a_5 x_{5i})]^2
\]
achieve the minimum, than calculate the formula (1) of the linear regression coefficient: \( a_j (j = 1, 2, 3, 4, 5) \)
\[
(a_1, a_2, a_3, a_4, a_5)^T = (B^T B) (y_1, y_2, \cdots, y_n)^T
\]
and, 
\[
B = \begin{bmatrix}
1 & x_{11} & x_{21} & x_{31} & x_{41} & x_{51} \\
1 & x_{12} & x_{22} & x_{32} & x_{42} & x_{52} \\
\vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\
1 & x_{1n} & x_{2n} & x_{3n} & x_{4n} & x_{5n}
\end{bmatrix}
\]
The linear regression equation is calculated and the fitting of the linear regression equation is finished. As the regression equation is obtained on the basis of the analysis of the sample data, whether it can objectively reflect the statistical relationship between variables and can be used for prediction, There are many methods to test the fitting effect of the multiple linear regression equation. There are many tests R-square and F-tests in common use. That is, the complex correlation coefficient is calculated:
\[
R = \sqrt{1 - \frac{Q}{l_{EE}}}
\]
\[
Q = \sum_{i=1}^{n} [y_i - (a_1 x_{1i} + a_2 x_{2i} + a_3 x_{3i} + a_4 x_{4i} + a_5 x_{5i})]^2
\]
\[
l_{yy} = \sum_{i=1}^{n} (y_i - \bar{y})^2
\]
and, 
\[
\frac{Q}{l_{yy}}
\] The relative error of multivariate linear fitting is expressed. Therefore, if the calculated value of R is close to 1, the error of multivariate linear fitting will be smaller and the effect will be better.
F test, also known as the significance test, is based on the test carried out, there are the following correspondence between them:
\[ f = \frac{R^2 / m}{(1-R^2) / (n-m-1)} \sim F(m, n-m-1) \quad (5) \]

Where: \( m \) refers to the number of independent variables; \( n \) refers the number of samples; if the known confidence, from the F distribution table to detect the critical value, if \( F \geq F_\alpha \), can be considered significant regression effect.

As the regression analysis is a linear regression based on statistical data to predict the results of the equation, there is a certain degree of uncertainty, that is to say the forecast results have a certain risk rate, the quantitative calculation of the risk of specific values undoubtedly predict the accuracy of the results of the judgments of great significance. Calculating the Probability of Undergraduates' Actual Leadership \( y_{\text{real}} < y \) as the risk rate corresponding to the predictive value \( y \) derived from the undergraduate leadership prediction model, the probability \( P_f \) that the actual leadership of the undergraduates is less than the predicted value \( y \) is:

\[ P_f (\infty < y_{\text{real}} < y) = \frac{1}{\sqrt{2\pi \sigma_y}} \int_{\infty}^{y} \exp\left[-\frac{1}{2} \left(\frac{y_{\text{real}} - y}{\sigma_y}\right)^2\right] dy \]

and:

\[ \sigma_y = \sqrt{\frac{\sum_{i=1}^{n} (y_i - \bar{y})^2}{n-1}} \quad (6) \]

APPLICATIONS

In order to obtain the data needed in the model, the questionnaires were used to investigate the undergraduates of the College of Electrical and New Energy of China Three Gorges University. The questionnaire included the undergraduates' leadership professional knowledge scale, Healthy Social Participation Scale, Undergraduates' Family Function Scale, Undergraduates' Personality Inventory, Undergraduate Students' Organizational Factors Scale, Undergraduate Leadership Structure Scale, etc. The undergraduate leadership professional knowledge scale includes 5 to the type of questions, mainly used to measure the students in the school during the elective management class related courses, read the management class books, studied the electrical related policy and whether participate in civil service examinations. The undergraduate social participation questionnaire contains 20 questions, which are used to examine the students' daily professional knowledge absorption, information acquisition, participation in activities, expression of opinions and public affairs participation. There are 19 question types in the undergraduates' family function scale, which are used to examine the family emotion, family intimacy, family communication and family conflict. Undergraduates' personal disposition scale includes 10 questions, mainly focus on the study of students' personal characteristics and personal charm. The Organizational Factors Scale of Undergraduates consists of 11 questions, focusing on the organizational climate and organizational culture. Undergraduates' Leadership Structure Scale mainly includes four aspects: information processing ability, task execution ability, cooperation ability and communication and coordination ability.

In order to improve the accuracy of the questionnaire, the questionnaire was collected from 5 students in each class, and the questionnaire was collected on the spot.
The total number of questionnaires was collected on the spot. Copies of invalid questionnaires were removed, a total of 26 valid questionnaires were obtained. The questions were divided into two types: positive and negative. All the subjects used the five-point scale. The subjects were based on "totally disagree", "somewhat disagree", "generally agree", "fully agree" and so on from 1 to 5 score, the reverse title is the opposite. According to the results of the survey, the total score of each student in terms of leadership and each influencing factor was calculated. The results are shown in Table 1.

TABLE 1. STATISTICS ON LEADERSHIP AND CORRESPONDING INFLUENCING FACTORS OF UNDERGRADUATES.

<table>
<thead>
<tr>
<th>ID</th>
<th>Social participation X1i</th>
<th>Family functions X2i</th>
<th>Personal disposition X3i</th>
<th>Organizational factors X4i</th>
<th>Professional knowledge X5i</th>
<th>Leadership Yi</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>55</td>
<td>94</td>
<td>44</td>
<td>50</td>
<td>9</td>
<td>60</td>
</tr>
<tr>
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<td>86</td>
<td>45</td>
<td>53</td>
<td>13</td>
<td>67</td>
</tr>
<tr>
<td>3</td>
<td>80</td>
<td>80</td>
<td>40</td>
<td>44</td>
<td>16</td>
<td>60</td>
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<tr>
<td>4</td>
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<td>88</td>
<td>47</td>
<td>51</td>
<td>12</td>
<td>69</td>
</tr>
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<td>65</td>
<td>85</td>
<td>45</td>
<td>49</td>
<td>10</td>
<td>67</td>
</tr>
<tr>
<td>6</td>
<td>73</td>
<td>84</td>
<td>41</td>
<td>52</td>
<td>9</td>
<td>65</td>
</tr>
<tr>
<td>7</td>
<td>55</td>
<td>54</td>
<td>31</td>
<td>35</td>
<td>11</td>
<td>47</td>
</tr>
<tr>
<td>8</td>
<td>81</td>
<td>89</td>
<td>47</td>
<td>51</td>
<td>12</td>
<td>70</td>
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<tr>
<td>9</td>
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<td>93</td>
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<tr>
<td>11</td>
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<td>52</td>
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<td>72</td>
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<td>87</td>
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<td>41</td>
<td>16</td>
<td>57</td>
</tr>
<tr>
<td>26</td>
<td>90</td>
<td>90</td>
<td>41</td>
<td>50</td>
<td>19</td>
<td>73</td>
</tr>
</tbody>
</table>

For this example, we use the undergraduate leadership prediction model built by Eqs. (1) to (6), and combine the data from the above table, and get the results as shown in Tables 2 to 4.

TABLE 2. REGRESSION ANALYSIS.

<table>
<thead>
<tr>
<th>R</th>
<th>R2</th>
<th>Adj-R2</th>
<th>Std.Err</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.912</td>
<td>0.832</td>
<td>0.790</td>
</tr>
</tbody>
</table>

Table 2 shows that the correlation coefficient of undergraduates' leadership and each influencing factor is 0.912, which is close to 1, which shows that the regression coefficient is better.
TABLE 3. ANOVA.

<table>
<thead>
<tr>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>1090</td>
<td>5</td>
<td>218</td>
<td>19.765</td>
</tr>
<tr>
<td>Residual</td>
<td>221</td>
<td>20</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>1310</td>
<td>25</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

In the above table, the P statistic of this example is 0.0000004, which is far less than the significance level of 0.05, so the regression equation obtained is significant.

TABLE 4. REGRESSION COEFFICIENT OF MULTIPLE REGRESSION EQUATION.

<table>
<thead>
<tr>
<th>Model</th>
<th>Coef</th>
<th>SE</th>
<th>T</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>-1.892</td>
<td>7.508</td>
<td>-0.252</td>
<td>0.804</td>
</tr>
<tr>
<td>VAR00001</td>
<td>0.094</td>
<td>0.265</td>
<td>0.647</td>
<td>0.525</td>
</tr>
<tr>
<td>VAR00002</td>
<td>0.078</td>
<td>0.103</td>
<td>0.918</td>
<td>0.370</td>
</tr>
<tr>
<td>VAR00003</td>
<td>0.322</td>
<td>0.112</td>
<td>0.701</td>
<td>0.492</td>
</tr>
<tr>
<td>VAR00004</td>
<td>0.753</td>
<td>0.219</td>
<td>1.470</td>
<td>0.157</td>
</tr>
<tr>
<td>VAR00005</td>
<td>0.172</td>
<td>0.185</td>
<td>4.077</td>
<td>0.001</td>
</tr>
</tbody>
</table>

Table 4 shows the regression coefficients of the multiple linear regression model constructed by Eq. (1), \((a_1, a_2, a_3, a_4, a_5)^T = (0.094, 0.078, 0.322, 0.753, 0.172)\), and the multivariate linear regression model of the undergraduates' leadership is:

\[
y_i = -1.892 + 0.094x_{i1} + 0.078x_{i2} + 0.322x_{i3} + 0.753x_{i4} + 0.172x_{i5} \quad (7)
\]

According to the above model, if a college student is known to score in the other factors, we can achieve the prediction of the students' leadership level. For example, if a university student is known to have scores of 10, 80, 90, 50, and 50 in social participation, family function, personal disposition, organizational factors, and professional knowledge, the model is used to calculate the student's leadership Force score of 82.41 points.

If we want to judge the accuracy of the above prediction result, we can use the formula (6) to evaluate the error, according to (6), the probability is lower than the predicted value is 0.056. Because the risk value is small, the value obtained from the article prediction model is in an acceptable range.

CONCLUSION

Based on the four aspects of communication, coordination, win-win ability, information processing ability and task execution ability, this paper summarizes the main influencing factors of undergraduates' leadership: focusing on social participation degree, family function, personal disposition, organizational factors and professional knowledge. Based on this, the multiple linear regression prediction and error analysis model of undergraduates' leadership are constructed. Through the first-hand data obtained from the on-site investigation of undergraduates in the Three Gorges University, this paper analyzes the data, this study provides the scientific method model for the undergraduate students' actual leadership ability, and can provide some help to the undergraduate talents cultivation in engineering colleges.
REFERENCES