Research on Innovation and Entrepreneurship Training System of Engineering Students Based on TIPO Engineering Education Theory and the Coordinates of Talent Growth

Yutian Zhang, Chao Li, Shanshan Xie, Wenhui Fan
Beijing Institute of Technology, Beijing, China

ABSTRACT: In this paper, we found that the situation and the development trend of engineering college students’ overall quality will focus on the improvement of innovation and practical ability. Meanwhile, the employability also requires students to have excellent overall quality. Therefore, this paper mainly research on an effective innovation training System of entrepreneurship and practical ability of students. Combined with classical theory of CDIO engineering education and the "ten evaluation elements" of the coordinates of talent growth, "TIPO" innovation model was proposed. And a "four functions platform" theory and the "Eight Elements Management Guidelines" management system and mechanism was proposed by elaborating the model for the specific application of mechanical College Students Technology Innovation Base. Finally, based on all the index of the growth of talent coordinates, the effect of College Students' Innovative Practice Training System and Technology Innovation for engineering students under TIPO model was analyzed and studied by the way of questionnaire survey and data analysis. In the past three years, large number of students has graduated from this base, and the theory also achieved remarkable results in the system application of "Creativity - Innovation - Entrepreneurship".

KEYWORDS: TIPO; Engineering education theory; Engineering quality; The Coordinates of talent growth

1. THE CONTENTS AND TRENDS OF CULTIVATING THE ABILITY OF COLLEGE STUDENTS' QUALITY

Quality is a person's stable, intrinsic and basic structure that comes from the nature and is worked together by acquired education and the environment. And it means the deep features that distinguish common people and excellent people in some work. There are variety of different interpretations for quality, and most people agree iceberg model.

The ability of quality is an important part of college students cultivation system at present stage. Through retrieving literature, the author found several researches successively which are at different levels and different directions at home and abroad. Among them, at abroad, the typical exploration concludes the one about features of competency that Mc Clelland did against the United States government workers. Up to now, the model of competence quality is becoming more abundant. At home, Xia Wei, Zheng Bangshan and Fu Jinjun also put forward the corresponding research results. With the implementation of quality-oriented Education in colleges and the gradual improvement of comprehensive quality training system, the author summarize the trends of current comprehensive quality system from different perspectives. The first, the contents of comprehensive quality are more comprehensive and fully consider the student's career development needs. It not only measures the student's course grade, and pays more attention to internal potential containing the students' social practice and innovation consciousness; the second, the comprehensive quality system tends to be modular. Through the top-level design to built a full range of all kinds of quality platform, it perfects the corresponding evaluation system and makes the modular system tend to be perfect; The third, comprehensive quality cultivation views tend to be diversified, and students' development has a personalized trend.
2. EVALUATION INDEX AND THE IMPORTANT SIGNIFICANCE TO CULTIVATE COLLEGE STUDENTS' COMPREHENSIVE QUALITY

2.1 Talent growth coordinate system can effectively quantify the student quality growth process

By Combining the differences of different types of employing persons unit, considering the requirements of students' level of talent quality education and basing on the education goal of employment demand of students competency assessment model, we put forward the concept of talent growth coordinate system that can provide an effective visualization method to quantitative research students' the development track of quality ability.

Students' quality evaluation index is divided into ten classes in the talent growth coordinate system:

<table>
<thead>
<tr>
<th>Number</th>
<th>Evaluation Index</th>
<th>Number</th>
<th>Evaluation Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Learning initiative</td>
<td>6</td>
<td>Ability to work independently and analysis to solve problems</td>
</tr>
<tr>
<td>2</td>
<td>Ability to practice</td>
<td>7</td>
<td>Psychological quality ability and consciousness of innovation</td>
</tr>
<tr>
<td>3</td>
<td>Ability of development and career planning</td>
<td>8</td>
<td>Professional knowledge</td>
</tr>
<tr>
<td>4</td>
<td>Ability and consciousness of team cooperation</td>
<td>9</td>
<td>Social responsibility and moral accomplishment</td>
</tr>
<tr>
<td>5</td>
<td>Ability to adapt</td>
<td>10</td>
<td></td>
</tr>
</tbody>
</table>

The three axes of the talent growth coordinate system is the Enterprise Demand, Personal Development and Teaching Objectives, that covers study and work's period of all the factors related to talent evaluation.

2.2 The cultivation of College Students' comprehensive quality is the key factor to improve the ability of employment.

Employment ability refers to the ability of graduates to obtain employment ideal, meet the needs of society and realize their own value in social life through knowledge learning and the development of comprehensive quality when they were in school. The employment ability of college students needs to be market and the employer demand-oriented. Besides, the different employers' demand for talent is certainly different. According to the talent growth coordinate system, a questionnaire survey was conducted to the enterprise employees and some college students in a university. The results showed that the innovation ability is the most important quality of graduates for state-owned enterprises. However, business institutions focus on teamwork and social responsibility, etc. The matching degree of the students' individual quality and the ability the target enterprise focus on greatly affects their job search outcomes. Therefore, the talent training in colleges should provide a comprehensively open development platform according to different students' quality ability foundation and professional character.

3. SCIENCE AND TECHNOLOGY INNOVATION BASE OF MECHANICAL ENGINEERING STUDENTS OPERATION IN A UNIVERSITY IN CHINA

3.1 Innovation and entrepreneurship practice center operations overview in a university

The innovation and entrepreneurship practice center is reintegrated to set up in the first half of 2012 with deep combing in terms of hardware facilities, management concepts and cultural construction, which is based on the mechanical discipline, for the whole school undergraduate and graduate student at the same time.

The innovation center construction area totaling approximately 1000 square meters, contains creativity and the cultivation of works function area, minicomputer processing equipment area, electrical and control practice area, the results display area, material reserve area, seminars and other functional areas which provide a relatively fixed office and design room for students' innovation team with a larger scale and annual task. Meanwhile, it can accommodate about 200 people to carry out all kinds of innovative activities, can provide 50 person scale meeting place, the hall region has hosted the 200 scale academic exchanges, activities such as the report and the hall region has hosted the 200 scale activities such as academic exchanges, the report and others.
3.2 “TIPO innovation model” and the application of the theory in the center operation

Engineering education theory - CDIO theory refers to the Conceive, Design, Implement and Operate. On the basis of CDIO theory, the center innovatively established the mechanism of mechanical innovation and entrepreneurship by the early years of theoretical exploration and practice summary, and discussing kinds of training ways of evaluation index proposed in the coordinate system deeply. TIPO represents Think, Innovate, Practice and Operate.

Based on TIPO model, the innovation and entrepreneurship practice center constructs four development platforms by thinking, innovation, practice, as the main line, and builds a training system with four carrier platform for the creation and innovation of College Students. Moreover, playing the advantages of the four platform training system, it establishes the college students’ innovation and entrepreneurship management system on the base of the eight high standard elements.

3.3 Innovation and practice training system of engineering students based on “TIPI” theory

3.3.1 Four functions platform of innovation and practice training system

Function 1: Cultural Diffusion Platform: by means of learning exchange activities provided by Practice Centre such as Technological Innovation Exchange, Auto Cultural Festival etc. to spread innovation and entrepreneurship culture of college students and to cultivate centre’s advanced culture.

Function 2: Scientific Research Platform: through all kinds of competition items training, curriculum design, graduation project and other forms to encourage undergraduates to carry out scientific research on campus.

Function 3: Practice-Growth Platform: to provide teachers and students with quality service in the education of innovation and entrepreneurship. Consistently to improve the practice-growth platform of college students’ innovation and entrepreneurship that consists of all kinds of competitions.

Function 4: Collaborative Innovation Platform: through theoretical education, practice training and other ways to improve the ability of entrepreneurship of students, to promote entrepreneurship by innovation, to strengthen collaboration between the university and the enterprise, and to promote the transformation of innovation results.

3.3.2 The practical operation of “four functions platform” in innovation and practice training system

The main activity of the practice-growth platform is that students can take part in different types of technological innovation competitions. The work system diagram is as follow built by the center that consists of 2 brand cultural activities for popular science, 3 incentive funds for technological innovation, 5 work carriers, 6 students’ science and technology innovation teams:

![Figure 3. Work systems of practice growth platform.](image)

3.3.3 “Eight Elements Management Guidelines” of innovation and entrepreneurship management system

All-dimensional disciplines support: a rich variety of disciplines, multi-level research directions, combination of multiple disciplines based on machine.

Strict norms of work: scientific work norms, the perfect management system, the guidance of teacher management system and student team operational norms.

High level of guidance: the professional guidance team of a certain number of teachers with Innovative capacity and enthusiasm for guidance.

Diverse sources of funding: various and stable technological innovation and entrepreneurship training funds composed of 985 construction funds, education funding, social lateral funding and other components.

Specialized hardware environment: the mechanical innovation and entrepreneurial activities required site, equipment, environment and other infrastructure and sufficient quantity, matching low priced and easily worn articles.

Advanced software conditions: advanced virtual experimental conditions for students that provide advanced soft power guarantee for the study and
4. RESEARCH OF ENGINEERING STUDENT'S QUALITY UNDER THE GUIDANCE OF "TIPO CONCEPT"

4.1 Questionnaire design and data analysis method

The research objects of the questionnaire are university undergraduate and graduate students of the college machinery and vehicle, audits purpose is to research the scientific and technological innovation ability of students and probably influence factors, and to combine talents growth coordinate system model to test whether the corresponding education measures on college students' competency model to play a good role.

Questionnaire surveys students' science and technology innovation ability and the influencing factors, as well as the personal assessment. In the data analysis, the "impact factor" is divided into two groups which are individual ideas and Science and technology innovation activity participation, and the two groups had their discussion. All topic scores were summed within each group to give the final score. Assume that each subject as well as within each option for students' science and technology innovation ability of the influence degree is the same, and it doesn't explore weights of the influence of various factors. Based on this assumption, z score formula is as follows:

\[ z = \sum_{i=1}^{x} \left( \frac{x_i - 1}{n} \times \omega \times 100 \right) \quad (1) \]

Among them, n is the number of options; xi is the option value of coding; w is the percentage of each group of students choosing the subject accordingly in the "reason" of the corresponding option. The lower the score, the weaker the factors affecting the role; and vice versa.

104 questionnaires are recycled, and they are effective.

4.2 Questionnaire design and data analysis method

4.2.1 Students generally recognized the importance of participating in scientific and technological innovation activities

The higher of horizontal numerical value, on behalf of more science and technology innovation achievement, or more highly personal evaluation, as indicated in figure 5 and table 2. Comprehensive figure 4.1 and 4.2, each group of students individual oriented concept scores were generally higher, basically in between 120-200 points. The standard deviation in tables 4.1 and 4.2 is smaller (in addition to the individual situation of 30, with the rest of the basic in about 13), regardless of whether there are differences in the ability of innovation of science and technology, the students were accepted to the significance of participating in science and technology innovation activities.
4.2.2 The higher participation of scientific and technological innovation activities, the more prominent the students' scientific and technological innovation achievements, the more positive attitude towards personal evaluation

As seen in figure 6 and table 3, students won the provincial, ministerial awards and national awards, academic achievements have a correlation with the degree of participation of technological innovation. According to figure 6, it is evident that there is an obvious positive correlation between the horizontal axis and vertical axis, score span considerable (50-300), and the standard deviation in table 3 is high. We can see the degree of participation of technological innovation activities have severity influence in their technological achievement output.

Figure 7 and table 4 reflect the correlation of personal evaluation and the degree of participation of technological innovation. As seen from the statistical results, the students with high personal evaluation is more active participating in science and technological innovation, generally concentrated in the higher range (50-70), on the contrary that a lower personal evaluation contributes to lower quantitative scores (20-50). From table 4.4, we can see that the standard deviation is larger (13-20), summarizes the students with different personal evaluation has bigger different in participation index.

<table>
<thead>
<tr>
<th>Table 2. Individual evaluation of each option corresponding to the individual concept oriented value.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Item</td>
</tr>
<tr>
<td>mean value</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 3. The number of awards, the academic achievements of each option corresponding to the degree of participation in science and technology innovation.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Item</td>
</tr>
<tr>
<td>mean value</td>
</tr>
<tr>
<td>standard deviation</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 4. Individual evaluation of each options corresponding to the degree of participation in science and technology innovation.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Item</td>
</tr>
<tr>
<td>mean value</td>
</tr>
<tr>
<td>standard deviation</td>
</tr>
</tbody>
</table>

Figure 4. Incentive measures of innovation cultivation system.

Figure 5. The relationship between Personal evaluation (horizontal) and Individual oriented concept (vertical).

Figure 6. The relevant relationship between the awards, academic achievements (horizontal) and the degree of participation of technological innovation (vertical).

4.2.3 The quality model corresponding to “self-cognition” and each item in the evaluation of self ability quality

The survey (Chart 9) shows that the option of items such as Physical Exercise, Anti-Pressure Capability, etc., is mainly “quite accordant”. This indicates the
engineering major undergraduates nowadays pay much more attention to enhance their physical and psychological quality. Meanwhile, they put much importance to the “engineering quality” as well.

As the result of Chart 9 shows, what the engineering undergraduates value most are qualities of psychological endurance capacity, etc. Among them, psychological endurance capacity, physical quality, and interpersonal communication skill are of most prominence. The percentage is all above 80%.

We can conclude from the survey, together with the evaluation indicators in the talents’ growth coordinate system, that the Quality Education among engineering undergraduates based on the College Innovation Practice Center, under the guidance of TIPO Theory, has achieved quite good effect. This can be reflected in positive feedback from aspects of Innovation capacity, Teamwork, Learning initiative and Practical ability, etc.

5. ESTABLISHING COLLEGE PRACTICE EDUCATION BASE UNDER THE PROFESSIONAL INNOVATION AND ENTREPRENEURSHIP INSTRUCTION OF “TIPO THEORY”

Scientific Innovation Competition, Scientific Innovation Project Research and Scientific Popularization Preaching are three main forms of innovation activities carried by the Practice Center in the past three years. The center has already won 107 national and international awards and 53 provincial and district awards. It launched 190 College Innovation Experimental Project, including 20 national projects and 14 Beijing city’s projects. In addition, it also participated in the annual meeting of SAE International, Beijing International Automotive Exhibition, National Science and Technology Week, etc. during these times, received many leaders warmly.

By the end of 2015, the Practice Center had achieved fruitful results which were divided into the following five categories, teaching results, teachers’ academic results, students’ scientific innovation coverage, students’ participation of scientific research, students’ scientific research results and graduates’ flow. The statistical condition shows as Table 5, Chart 10 and 11.

6. CONCLUSIONS

Through the early construction and operation, the talent training in the Practice Center especially innovation practice term regards a novel and pragmatic theorem as a guide, the discipline group which has a strong comprehensive strength as the basis, and the innovation activities which have lots of influence in domestic and foreign regions. It not only brings forth new ideas for management mechanism, but also cultivate the innovation achievements. These help the Practice Center win the praise from teachers and students.

The innovation and entrepreneurship practice training system and the management systems and methods in the Practice Center, such as the ‘four-functional-platform’, the ‘eight-factors-management-guideline’, all works well and orderly. And these have won significant educational achievements in ‘creativity- innovation-entrepreneurship’ system. And these have been more mature in the field of the creativity and innovation. In the next stage, on the basis of consolidating innovation cultivation system, it is necessary to explore in the field of entrepreneurship, find the balance between the trend of social economic development and students’ education in engineering, and cultivate talents which have engineering ability and comprehensive quality.

At the same time, facing the trend of the domestic and international development of higher education and the expectations and requirements of social construction for the cultivation of top innovative talents, the Practice Center also has to broaden the space for further construction. For example, to broaden the knowledge service beneficial, infrastructure construction still needs to be further strengthened; to further stimulate the vitality and enhance the effectiveness, it is wise to combine the reformation and innovation of personnel system in the comprehensive reformation with regard to the building of the teachers’ contingent; in the training for international exchange students, we can also expand the international exchange connotation of innovation practice, and attract students of overseas university and exchange students to participate in these activities actively.

Figure 7. The relationship between Individual evaluation (horizontal) and the degree of participation of scientific and technological innovation (vertical).
Table 5. Scientific Innovation Achievement of Students from the Center in these Years.

<table>
<thead>
<tr>
<th>Year</th>
<th>Coverage Area (Person Time)</th>
<th>Number of works fostered by the project</th>
<th>Above the Second Prize of National Competitions</th>
<th>The Third National Prize and the First Provincial Prize</th>
<th>The Second and the Third Provincial Prize</th>
<th>Research Thesis Published by Undergraduates</th>
<th>Applying for a Patent (Authorization)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Above 500</td>
<td>Above 600</td>
<td>Above 500</td>
<td>Above 600</td>
<td>Above 600</td>
<td>Above 600</td>
<td>Above 600</td>
</tr>
<tr>
<td>2012</td>
<td>93</td>
<td>110</td>
<td>129</td>
<td>31</td>
<td>11</td>
<td>16</td>
<td>17</td>
</tr>
<tr>
<td>2013</td>
<td>110</td>
<td>129</td>
<td>136</td>
<td>44</td>
<td>12</td>
<td>21</td>
<td>15</td>
</tr>
<tr>
<td>2014</td>
<td>129</td>
<td>136</td>
<td>44</td>
<td>15</td>
<td>6</td>
<td>10</td>
<td>19</td>
</tr>
<tr>
<td>2015</td>
<td>136</td>
<td>44</td>
<td>15</td>
<td>6</td>
<td>9</td>
<td>9</td>
<td>10</td>
</tr>
</tbody>
</table>

REFERENCES

