The Cultivation of Innovative Talents from “Mechanical Innovation Design” Course

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Abstract. In order to cultivate and motivate the creative and innovative ability of undergraduate students, the “mechanical innovation design” course takes the pattern of topic seminar. This teaching mode can fully mobilize the self-learning initiative of students. Teachers teach students what’s innovation and the basic innovative methods and technique. The class is organized with students preparing lessons, topic seminar, and integration of theory with practice. Students built the self-confidence of innovation in the studying of this course, and accepted the basic innovation method and theory. More than 80% students have participated all kinds of science and technology competitions, and got more than 40 awards in recent years. Their creative and innovative ability of students are fully cultivated in this process. This innovative way of thinking is also helpful for student’s future work.

1. Introduction

China is a big country in manufacturing, but is not a strong country. To realize the dream of strong ability for manufacturing in China, large quantity technology researchers, who have innovation idea and innovative ability, are needed. University students are the main force and vital force for the national technology development. In order to improve the national technical innovation level, we must cultivate the innovative ability for university students, stimulate their interests in innovation and initiative. Therefore, one of the important teaching content reforms is to cultivate the consciousness of innovation of the university students, to teach their initiative thinking [1-3]. Such courses in innovation or mechanical design have been offered in many universities in China, and various improvements and explorations have been carried out in these schools [4-6]. Such as the practice teaching mode based on “curriculum” guiding science and technology competition in the Beijing University of Science and Technology [7]. Three dimension modeling software is introduced in the mechanical design course in Henan University of Science and Technology, and students are encouraged to participate all kinds of competition [8]. The teaching reform for “mechanical design” was carried out in Shihezi University [9]. The cultivation of innovative ability for students is based on the mechanical innovation platform in the Taiyuan University of technology [10]. In order to guide students to study independently, and to cultivate students’ innovative consciousness and ideas from the beginning, the “mechanical innovation design” course, which combines theory and practice, is set up for freshmen in our university. Both the teaching contents and the teaching methods of this course are focus on the cultivation of students’ innovative ability.

2. Orientation and Purpose of This Course

Freshmen seminar course originated from the freshmen education courses at the American universities in the late 19th century. It adapts discussion in groups method for specific topics [11,12]. This kind of course was first set up at Tinghua University in China in 2003, then many other universities tried to push ahead [13]. We set up freshmen seminar course in our university in 2012. With many years’ practice, these kinds of courses have a good promotion for freshmen to the learning method transmission from middle school to college.

“Mechanical innovation design” course is a freshman seminar course, opened by the mechanical engineering school in our university. This course is characterized with small class teachings, which take the combination of theory discussion and practice training. This course does not intend to teach
professional knowledge, but to promote students’ innovation interest and passion, and to master the technique and methods for mechanical innovation as the teaching purposes. As Richard Levin, the President of Yale University, puts it, "the key to education is not the content of teaching, but the way it is taught."[14] We will introduce the teaching methods for this seminar course and its teaching results for students.


3.1 Planning for teaching contents

In order to cultivate the innovation consciousness of students, the mystery and fear for innovation and invention of students should be broken first, and the basic methods and technique for innovation should be taught to students secondly.

Most freshmen of university were taught by teachers’ “cramming” in their junior and senior high school years. They cannot transfer knowledge flexibly, so they felt that the invention and innovation to them are too high to attain. Therefore, the first thing we need to do to cultivate students’ innovative ability is to let students understand the truth that invention and innovation is not absolutely undeveloped technology. In fact, innovation is always around us, and invention is not impossible. Displaying the works that students participated in the mechanical design competitions and the patents that students applied in recent years, the freshmen can intuitively feel what innovation is and how to innovate. Because the national college mechanical innovation design competition is based on theme mode, the topics came from life problems and social hot spots, students can relative easy to design their work creatively, combined with their life experience. We take the theme of the third national mechanical competition, “green and environment”, as an example in the class. The content for the competition was the creative design and manufacturing of environment protection machine, sanitation machine and kitchen sanitary machine. Students discussed their design warmly during class. A lot of ideas, such as a sweeping and mopping floor all-in-one machine, automatic glass polishing device, convenient garlic peeling device, were put forward by students. In the thinking of these thoughts, students have a more objective and accurate understanding of innovation. The confidence that I can invent were established quietly in their minds.

Not only the sense of innovation, but also the guidelines are needed to keep improving for students, therefore, they have to master common innovation techniques also. The Triz theory provides the general principles of innovation. The most useful methods in Triz for students are the brainstorming and the systematic questioning. We took the improvement of bicycles as an example, students brainstormed and discussed extensively, all kinds of bicycles were put forward in the class, and the basic innovation methods and theory were mastered by students in this process.

3.2 Organization of this course

The task of the freshmen seminar is not just teach knowledge, and not same as the major introduction or other educational courses, but to organize students to study independently with discussion. Because students are accustomed to passively accept knowledge, it is not easy for students to study actively and express themselves in classes. Therefore, it’s necessary to organize the curriculum properly to motivate students to participate the course in the form of assess and practice. According to common mechanical design, several themes, such as walking mechanism, obstacle-surmounting mechanism, grasping mechanism, are set for students. Each time the subject is guided by the teacher, and students will choose two groups to prepare for the course after class. In the classes, two groups of students will present and explain the contents of their slides respectively. In order to prevent other students from being absent-minded, their participation should be aroused also. The way of students asking questions can expand and deepen the contents of the presentation groups. The answers to those questions were vies to be answered first by two groups of students. The questions and answers in the class determine the students’ performance score, so the class atmosphere is very lively. The function of students in this kind of class is twofold, both learning new knowledge and teaching new knowledge. Through this form of classroom discussion, not only enable students to master and extends the basic knowledge of mechanical innovation, also can exercise the students’ ability of information searching and knowledge expression ability.
The knowledge and information got from class discussion is still stay on a paper or in the heads, so, the practice is necessary to turn them into tangible objects. That’s what we call “what’s learned from books is superficial after all. It’s crucial to have it personally tested somehow.” However, the mechanical processing is limited by time and material, so the fischertechnik model is a good choice. The fischertechnik model covers the mechanics, electronics, control, pneumatics, motor technology, energy technology, robot and other fields. Using standard industry components (mechanical components/ electrical components/ pneumatic components), it can realize the reduction of any technology process, using the design planning and experiment analysis of system [15]. Students can take use of the abundant fischertechnik mechanical components and structures to make their design to entities, with the mode of components binding and assembling. For example, there is a carton packaging machine designed by students with the fischertechnik model, as shown in Fig. 1. It will reduce the time for material purchasing and processing in this mode. On the one hand, students will experience the whole process for products processing, on the other hand, they can test the rationality of their innovation design.

![Figure 1. Students’ work with fischertechnik model.](image)

4. The Implement Effects of This Course

After three years development of the “mechanical innovation design” freshmen seminar course, not only the students can master basic methods and theories for mechanical design, more important is it promotes the students’ passion for innovation. We cultivate a large number of outstanding talents for all kinds of technology competition. With a rough statistics, more than 80% students who had taken this seminar course, have participated mechanical innovation design competition, challenge cup, undergraduate competition for innovation and entrepreneurship, Xinmiao talents program, and other college students’ innovation projects, and got good results. The students in our mechanical engineering school have won 11 national awards, 33 provincial awards, and 7 national innovation and entrepreneurship projects since 2013, as detailed shown in Table 1. At the same time, students have built the awareness of intellectual property rights protection in these competitions. They have applied
dozens of invention patents and utility-model patents; further enhance their motivation and confidence in innovative design.

Table 1. Statistics of awards for our school’s students in recent three years.

<table>
<thead>
<tr>
<th>Project title</th>
<th>Grand prize</th>
<th>First prize</th>
<th>Second prize</th>
<th>Third prize</th>
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<tbody>
<tr>
<td>National “challenge cup” competition</td>
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<td>1</td>
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<tr>
<td>Zhejiang province “challenge cup” competition</td>
<td>1</td>
<td>4</td>
<td>7</td>
<td>4</td>
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<tr>
<td>National mechanical innovation competition</td>
<td>1</td>
<td></td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Zhejiang province mechanical innovation competition</td>
<td></td>
<td>8</td>
<td>3</td>
<td>10</td>
</tr>
<tr>
<td>National mechanical innovation competition (fischertechnik)</td>
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<td>1</td>
<td>9</td>
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</table>

With the cultivation of creative consciousness and mechanical design ability, and the training of discipline competitions, these parts of students also performed well in the job hunting and their work. They are widely praised by their employing units and be entrusted with an important post, thus a virtuous cycle is created in the process.

5. Conclusions

The way of the combination of teachers guidance and students discussion, which the “mechanical innovation design” seminar course taken, can fully mobilize students’ study enthusiasm. They learn independently, think independently, and discuss freely, which made students’ wisdom and creativity encouraged, the innovative ability of students promoted and improved. This innovative way of thinking is good for both students’ competition score and their work of the future.

6. Acknowledgment

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7. References


[15]. “Fischertechnik” http://baike.baidu.com/link?url=hAhvYDIlnIPk5Qxm4o0I4 rFNLnfqMt0NPAImlHEAljb1P8uco6CCSxs5tRxMrB5XxeCwqlLfcEB0WMclwo4RaYq.