

Enhancing Students' Innovation Competences by Contests in Engineering Education: A Case Study

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Abstract—*For enhancing students' innovation-related abilities, we had built a competition platform by which students' interests in Lab' experiments, designing practices, and multi-discipline learn were inspired widely. This platform is composed of three levels competition activities. In innovation contests, students had shown great innovation competences. In every year contests, there were always some great designing works. Some of them have been transformed into products utilized in the day life or for some special purpose.*

Index Terms — *Contest Platform, Engineering Education, Innovation Activities.*

INTRODUCTION

As we know, successful engineers should be able to solve an engineering problem, design a system and make an innovation. How to prepare undergraduate students for these, this has become the most important issue of our university. Today, in China, more and more undergraduate students are desirous to get some experience in solving engineering problems and making an innovation, to get innovation-related skills for preparing them for the competition in the future. It had been also highlighted in government reports that innovation abilities of industry companies should be improved for coping with the global competitiveness. Looking around us, a lot of work had been done. Universities, in different countries, had also made widely and deeply exploration in developing educational resources to support a broad range of personal characteristics, cognitive capacities, knowledge, skills and processes for students to improve the innovation-related capacities. They had done a lot in seeking good education approaches for meeting the demands of improving students' abilities of innovation. For example, they developed commercial courses for engineering students, developed project-based methods to strengthen students' abilities in solving engineering problems. In these reformations, they also tried to constitute new regulations of education management to motivate students to get more practice in design or entrepreneurship, to awaken students' interests in creative thinking. Our university also did some work in enhancing students' competences of innovation. Today, we have got some progresses in this field. One of the progresses is that we have built a competition platform including competition activities on three levels, by which to enhance the capacity of innovation and to build an innovation culture in campus. On the competition platform, there are about twenty contests. Now almost 1000 students attend different competition activities in a year. Students are inspired by series of innovation contests. They show more interest in the study of multi-disciplines knowledge and lab work, and great innovation competences. In every year contests, there are always some great designing works. Some of students' innovation works had got the highest awards of National University Innovation and Entrepreneurship Contest in recent years, such as the Mini Bird Flight which was designed by imitating bird flying principles, the Qiqi Flight Platform which was designed by adopting helicopter's principles. Some of them had been transformed into products utilized in the day life or for some special purposes.

For supporting contests, we have also built some innovation labs in which students can finish their designing works and accept some basic training on designing works. In them, there are also collaborating innovation labs built by our university and companies, such as the NUA-YONGYI Industry Design Center which is funded by the YONGYI Ltd. NUA-YONGYI Industry Design Center had held the 1st Office Chair Designing Contest of YONGYI Cup was held in December, 2009. 213 students took part in the contest, 186 works were present at the contest, 5 concepts of contest works had been adopted by the YONGYI Ltd. Any other cooperation innovation platform is the Students Technology Innovation Center founded by NUA and Jiangsu Lishui Aviation Industrial Park.

BUILD THE COMPETITION PLATFORM

As we know, the capacity of innovation has become the most important issue in facing the globalization of economics and global competition. As we had known, an innovation is a process generating new ideas and bringing them to life as new products, processes or services for commercial use or social/environmental wellbeing¹. During the process,

we have to take three phases of works including generating new or innovative ideas, managing the innovation processes, and capitalising on innovative ideas, products, processes and services. Innovation requires abilities include²:

1. **Generating innovative ideas.** Include the knowledge, skills and personal attributes to generate innovative ideas/processes, such as speculating, solving problems creatively, communicating a new idea.

2. **Managing innovation processes.** Include the knowledge, skills and personal attributes to manage the processes and people involved in an innovative process, such as monitoring progress, arranging capital, building a culture that fosters innovation.

3. **Capitalize on new innovative ideas.** Include the entrepreneurial knowledge, skills and personal attributes to capitalize on innovative ideas/processes, such as showing leadership, taking risks, developing strategic partnerships, selling an idea to access finance.

In these fields, universities, in all over the world, have developed deferent approaches. There are commercial courses developed for engineering program, CDIO model of MIT, and new inter –disciplinary program. All of them were developed with defferent purposes. For example, the commercial courses were developed to let engineering studets know about how to run a company or undrstand deeply the economical situation. As shown above, in geneating innovative ideas, managing innovation processes and capitalize on new innovative ideas, there are defferent demands of knowledge, skills and personal attributes, students would get them based on their career planning. Their demands on the educational resources are diverse. For example, a student, in an engineering department, wanted to be an engineer, he/she would be to get more knowledge and skills in creative design, especial skills in generating creative ideas. And the design skills would be the key contents that he/she had to learn. If a student liked to be an enterpriser, he/she would learn more knowledge and skills in managing innovation processes and capitalize on new innovative ideas. Students’ demands, in a university, would be diverse according to students’ career plans. How to meet the divers demands, this is the key question we have to answer at first. Meeting diverse demand, the beast way is to provide open and diverse education resources. For this, we built a competition platform and a support system. This platform is composed of there levels competition activities refering to creative design, enterpreneurship, and so forth, showed in Fig 1, the support system includes some polices and regulations on the academic activities, credit awards, financial aid, and labs and creation design centers for studeents to fulfill their design works.

On the competition platform, on deferent levels, the contents were designed for deferent purposes. Students could choice one or sereial of them.

On the based level, there are general knowledge and skill contests, such as Social Knowledge Contest, Aviation Knowledge Contest, Aerodynamics Knowledge Contest, Engineering Skill Contest, Math Contest in Modeling (MCM), Interesting Chemical Science and Technology Contest. The based level aims at incenting students to broaden their knowledge and get trained in solving problems.

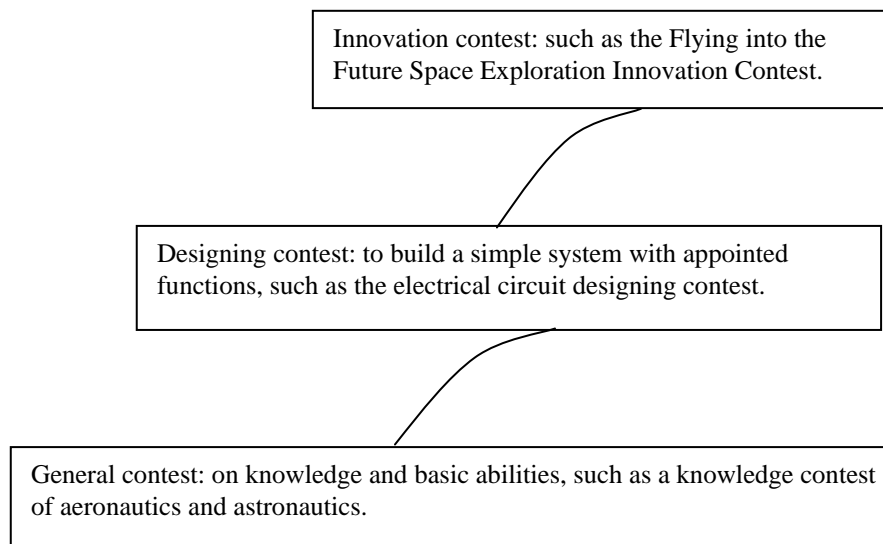


FIGURE 1
STRUCTURE OF CONTEST LEVELS

On the second level, we designed some designing and buisness planning contests to strengthen innovation-related skills. There are eleven contests, including the Electronic Design Contest, Chopsticks Bridge Structure Design Competition, Mechanical Design Contest, Helicopter Design Contest, Programming Contest, Business Simulation

Contest, Corporate Identity Design Contest. The contests were developed for engineering students, they could choose one or more of them to participate. In the most of the contests, students have worked with other students, they worked in a team to finish a designing task. In them, skills of using designing tool, carrying out experiments, communicating with team mates, leading and working with other students, oral presentencing, and some basic innovation-related skill would get trained. Such as in the Mechanical design contest, each team, composing of 4-5 students, had to design a work with a appointed function. In the contest, they would make a working plan, do the principle design, draw the designing drawings, process or purchase the components and parts, make a prototype. After finished designing work, a team would provide a designing introduction book, and give a presentation to the review committee. Through the progress, students could get more deeply understand about a real designing processes, what included in a designing work, how to work in a team, they also get a systematically train in generating a new idea and implementing it to build a product.

On the top level has two kinds of competitions, one is technical creation contest, and the other is Entrepreneurship contest. During 2005- 2009, we had hold about 10 kinds of contests in campus, including the Future Aircraft Design Competition, Future Aircraft Aerodynamics for Creative Design Competition, Creative Ideas and Technological Innovation Activities, Office Chair Creative Design Competition, Energy Saving Technology Innovation Contest, Experimental Fluid Mechanics Innovative Design Contest and Entrepreneurship Contest. As an example, the Future Aircraft Design Competition was hold every year for aircraft engineering undergraduate students and graduate students. The 2008' content of Future Aircraft Design Competition was held from March to May. The theme was "Blue Sky, Fly Your Dreams". The contest was divided into to parts, one was for students coming from the airspace department or aviation department, the second was for those came from disciplines not to refer to the aircraft design. According the competition principles, each team, composed of fiver students, had to design a aircraft for the future in 20-30 years. In the contest, students had handed in a design report, design drawings of aerodynamic layout, cabin layout, propulsion system, control system, take off and landing system to review committee. The 2010' competition is holding form April to August. The demands of contest are that each team to finish a concept design of personal aircraft or near spacecraft for the future in 20-30 years.

Three levels of contests would provide opportunities for students, with deferent wish, to improve their ability in build a broad and deep knowledge base, to develop innovative thinking, to get skills in solving problems, working in an interdisciplinary team, and in running a company. Contests, held in 2009, listed in Table 1.

No	contest	time
1	Aviation Knowledge Contest	2009
2	Aerodynamics Knowledge Contest	2009
3	Social Knowledge Contest	...
4	Math Contest in Modeling (MCM)	...
5	Interesting Chemical Science and Technology Contest	...
6	Programming Contest	...
7	Cartoon Design Competition	...
8	Electronic Circuit Design Contest	...
9	Helicopter Design Competition	...
10	Airport Planning and Design Contest	...
11	Creative Ideas and Technological Innovation Activities	...
12	Experimental Fluid Mechanics Innovative Design Contest	...
13	Concept Car Design Competition	...
14	Campus product Design Competition	...
15	Business Plan Competition	...
16	Business Simulation Competition	...
17	Corporate Identity Design Contest	...
18		2009

TABLE 1
CONTESTS HELD IN 2009

BUILD THE SUPPORT SYSTEM

In an university, effects of teaching and learning are based on students activities, lerning condition and education approaches. In short, teaching should be student-centered, and students should study actively. If they studied in a

negative state, the result of study would be unsatisfied. So that, after the competition platform was built, there was another work we had to do, it was how to incent students to participate them, to motivate students to actively learn, eg:

1. How to inspire students to attend contests actively, and to learn automatically.
2. How to support students to pursue their creative ideas, could they get some funding and get credits instead of sign up for a regular course.
3. How to encourage teachers to tutor innovation activities and contests.

For solving these problems, it was needed to make some reformation in the traditional education and management to build the innovation culture in campus, to incent students and teachers put more attention on the innovational activities, and get more and more students to sign up for contests. At the end of 20th century, we began to do some reformation. While coming to 21th century, we promoted the reformation rapidly. In 2004, we set up a fund to supporting innovation activities, reformed the credit identifying mechanism and the evaluation benchmark for teacher's teaching works. These had improved the innovational culture in campus. It had brought some satisfactory results to us in incenting students to participate into contests and creative activities.

As the Students' Innovation Fund Management Regulation prescribed, since 2005, the university will provide one million Yuan for supporting students to fulfill their innovation activities in every year. Students' Innovation Fund Management Regulation will support two kinds of innovative activities. Firstly, it will support students to fulfilling a creative idea proposed by them. Under this situation, students had to be the proposer. they had to have a tutor. Students will be in charge of the project, the teacher, as a tutor, will give them some instruction. Others were some projects proposed by a Lab or an enterprise. This fund supported also those who bringing a creative work to attend a competition. After this fund set up, there were about 1000 student applying for the fund in every year. In 2010, 240 of projects were supported. For example, one of them was "Developing a New-type Fan-wing Aircraft" proposed by a student coming from the airspace college.

According the management regulation of Students' Innovation Fund, at the end of projects, students have to hand in a research report and the prototype or the papers published on academic journals, and give a presentation to the review committee. The review committee will grade their works and identify the credits awarded to them. If students got a great progress in a field, the committee would give them an award and nominate them for participating into a national competition. The tutoring work, to instruct students to fulfill innovation projects or to participate into a contest, is listed in the teachers' work evaluation benchmark. It is a part of their duty. When students get rewards in the national competition, the teacher, as a tutor of the project, will get a reward also from the university.

Beside of the new regulation and polices, for supporting innovation activities, some innovation labs had been built for students to do experiments, make their prototypes or as the incubator for their inventions. For example, the NUAA-ANJI Creative Design Center is a creative design lab built by our university and Anji Government which is located in the NUAA Engineering Train Center. NUAA-ANJI Creative Design Center provides a creative designing curriculum for undergraduate students. It was developed to strengthen the abilities in product design, about 30 students signed up for the curriculum in 2010. It had also held the 1st Office Chair's Designing Contest of YONGYI Cup in December, 2009. 213 students took part in the contest, 186 works were present at the contest, and 5 conceptual of contest works had been adopted by the YONGYI Ltd. Any other cooperation innovation center is the Students Technology Innovation Center founded by NUAA and Jiangsu Lishui Aviation Industrial Park, located at the industry park, registered capital being four million Yuan, called as in Nanjing LiXin Venture Capital Management Limited, as the entrepreneurship platform for students to incubate their creative design products or prepare for establishing a new company. The intellectual property rights of a project would be shared by companies and students. The company and students share the project profits, the company enjoys 90% and the team of students enjoys 10%.

CONCLUSION

Since 2005, more than 5000 thousands of student have participated deferent contests or creative activities, 56 teams have got the rewards of national level competition, the competition platform has play an important role in inspiring students to learn actively, in enhancing students' ability in building a broad and deep knowledge base, developing innovative thinking, getting skills in solving problems, working in an interdisciplinary team, and in running a company or entrepreneurship. As a result of it, five effects have shown.

1. **Promote a creative and entrepreneurial culture.** After 5 years practice, the creative culture has got widely accepted in students and teachers, more and more students participates into creative activities and contest every year, the word of "Enjoy Creation" is popular in campus. An open environment for students' innovation activities had been created.
2. **Inspire, far and wide, students' enthusiasm for participating creative creativities and learning.** As mentioned, there were about 1000 students who took part in deferent contests and innovation activities in every year, students showed great enthusiasm in the creative project. In 2010, 311 teams applied for Students' Innovation Fund.

3. **Enhance students' abilities in innovation and entrepreneurship.** By participating in the contests or creative activities, students got more train and experiences in innovation. About 600 students had got awards in national innovation competition or provincial innovation competition. They got train in team work, in creative think, in making entrepreneurship plan, and in design and experiment.
4. **Motivate teachers to reform teaching approaches and update teaching content.** With the Students' enthusiasm rising about innovation, teachers gave more attention on students' creative activities also. In 2010, about 300 teachers, as tutors, took roles in contests and students' technical creation project. This also incited teachers to reform teaching methods and course contents.
5. **Boost the cooperation of university and company.** Besides students being inspired, the university and some enterprises were also attracted to innovation contests. Enterprises were interested in new ideas generated in contests and creative activities, they came to the university to hold contests collaborated with the university, hope to get some creative conceptual products. So they were interested in building creative design center in campus, or building joint-venture incubator in economic zone.

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