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An ability centric model for education system optimization in mechnical engineering

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ABSTRACT

The core and key of the "Excellent Engineer Program" of the Ministry of Education in China is to improve the students' engineering consciousness and engineering quality and cultivate the students' engineering practical ability and innovative capability, which is based on society demands and engineering needs. This paper is a case study of the "Excellent Engineer Program" experimental class of Shandong University. An ability centric model for education system optimization in mechanical engineering is put forward. Through five years' practice of improving the educational concept, optimizing the program of talent cultivation, strengthening the cooperation with the enterprises and transforming the teaching methods, it has preliminary formed the relatively integrated system of excellent engineer education, which is oriented toward practical and innovative ability.

KEYWORDS

Ability centric model; Excellent engineer program; Mechanical engineering; Education system.

INTRODUCTION

Nowadays, there exist three problems in the teaching in mechanical engineering[1-3]:

The traditional teaching method focuses on the "teaching", which focuses on the amount of transferred knowledge and neglects the actual outcomes. Consequently, the enterprises generally reflect that the graduates in mechanical engineering are lack of the practical ability.

The textbooks and content of courses are relatively hysteretic and divorced from the practice because the knowledge of mechanical industry updates with time. And the students are not able to select the studying content and have no chance to establish their own structure of knowledge. It is urgent to optimize the curriculum system to adapt the demand of the new times.

The traditional teaching is mainly face-to-face teaching in classroom and is likely causing cramming education and neglects developing the students' subjective initiative.

The teaching in engineering should be students oriented, which puts the ability training to the students on the first place[4]. By means of innovating the teaching content and introducing amounts of practical cases from the enterprise line, it has formed the cultivation system which is aimed at the practical and innovative ability. It emphasizes that only strengthen the cooperation with the enterprises can the students become the masters of the learning knowledge[5]. It proposed the teaching method of interaction between the enterprises and universities by introducing the engineers of the enterprises to the universities and arranging the students to the enterprises.

Students' study is composed of two parts, one part at schools and one part in the enterprises. At schools, curriculum system is rebuilt based on the goal of the excellent engineer program. The inquiry learning method-oriented educational reform is strengthened. In the enterprises, students are involved with the actual technological innovation and project development. That means the effect of practical teaching is taken seriously. Teachers' engineering quality and capstone design with the actual engineering problem are also necessities for the reformation.

THE ABILITY CENTRIC MODEL IN THE EDUCATION

In order to cultivate students with practical and innovative ability, educational concepts, education curriculum and teaching methodology are updated and optimized based on the needs of enterprises and practical engineering background. After the exploration and practice of school-enterprise cooperation with depth, an ability centric model in the education reformation is put forward, as shown in Figure 1.

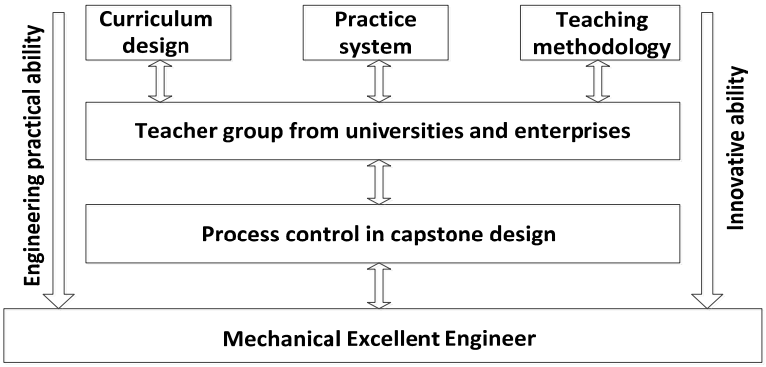

Figure 1 : The ability centric model

Syllabus highlights ability. All the professional education objectives should be achieved by specific sections. Aimed at the forefront of professional development, curriculum and courses are reformed with the needs of enterprise development. Syllabus also reflects the cutting-edge engineering science and technology development, emphasis on learning and practice of new techniques, methods and process.

Factory practice is strengthened through building student entrepreneur practice system. Combined with professional features, a group of students engineering practice and hands-on bases are built, including a national engineering practice joint education center and 3 practice bases which are combined with foreign industries that are the representative of the modern enterprises.

Real cases are introduced into teaching. Some business cases are refined and brought into textbooks. Some scientific research outcomes are translated into teaching content or comprehensive experiment. Some professional courses are conducted on the spot in factory. Capstone design and projects competition projects come from real problem of enterprises.

Students' practical knowledge is expanded by a two-way interchanges of teachers and engineers, in which teachers go into the enterprises and engineers go into the classroom. The policy guidance (e.g. professional title appraisal) encourages teachers to go to practice in business, participate in projects to improve teachers' practical ability. Engineers are invited to

direct internships and capstone design. Some high-level senior engineers are hired as part-time professors to participate in technical courses teaching.

Process control technique is employed in the management of capstone design, which is a crucial link between knowledge and ability. The selection of the projects, the project proposal, midterm examination, graduation oral examination and feedback are the controlling aspects. The capstone designs are preferred to be submitted by the combination with enterprises, tutored by engineers, completed in companies. Enterprises also play a role in final grade evaluation.

CURRICULUM OPTIMIZATION AND COURSE REFORMATION

To meet the requirement of the developing society and education objectives, the curriculum and course are reformed and optimized. The teaching syllabuses need to highlight practice and achieve the education objectives at length, which can link closely to the knowledge gaining and ability training. The content of teaching covers engineering problems, engineering cases and projects, meeting the needs of practice and innovation. The solutions are below:

Education objectives are solidified by curriculum. The education criterion matrix is built with knowledge, ability, course and practice phase, which is an important tool to achieve education objectives.

Curriculum is reformed and optimized aimed at the technical leading edge and society developing needs. A wide range of opinions and advices, from course responsible persons, course teachers, technicians, engineers, scientists, experts, in school students and graduates, are investigated in the process.

Teaching content is updated. Besides the reformation of the curriculum, the course contents need to be designed and updated in order to meet the every requirement in education objectives, taking into account the long-term nature, novelty and irreplaceability of knowledge.

STUDENT-CENTERED, RESEARCH-BASED TEACHING & LEARNING

Through research-based learning, such as problem-based learning, case-based learning, project-based learning, students' learning initiative are motived. The practical and innovative ability are formed in this practice.

Problem-based learning emphasizes the study of complex, meaningful problem situation, in which the students learn the underlying problems implied in scientific knowledge, solve the real problem and form the problem solving skills and the initiative learning ability. For example, in the teaching of "mechanical design", mechanism design capability is set as the main line runs through the whole teaching process.

Case-based learning is a kind of teaching situation with much freedom, where there is no specific standard answer. Teachers play the role of designers and inspirators to encourage students to participate in discussions actively. In the excellent engineer program, the course of Mechanical Graphics adopts the case-based learning, in which typical products are disassembled, measured, assembled, designed analyzed and modified step by step, and the quality of learning is naturally promoted.

Project-based learning aims to conquer the problem occurred in project development period and students are essential parts in this process, additionally we also concentrate on vigorously promoting the interaction between research and teaching, moreover, transferring scientific research project into teaching content timely.

PRACTICE TEACHING DONE IN PRACTICE

For the purpose of ensuring practice teaching, the following measures cannot be ignored: reforming the practice teaching content, guaranteeing the quality of teaching practice, promoting the diversity of practice teaching, strengthening the construction of off-campus practice bases and in-campus practical bases and taking full advantage of in-campus and off-campus practice bases.

The more specific measures are listed as following.

Making normative internship outline and internship plan. Internship purposes, missions, requirements, organization and leadership in internship, practice content, form and schedule, practice assessment and performance evaluation method and many others things are included in internship outline. Internship plan includes internship content, spot, timing and budget.

The formulation of enterprise training scheme. Students go into the enterprises in stages to do some practice and engineering design. Students can follow the whole process of implementation of enterprise products; experience the completely product-developing process from ideas formulation, product design, product realization to production operation in real enterprise environments. The practice course that students have closely connection in excavator production, design and development in Shandong Lingong Construction Machinery Co., Ltd. is a wonderful instance.

Establishing university-enterprise education commonwealth. Signing long-term stable personnel training agreements with some classic large enterprises whose facilities, projects and advanced technology can be regarded as quality resources. Now we have healthy cooperation with companies such as Shandong Lingong Construction Machinery Co., Ltd, Shandong Heavy Industry Group, Haier, Sinotruk, Jinan Diyi and Dier Machine Tool Company.

Strengthening the ability in teachers' side. In order to meet the requirements of the excellent engineer program, teachers without engineering experience are arranged to go into enterprises and undergo practical project. Personnel of

enterprises with experience are hired in university at part time, undertaking some teaching missions in specialized courses, guiding capstone design, and teaching based on practical cases.

PROCESS CONTROL IN CAPSTONE DESIGN

Graduation design is the most important practical aspects, and it is essential to enhance the management in the process of selecting the capstone design subjects, the capstone design proposal, the mid-assessment, the defense and so on. Most capstone designs combine with the actual projects from the enterprises, and technical personnel of the enterprises are involved in specific guidance. The capstone design must concentrate on solving the actual engineering problems; in addition, it is preferred to be completed in the enterprise.

Arousing the initiative of the teachers and students with the key point checking, the students manage to realize the importance of the capstone design, which evokes the students' learning motivation. Consequently, the relatively thorough quality control of the capstone design has been formed. The main contents can be summarized as "two advisors, five links" as follows:

Two advisors

Employing two-advisor system, the one at school focuses on theoretical guidance, and the other in the enterprise mainly cultivates the students' practical ability. It is significant to take full advantage of the respective superiority of the two advisors. Based on studying the relevant engineering projects in the enterprises, go deep into the enterprises to participate in the practice and study the projects, then train the students' ability to solve the actual problems in the process industry on their own.

Five links

Selection of the projects. Scientifically selecting the project is extremely important, which directly influences the quality of the capstone design.

Capstone design proposal. According to the "triple supervision" requirement, firstly, the advisors give strict demand and management to the students on the basis of the plan, and seriously instruct the students to look up the literatures and finish the capstone design proposal and organize the argumentation and reply as well in the beginning three weeks.

Mid-term examination. Mid-term examination is mainly to see the execution of the students and the advisors in the implementation of the capstone design, supervise and urge the students to complete the design task better.

Defense. The defense can check the students' abilities of analysis, generalization, logical thinking and language expression. What's more, the students' capabilities to work independently, analyze and solve the actual engineering problems are examined as well.

Process evaluation. During the two weeks after the capstone design is finished, the academy organizes the experts from the enterprises to examine and verify the capstone design. It is mainly to inspect whether the materials for defense are complete, the grade evaluation is appropriate and so on. Timely, the experts give the feedback to the academy and enterprises.

CONCLUSIONS

While focusing on the development of excellent engineer along with the emphasis on strong foundations of theoretical knowledge, attention was paid to cultivating the ability of engineering practical and innovative ability to apply their engineering knowledge in a practical setting. As we considered in the ability centric model, curriculum, hands on practice system and teaching methodology reformation is needed. The current teaching groups are practice experienced by university-enterprises teacher interchanges. Finally, students' knowledge and ability are tempered and integrated in the capstone design, which is managed with the philosophy of quality and process control.

This innovative model has been demonstrated over recent five years and has achieved satisfactory results, overcoming the bottleneck in the practice of excellent engineer cultivation in mechanical engineering with the ultimate goal of improving the engineering practice and innovative ability.

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REFERENCES

[1] Yong Wang, Jianfeng Li, et al; The Discussion of Cultivating Excellence Engineers of Machinery Professional. Modern Manufacturing Technology and Equipment, **6**, 60-70 **(2010)**.

[2] Erin Crede, Maura Borrego; Learning in Graduate Engineering Research Groups of Various Sizes, Journal of Engineering Education, **101(3)**, 565–589 **(2012)**.

[3] Shuquan Song, Weidong Wu; Research and practice of the cultivation mode of application-oriented talents for students majoring in mechanical engineering, World Transactions on Engineering and Technology Education, **2(2)**, 221-224 **(2014)**.

[4] Walczak Magdalena, Uziak Jacek, M.Oladiran Tunde, Baeza Claudia Cameratti, Paez Patricia Thibaut; Industry expectations of mechanical engineering graduates. A case study in Chile. International Journal of Engineering Education, **29(1)**, 181-192 **(2013)**.

[5] Brad Stappenbelt;Plagiarism in mechanical engineering education: A comparative study of international and domestic students, International Journal of Mechanical Engineering Education, **40(1)**, 24-41 **(2012)**.