ATLANTIS PRESS
Advances in Social Science, Education and Humanities Research (ASSEHR), volume 182
2018 2nd International Conference on Education, Economics and Management Research (ICEEMR 2018)

Research on Training Mode for Excellent Engineer Plan in Light Chemical Engineering Specialty

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***Abstract*—The "3+1" teaching mode and project binding engineering capacity training system are introduced into the "Excellent Engineer Plan" of application-oriented light chemical engineering specialty. The applied excellent engineer training concept is determined through the analysis of the nature of engineering education and academic education, and the talent training system is built by highlighting the characteristics of engineering. The education system is carried out by taking advantage of industry development and background. The exploration and practice of teaching is conducted by the deep cooperation between university and enterprise for light chemical engineering, one of the outstanding project training specialties. This will be beneficial for cultivating high-quality engineering application talents characterized with engineering consciousness, engineering practice ability and innovation ability. The implement of teaching reform through the "3+1" training project, can serve as a reference on the training system for the university with same leve1.**

Keywords—excellent engineer plan; application-oriented; engineering education; cooperation.

I. INTRODUCTION

With the acceleration of the industrialization process, traditional production methods and industrial structures are showing a new form, diversification and a rising level of demand for talent trends to meet the new requirements of society and business. In the 21st century, education circles at home and abroad have put forward the concept of "comprehensive engineering education". [1, 2] Engineering education returns to the core content of the project, namely practice and innovation, and needs to change the situation that put too much emphasis on science orientation leading to deviation from the engineering practice [3].

China's higher engineering education was ranked first in the world, but the number of engineers and the overall quality was below expectation. This was attributed to the fact that the mode of traditional education is far from satisfying the needs of the cultivation of comprehensive quality talents in the contemporary market mechanism. According to the Swiss Institute for International Management Development's "Global Competitiveness Report", the number of qualified engineers in China ranked only seventh from the bottom on the list of 55 participating countries. "2010 National Competitiveness Blue Book" reported that China's human capital composition index value was only one-twelfth of the United States', and 10% of Japan's. [5] This data showed that although the total amount of China's human resources was big, the overall quality was low, especially skilled personnel, engineers and scientists who account for a very low proportion. In 2015 "Made in China 2025" was written in the government work report during the two important sessions, reaffirming the dream and planning of building China-Manufacturing-Excellence. To achieve this plan, there is an urgent need for a high number of top-quality talented engineers. [6]

At present, China is in the middle term of the industrialization development. The Chinese government made a major decision and took a new road to industrialization. In order to implement the "Outline of National Medium and Long-term Education Reform" and "Development Plan (2010-2020)" and "National Medium- and Long-Term Talent Development Plan (2010-2020)", the program of education and training for excellent engineers (the Outstanding Program) has been proposed and implemented to strengthen the practical ability as the core [7], to serve the practice of constructing an innovation-oriented country and to reinforce strategy of strengthening the country with talent.

Zhejiang University of Science and Technology (ZUST) has been the first pilot of the 10 local applied undergraduate institutions, and is also one of the most unique institutions learning from the German University of Applied Sciences experience. ZUST refers to the education model of the German University of Applied Sciences, develops international, applied, high-level talents as the position, and constantly explores the establishment of talent cultivation mode for application-oriented undergraduate with Chinese characteristics. Among them light chemical engineering (pulp and paper engineering) is one of the Outstanding Program pilot specialties, provincial key disciplines of "the 12th Five-Year Plan" and the provincial emerging characteristic specialty, runs a school based on industry advantage and industry background, carries out in-depth comprehensive school-enterprise cooperation projects, fully embodying the concept of "learning by doing secondary". Now, light chemical engineering has established good cooperative relations with the only three listed paper making companies in Zhejiang province, two major industrial base of "Chinese white paper" and " "Chinese specialty paper", and many large and medium-sized paper making enterprises, and developed more than 20 internships and employment avenues. A useful "exploration and try" has been put forward in the

cultivation of high-level application talents, and a sustainable development path appears.

II. Difference Between Engineering Education and Academic Education

To do well in engineering education, there is the need to clear the difference between engineering education and academic education. It is based on the understanding of the nature of engineering education to explore the ideas of implementation of engineering education and specific methods. The American Society of Engineering Education (ASEE) views engineering as an art that uses science, mathematical principles, experience and common sense judgments to create human-friendly projects and facilities. William, a former president of the Institute of Electrical and Electronics Engineers, argues that the most essential difference between science and engineering is the analysis and the synthesis. Exploring the results of a given cause is the primary task of science, and the aim is to explore the “what” and “why” of natural phenomena. The essence of engineering is to achieve a predetermined goal by the combination and creation of human and material resources or to re-create the intended goals. [8] It can be obtained through the above analysis that academic research is to explore or discover, revealing the nature of the phenomenon or regularity, not to innovate. Engineering is inseparable from innovation based on the characteristics of society and economy. Engineers and scientists are two different "products" of the two modes of education. As Theodore, father and educator of the American supersonic era said, "Scientists are discovering the inherent real world, and engineers are creating new worlds which have not yet appeared." [9] Therefore, engineering education should have different teaching ideas and methods from traditional academic education.

III. Building a Distinctive Project for Talent Training Program

A. Project binding system of engineering paradigm

The curriculum system of "engineering paradigm" strictly follows the thought of balance and cooperation. The main contents include theory and practice, knowledge and ability, technology and non-technology. On learning time, the process should be consistent with the practice of cognitive law, so that students participate in engineering practice as soon as possible. On learning space, the actual engineering scene needs to reproduce the curriculum based on a comprehensive school-enterprise cooperation basis. On learning depth, it reflects the purposiveness to solve engineering problems and emphasizes the integration and application of engineering knowledge, and on learning width, it emphasizes the integration of interdisciplinary knowledge, and reflects the complexity and timeliness of the project. The curriculum system integrates organically the three courses of "curriculum, skills and comprehensive quality", based on "3 +1" training program, and is closely linked with the training objectives. During the first three years, students get theoretical courses and teaching experiments in the school while short-term business practice and skills training are interspersed around the training objectives. The practice time of students is accumulated for more than a year, which is arranged for the cognitive internship, job training, engineering practice and graduate internship. The effect of the student's learning stage determines the key to the successful implementation of the Excellence Program [10]. There are clear requirements and contents reflecting the relevant engineering quality and capacity-building in each module of the curriculum.

B. Engineering innovation curriculum model with students-oriented.

The teacher acts as a knowledge provider, organizer and designer of teaching which follows the principle of "teacher-led and student-centered" in the process of teaching and practice of excellent engineer cultivation, to maximize the initiative and creativity of teacher and student into full play. On the basis of analyzing the students' cognition and psychological characteristics, the teacher should lecture the theoretical course to the point and lose no time to guide students productively. Things will work themselves out. At the same time, information technology serves as an effective auxiliary form of teaching, providing free exploration, the actual situation interaction and teamwork and sharing of resources and other learning atmosphere, and fully mobilizing the initiative and enthusiasm of students. It is important to organically integrate engineering abilities into discipline theory and knowledge system, to design and organize the teaching content based on the engineering project, engineering cases and engineering problems. Several kinds of research-based teaching methods are carried out such as inquiry teaching based on problems, cases and projects, discussion-based teaching and participation. The learning atmosphere of students is characteristic with independent thinking, active exploration and innovation based on large operations, thematic reports, literature review and thematic research reports as the carrier. Students develop capabilities which include program design, project implementation, teamwork, and communication in the "engineering paradigm" training. The higher professional quality will form, and the engineering practice and innovation gets strengthened. Based on ability training, American college education gives students great autonomy, so that students can watch the market, adjust them at any time, and cultivate themselves into talents needed by enterprises. Whatever they want to learn, under the guidance of student mentors, the students are in charge of their own decisions [11].

C. Establishment of the whole process and practical assessment mechanism.

In order to establish the whole process of assessment and evaluation mechanism, it is necessary to focus on the assessment of student’s ability of knowledge application and innovative thinking. The students are guided from the superficial and utilitarian to intrinsic, deep desire for knowledge, from the focus on the knowledge point of the mind to engineering applications, from the pure score first to the overall quality of the upgrade. The marks adopt cumulative calculation method, and the assessment will go throughout the entire teaching process. At the same time, the ratio of assessment is put forward including school attendance, classroom performance, the group project, the period of the examination and so on according to the characteristics of different courses, especially giving a larger weight for project design and case discussion. Assessments focus on practicality.

The practical characteristics of engineering education determine the practicality of the assessment content. In the past, the content of the course exam focused on the understanding and memorization of knowledge, such as theory, principle and structure. The scope of the examination came from books, courseware and class notes. Before examinations, the scope and emphasis are usually given resulting in a bad state that students adopt strategies of rote targeting test. So it is obviously detrimental to the cultivation of student innovation and practical ability. Based on the training objectives and requirements of application-oriented excellence engineers, the examination content should focus on innovation and practicality, taking into account this basis reduces the proportion of objective knowledge points and amplifies the proportion of practical problems associated with engineering practice including engineering cases, engineering projects and engineering problems.

IV. Reform and Practice of Outstanding Talent Cultivation of Light Chemical Engineering

A. Enterprises participate deeply the whole process of talent cultivation

Good cooperation between the school and the enterprise can make the advantages and resources of both sides to get the best complementation, configuration and sharing. However, the value orientation of enterprises and universities is different. Under the traditional education mode, due to lack of system guarantee and policy support, the responsibility of enterprises in practice training is not clear, and the initiative of accepting interns is lacking. The training effect of practical ability in key engineering practice is weakened, which will significantly affect the student's engineering ability. The specialty puts forward a comprehensive cooperation agreement based on the three parties of school, enterprise and students, clarifying the responsibilities, rights and obligations among them, as well as the technical secrecy and the repercussions for breach of contract. Through the inspection of internship part, enterprises can choose the most suitable graduates who can meet the needs of the work requirements and are familiar with the corporate culture and operation, and able to work independently. This is vital to lay the foundation for enterprises actively participating in personnel training. This will turn a simple unit of employment into a joint training unit, and colleges and enterprises will achieve a real win-win cooperation. The enterprises select experienced technicians or administrative staffs to participate in the amendments of personnel training programs, syllabus and so on about excellent talent cultivation of light chemical engineering. In order to ensure good progress of the students in the enterprise engineering practice, each student will be equipped with an intern mentor by the enterprise and all the students will learn management and norms. In accordance with internship assessment requirements by collective setting, the student will get guidance and supervision at each stage of the internship process. At the same time, the enterprises provide students with graduation design/ thesis topic according to their own operation and development needs.

B. Construction of high-level engineering education teaching faculty

The specialty tries to establish a new mechanism which organically integrates teachers and engineers through the method of "sending out and leading in" and strengthens the teacher training of application engineering and innovation. The main measures are as follows: first, to establish an entering company system of full-time teachers and to develop a number of double-qualified teachers. New young doctors must go into the company for more than a year training, and are required to participate in the new project or new product development of companies in the process. The teachers above associate professors must dock more than one related company and carry out technical cooperation, turning into double-professionally-titled teachers with strong engineering capabilities. The proportion of double-professionally-titled teachers should be more than 80%. Secondly, there should be the introduction of high-level part-time enterprise teachers. The technical staffs with engineering experience and senior management personnel are selected from the cooperative enterprise as the school part-time teachers, who lecture on engineering cases, engineering awareness and corporate culture in the classroom. Thirdly, the level of teaching is taken into account as the indicators of academic level of teachers, including the preparation of handouts, knowledge transfer skills, student evaluation, and peer evaluation.

C. Strengthening engineering practice and innovation ability for four years study

From the first year, courses such as orientation education, engineering introduction and understanding practice are set up so that students are able to understand the new professional, practical engineering and the social role of engineers quickly. During the sophomore and junior year, certain experimental courses and design courses are added into some professional theory courses. The comprehensive engineering courses based on questions, projects and cases are open, and concentrated practice will be enriched through company visits, cognition internships, and on-site lectures. Senior year, students as "quasi-staff" take part in engineering practice and graduation practice in the co-production line. The students participate in the project design, new product development, process optimization and inspection of finished product of the enterprise by the model of "project system" and "rotation system", completing the curriculum module corresponding to the post and project.

David A. Sousa revealed that human brain work has its own characteristics, and hence active learning such as group discussion, demonstration and hands-on practice can increase the rate of knowledge retention to 70% to 90% [12].In the process, the students can analyze the engineering problems comprehensively and present the solution put into effect by using learned knowledge. They should be proficient at the positions of process control and equipment operation based on practical technology and engineering standards, understanding the technology status of existing products, and carrying out technological innovation and secondary development.

V. CONCLUSIONS

With the background of economic globalization, China's manufacturing industry has been sustained developmentally. However, under the impact of the global financial crisis, the low-end processing production of China's tradition exposed many drawbacks. Therefore, we must master the high-end core technology. The demands for engineering and technology talents on the ability are put on higher levels. Through the implementation of the "Outstanding Program", the pilot project of light chemical engineering has made use of industry advantages and industrial background to carry out the reform and exploration of talent cultivation. Based on practice and innovation as the core, the training is focused on engineering capacity and innovation capacity, and the students get comprehensive and coordinated development in the process. The result is that the buffer time from campus to company is significantly reduced to meeting the requirements of the company.

ACKNOWLEDGMENT

This work was financially supported by the class teaching reform project of Zhejiang province under Grant No.kg2015272, and the introduction project of the foreign excellent courses and enterprise courses in Zhejiang University of Science and Technology.

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