



Teaching Reform and Practice of the Course Mechanism Manufacture Technology Basis Based on CDIO Education Foundation

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Abstract. CDIO, established by MIT, is the advanced modern engineering education concept which had been used widely in the world. Aimed at the status and role of the course mechanism manufacture technology basis in the engineering personnel training and problems in teaching, this paper putted forward the model of curriculum reform thinking and practice of CDIO engineering education model in order to cultivate the ability of the innovative practice, comprehensive analysis and the team cooperation. Research and exploration of teaching reform had promoted on educational concept, training mode, organization and operation management and several aspects. The educational process in the specific context of the product/system life cycle, helped students to set up the engineering concept, occupation ethics, team spirit and success and share consciousness, which offered the reference and inspiration for the applied talents training mode innovation.

Keywords: CDIO · Machinery manufacturing technology · Training mode

1 Introduction

CDIO is a new engineering educational idea and implementation system, which is developed and proposed by Massachusetts Institute of Technology, together with three leading industry university Chalmers University of Technology, Linköping University and the Royal Institute of Technology University. CDIO is the abbreviation of English word conceive, design, implement, operate. The “conceive” including analysis of customer needs, design of technology, business strategy and regulations, formulation of development idea, technical procedures and business plan; The “design” including projects plans, design of drawings and implementation program; The “implementation” refers specifically to the process to transform design into product, including confirmation of manufacture, decoding, test and design program; The “run” is assessment process for pre-program mainly through products putted into use, including the revision, improvement and withdrawals of the system [1, 2]. CDIO syllabus divides the ability of engineering graduates into four aspects: technical knowledge and reasoning, personal and professional skills, interpersonal interaction skills, adaption and adjustment to large-scale systems, requires to enable students to achieve the desired goals in

these four aspects through a comprehensive approach. In the educational idea of CDIO, the culture of all-levels quality is integrated within the framework of the overall culture, comprehensively trained and developed which is based on team project. The establishment of part of the syllabuses in this mode directly corresponds to the engineering quality requirements, the framework of education is systematic and innovative in worldwide higher engineering education [3]. In order to achieve the goal of CDIO ability training, the existing professional training programs and professional fundamental course teaching model must be adjusted and reformed. Mechanical manufacturing technology foundation is a main technical foundation courses for the mechanical profession students, this course is streamlined from the original courses, such as tools and principles of metal-cutting, introduction of metal-cutting machine, machinery manufacturing crafts, machine fixtures. The main contents of this course include basic knowledge about common processing methods and equipment in machinery manufacturing process, metal-cutting theory, manufacturing process and fixtures of the parts. The broaden knowledge, rich content, good theory and practicality of the course make it play a very important role in training the ability to analyze and solve practical engineering problems, mechanical design ability, innovation ability of students and high-quality compound talents. But the traditional educational ideas, models and management tools are difficult to meet the requirements of present talents training, so exploring the advanced engineering educational idea and implementation system based on CDIO has great significance for the reform of mechanical manufacturing technology fundamental course.

2 Problems in Mechanical Manufacturing Technology Teaching

First, traditional educational idea pays attention to imparting knowledge while ignoring the training of self-learning ability and interpersonal communication skills, which makes students' learning ability, autonomy and creativity hard to full play, and students taught in this mode lack of suitability and competitiveness, the drawbacks of engineering innovation awareness and technological innovation ability training to talents are incompatible with present social requirements. Secondly, the design of course pays too much attention to engineering science instead of engineering systems, the course system is single, knowledge structure is antiquated, ignoring the systematic of engineering knowledge, which make it difficult to adapt to the rapid development of society. Thirdly, theory and practice are out of touch, practice opportunities for students are few, and it is difficult for students to have the opportunity to get involved in the actual project, then they are lack of initial capacity and quality to manage modern engineering projects. Lastly, there is a lack of scientific and effective teaching organization and evaluation mechanisms, which cannot give full play to initiative and enthusiasm for teachers and students, and seriously hampers the development of teaching reform. These are the major problems existing in higher education. It is an era of knowledge explosion, we should pay much attention to the training of self-learning ability, practical ability, innovative ability, self-control, teamwork and communication skills, not only the necessary knowledge.

3 Change of Educational Idea Based on CDIO

3.1 What's the Purpose of Education

The famous educator Whitehead said: “The reason for the existence of university is that university enables the integration of young and old, and makes imaginative exploration to scholarship, which can build bridges between knowledge and pursuit of life’s passion, and impart knowledge in an imaginative way. This kind of imaginative exploration can produce exciting ambiance, and knowledge is full of vitality, which inspires our dreams like a poet, set goals like a designer, it is no longer the burden of memory. Of course, the imagination is unable to be divorced with reality, if the young full of imagination are able to be strengthened by exercise, the vitality full of imagination is likely to remain for long time, and the task of university is to combine the imagination with experience.” American educator Hutchins pointed out: “What is education, education is to help students to learn to think independently, to make independent judgments, and to work as a responsible citizen.” Freud believed that the purpose of education is to make young people healthy, capable, adapted to their environment, and successful from the concept of the society. However the present education is just the opposite, in the teaching of mechanical manufacturing technology course, more attention is payed to imparting knowledge, which leads to out of touch between theory and practice, and limits the ability of independent learning and imagination. In recent years, the industry come to realize that professional engineering college graduates are difficult to meet the requirements of industrial production in reality because of being seriously out of the practice, the university engineering education must actively adjust the training model to meet the requirements of industrial production fields [4]. Therefore, a significant characteristic of CDIO engineering education model is prone to focusing on manufacture practice based on continuing to strengthen the learning of basic theory.

3.2 Change the Role of Teacher Based on CDIO

The educational idea of CDIO requires that teacher should become a innovator, and center on the students. The role of them should be changed from the leader to guider in the learning of integration of students and teachers “The learning of integration” (students should not only learn the professional knowledge, but also pay attention to the culture of personal and professional skills, interpersonal skills, and for large systems and regulation and adaption ability for huge system in the engineering project reality), ensures every student to actively participate in engineering project and development of team project, and improves the ability for teamwork and project. The role of teachers should be changed from the imparter of scientific knowledge to the designer of engineering project, they will build learning environments, develop learning resources and provide learning services for students, trying to make students take practice and participate in project full of passion. Teachers should propose the course plans on which is beneficial to the improvement of students’ ability, attitude and leaded by project, and arrange the teaching time and content reasonably based on the purpose of CDIO [5].

3.3 Requirements for Teachers' Ability Based on CDIO

The purpose of machinery manufacturing technology's teaching is to enable students to acknowledge and master the basic principles and methods of mechanical product manufacturing processes, lay solid theoretical foundation to professional courses learning, graduation project and the work of in mechanical product design, manufacturing and production management after graduation, mechanical manufacturing technology is largely based on the practice and application of the program. Teachers are the soul of teaching systems, and they directly determines the teaching quality. Standard 9 and 10 of CDIO put up some requirements for high-level teachers team. CDIO emphasizes the importance of teaching ability and CDIO skills of teachers. At present, the acknowledge of basic knowledge of many teachers are pretty good, disciplines relatively solid, but they are lack of engineering practice and experience in the business environment. Teachers should continue to enhance the knowledge and ability to reach the CDIO standards. CDIO faculty building is highly relative to engineering education reform, we must pay more attention to it, giving full play to the advantages of higher education in our country.

3.4 Talents Standard Based on CDIO

Under the great competitive pressure from the popularization of higher education, how to reflect the requirements for the students personalized training, and meet the different requirements for objectives and standard of talents is the problems faced by colleges and universities. We must emphasized that both imparting knowledge and education, theory and practice, learning and innovation are equally important. Standard of talents is not just the ability, loyalty, responsibility, gratitude, honesty, fairness, kindness and dedication are more important. The training of all-levels quality from CDIO educational idea is integrated into the overall training framework, and centered on team project. The training of the ability includes theoretical knowledge, personal and professional skills and professional ethics, interpersonal and project the conception, design, implementation, and operational abilities. We are trying to systematically improve the overall quality of students in a scientific training model, train those talents who are competitive internationally in the international education ideal to respond to the opportunities and challenges from globalization, and strive for Chinese dreams.

4 Establish the Training Mode Based on CDIO Educational Idea

4.1 Build the New Teaching System of Mechanical Manufacturing Technology Foundation

Mechanical Manufacturing Technology Foundation course has rich content, which is a combination of the original four major professional courses in accordance with the principles of more foundation, less hours, broader face, the newer knowledge. The course content is closely linked with the production practices and students can get

much knowledge from the practical teaching. The course is a comprehensive, fundamental and practical course. During the teaching design process the educational idea and implementation system of CDIO should be learned and the Mechanical Manufacturing Technology course should be reformed and created new course content and system. Centered on the training of engineering ability, a hierarchical system of practice teaching should be built and technological innovation practice will be strengthened. As for the problem of lack of theoretical hours, the contradiction between the course content and hours can be solved by two methods “learning in doing” and “teaching and learning in the project”. Thus, theoretical teaching and innovative practices can be well combined and the course system will be improved further while students’ engineering awareness and ability are improved.

4.2 Build the Platform of “CDIO Environmental Background”

Basic knowledge of project management and engineering, a strong sense of innovation and initial capacity of developing and designing products are dependent on engineering practice. Engineer is creating the specific product by abstract knowledge to create abstract knowledge. Engineering education is providing a situation of accumulating and exploring knowledge to make engineers gradually master and use the link between the abstract knowledge and specific products. The concept of “situation” is the first standard of CDIO (CDIO environmental background) [6]. Training engineering capability emphasizes practice and requires students to have first-hand experience. In accordance with the CDIO standards, engineering training center should base on the requirements of Mechanical Manufacturing Technology course and build “CDIO environmental background” platform. Engineering training center provides such a knowledge-capability transformation channel that students can obtain the basic vocational skills and project quality in a real professional environment.

The design of “CDIO environmental background” platform enables students to actively learn creatively and practically and supports the entire lesson plans. The platform provides the conditions for engineering practice: sites of conception, design and implementation. In the conception sites, thinking about engineering practice sites enables students to think out a new product and understand user’s needs and development concepts. The sites should include the individual and team practice sites for students to talk, listen and think in order to encourage the formation and optimization of concepts. In the design sites, students can design, analog design, share design and make interactions. Finally in the implementation and operation of engineering practice sites, students can obtain the corresponding feedback to improve the product system through the construction and operation of product systems. Of course, engineering training center can also simulate the outside plant normally in motion so that students in the school can directly accept practical and work on-site training.

4.3 Construct the Course Teaching Mode Combining “Case Teaching” and “Project-Based Learning,”

Mechanical Manufacturing Technology course requires teachers to integrate theory with practice in the teaching process. Therefore, teachers should explain procedure

cases fully to allow students to understand some abstract concepts and theory so that students will not feel boring and improve learning enthusiasm. Meanwhile students can have the initial cognition on the industrial systems, train professional interest and establish innovation and engineering consciousness. Training cases should include the “cognition about typical equipment, tools and fixtures construction”, “cognition about typical product line”, “cognition about typical parts machining technology”, “safe production and operation management” and so on. During the teaching process, students are familiar with planning, designing, implementing, operating about the main line of industrial products and form the CDIO consciousness. Case-based teaching methods will be the main means of education in the future, which has unparalleled advantages and should get high valued by whether teaching staff or teaching resource providers.

Mechanical Manufacturing Technology course is a comprehensive practical subject. It is necessary to apply the reform using “project-based learning” mode guided by constructivist theory. Teachers can design and organize teaching contents in the mode of project lead, task-driven, teaching and learning combination. The projects in teaching should have high technical content that include teaching knowledge and is close to the actual production. Teachers should make students become learning subjects and lead them to study in groups by solving problems. In groups students can learn actively through positive interaction with other team members, discussing, exchanging ideas, encouraging each other and communicating. After the new teaching mode is applied, students can improve their enthusiasm and initiative of learning and ability of solving the engineering problems, preparing for the future jobs fully.

5 Establish Quality Evaluation and Monitoring Mechanism About Course Teaching Based on CDIO

Teaching quality is the lifeline of higher education and improving teaching quality is the eternal theme in colleges and universities [7]. It appears very important that how to evaluate the quality of teachers and the ability of students. British educator Whitehead said, “it is very wrong to evaluate a teacher according to published works with his signature. In any group of teachers, you will find some outstanding teachers that don’t belong to those who published monographs. Their creative ideas need to be presented in the direct communication with students through speech or individual discussion. These people have had a huge impact on human development, such as Socrates. “Teaching quality management should be the management and monitoring of teaching process. The teaching mode based on CDIO must strengthen the control and evaluation of the teaching process, make new standards following scientific, leading and practical principles and regularize teachers’ “teaching” and students’ “learning” behaviors. Teachers should be strengthened talent training consciousness and focus on quality education and engineering training. Meanwhile, they should actively participate in teaching quality monitoring and pay attention to students’ ways of thinking, learning methods, operational ability and innovation ability. For students, they should be encouraged to learn actively and initiatively and gradually form a correct outlook on life, values, society, family and employment. Besides, the universities should create a

good educational environment and academic atmosphere so that students can take diversified study according to their own interest. The management of a university faculty is different from the administration of a business organization. Teachers' opinions and common passion for the university's educational goals is the only effective guarantee for running a university well.

6 Conclusion

The educational reform of Machinery Manufacturing Technology Foundation course based on CDIO educational idea establish the "learning in doing" and "teaching and learning in the project" teaching mode. The mode provides students with teaching situations which combine theoretical knowledge and practice and a systematic cognitive framework. In the mode, teachers change their own role and have the right outlook on talents. For students, they can carry out integrative learning and master the skills of planning, designing, implementing and operating in the enterprises and social environment. This reformation makes education process exposure to the specific situations of product or system life cycle and helps students gradually establish engineering concepts, professional integrity, teamwork and success and share awareness. Also, it provides reference for innovating the teaching model of training applied talents.

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