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Original Paper

Exploring and Construction On Practicality Instruction System in Engineering Education Based On CDIO Concept

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Abstract

Choosing a faculty of the college as an attempt, the author analyzed the CDIO concept and its necessity in practicality instruction system, discussed the construction of practicality instruction system in engineering education under the direct of CDIO concept.

Keywords

CDIO concept, practicality instruction system, explore and construct

1. Introduction

The urgent task currently facing higher engineering education in China is to cultivate engineers who are in line with international standards as soon as possible. However, there are still many problems in domestic engineering education in practice, such as emphasizing theory over practice, emphasizing individual academic ability over team collaboration spirit, and emphasizing knowledge learning over cultivating innovation. Compared to European and North American students, they are used to solve practical problems by team approach. However, engineering education in China, the students focus on theory, without practical training in project and team work. In actual work environments, students lack the skills to combine basic knowledge, personal and professional skills with team collaboration and communication.

In traditional higher engineering education, people tend to consider practical teaching as a supplement to theoretical teaching, and practical teaching is subordinate to and dependent on theoretical teaching as an explanation and explanation of theoretical teaching. Its teaching is often designed as a small part of theoretical teaching hours, generally not set up separately, and the practical teaching links lack close connections and are relatively scattered, making it difficult to form an independent practical teaching system. As a test of theoretical teaching content, practical teaching requires teachers to have rich experience in practice or experiments, and to guide students in the process of transforming indirect knowledge learned in the classroom into direct knowledge, deepening their understanding of theoretical knowledge, rather than students being passive operators and unable to exert subjective initiative in the practical process. This is not conducive to the cultivation of students' abilities.

In engineering education, the theoretical teaching objectives are clear, but the specific teaching objectives to be achieved in practical teaching lack specific requirements, and the measurement standards are vague. Teachers make judgments based on their own experience in the practical teaching process. Given the level of teacher quality, the results of judgments are also greatly different, so the implementation effect of the practical link is not ideal. The theoretical teaching content is constantly expanding, and the practical teaching resources are becoming increasingly scarce, seriously deviating from the original intention of engineering education. Therefore, the reform of engineering education is very urgent and necessary.

2. Engineering Education Practice Teaching under the CDIO Concept

CDIO represents Conception, Design, Implementation, and Operation. It takes the lifecycle from product development to product operation as the carrier, allowing students to learn engineering in a proactive, practical, and organic way between courses. It takes the lifecycle of engineering projects (including products, production processes, and systems) from development to operation as the carrier, allowing students to learn engineering through active practice and organic connections between courses. The concept of CDIO not only inherits and develops the engineering education reform concept of Europe and America for over 20 years, but more importantly, it proposes systematic ability cultivation, comprehensive implementation guidance, complete implementation process, and strict result testing, which has strong operability. Therefore, it is necessary to implement CDIO education in engineering education.

2.1 Practical Teaching Plays a Role in Cultivating Engineering Talents

The project conception, design, development, and implementation abilities under the CDIO concept cultivate students' strong self-learning ability, organizational communication ability, and coordination ability, rather than allowing them to focus on the specific knowledge content of the project. On the one hand, practical teaching can only be carried out through specific engineering projects, and the results obtained should also be students' ability and methods to transform theoretical knowledge into abstractions from specific engineering practices; On the other hand, practical teaching can leave ample space for students to fully unleash their autonomy. In the process of practice, students apply their knowledge and theories to discover, analyze, and solve problems, cultivating their spirit of continuous exploration and innovation. In the process of practical teaching, the combination of theory and practice, as well as the combination of hands-on and brainstorming, is an important way and means to improve students' level of integrating theory with practice, and cultivate their engineering awareness and practical ability.

2.2 Engineering Theory Teaching Requires Verification of Practical Teaching

The CDIO teaching method is a concentrated summary and abstract expression of “learning by doing” and “Project based education and learning”, which has achieved good results worldwide and has been widely welcomed by students and highly praised by the industry. Students in higher engineering colleges in China have a solid grasp of theoretical knowledge, but their engineering practical abilities are poor, and theoretical knowledge still needs to be tested through practice. Higher engineering colleges should cultivate students with strong hands-on skills in the field of employment, rather than just focusing on book learning. Enterprises value efficiency and cost, and do not spend a lot of financial and material resources to cultivate a “semi-finished product”. Moreover, many seemingly advanced technologies in the application field will be replaced by new technologies or tools in a few years. Only by placing equal emphasis on theoretical knowledge and practical abilities can they be used for life. On the other hand, without a solid foundation, it is difficult to understand more complex or advanced application technologies, which will be a huge obstacle for future career development and improvement. This requires engineering education to broaden the scope of teaching practice, integrate teaching practice resources, ensure teaching practice time, increase funding for teaching practice, and make great efforts to consolidate, expand, and develop various internship bases both on and off campus. It is particularly important to cultivate students’ practical and innovative abilities.

2.3 Improving Engineering Education Requires the CDIO Teaching System

Under the premise of emphasizing the strengthening of scientific foundation, current engineering education in China should emphasize individual ability, team ability, and system regulation ability. The effective means to achieve these goals is the CDIO teaching system. The basic content of CDIO can be summarized as follows: one vision; one outline and twelve standards. To improve engineering education, schools must set the task of cultivating engineers with professional skills, social awareness, and entrepreneurial acumen. This is necessary to maintain efficiency, innovation, and excellence in an environment that increasingly relies on complex technological systems. Complex engineering systems require individuals with mature thinking and modern teams based on engineering environments. This becomes a complete CDIO teaching system, namely: conceptualization-design-implementation-operation.

3. Exploration of CDIO Practice Teaching System in Our College

The teaching objectives of the “Multimedia Technology” course in our computer department require students to be familiar with the basic concepts of multimedia technology, learn to use multimedia hardware devices and software environments, and be able to use various multimedia creation tools to develop multimedia application systems or create multimedia works from an application perspective.

In traditional chalkboard and chalk classrooms, this course is difficult to teach. Even if classroom teaching is moved to multimedia classrooms for teaching, despite the large amount of classroom teaching information and the ability to provide intuitive and realistic performance effects, it is still difficult to achieve the “learning by doing” engineering education model proposed by CDIO. Only by arranging classroom teaching in multimedia classrooms, can various multimedia creative tools be taught while practicing, meeting the requirements of CDIO’s “learning by doing”. At the same time, the introduction of task driven teaching method has changed the traditional passive teaching mode of “learning by listening”, which is beneficial for stimulating students’ learning interest, cultivating their ability to analyze and solve problems, and improving their ability to learn independently and collaborate in teams.

The “Multimedia Technology” course is a highly practical course that fully embodies the organic combination of theoretical teaching and practical teaching. Therefore, it is necessary to run through the practical teaching system of the course in order to cultivate students’ practical skills and engineering innovation awareness. The following figure shows the list of multimedia laboratory equipment and the list of experimental projects offered in this course.

Table 1. List of Experimental Projects and Equipment for Multimedia Technology Foundation Courses

Experiment Name	Experiment Equipment	Experimental content
Sports broadcasting tools (validation)	MPC (including sound card and disc burner), ACDSee, MediaShow, etc.	Image browser, audio and video playback tool, multimedia electronic photo album, art character production
Sports broadcasting tools (validation) Image acquisition and processing (design oriented) Computer animation production (design oriented) Video capture and processing (design and validation) Multimedia production tools (design oriented and comprehensive) Multimedia application software (comprehensive and innovative)	Earphones, audio editing software, disc burning software Scanners, digital cameras, image processing software, CD burning software Animation production software Digital camera, camera, video editing software, disc burning software Multimedia creation tool software, multimedia webpage creation tool	Sound recording, audio acquisition, audio editing, sound effects processing, dubbing production, music CD burning Digital image acquisition, image editing and transformation, filter effects, photo retouching, painting art Animation design, basic software usage, simple animation production, ActionScript programming, interactive animation Digital video acquisition, video editing, transition effects, video filter, subtitle production, recording VCD/DVD Develop simple multimedia software (courseware) or multimedia websites Integration of images, text, audio, and

	video on a theme chosen by students themselves

The first six experiments used the CDIO "learning by doing" teaching model, while the seventh experiment used the "project-based education and learning" method. The practical requirements of this course require students to master audio, image, animation, and video production and editing processing, and be able to develop or integrate multimedia application systems or multimedia works. Therefore, in each media experiment, some creative tasks should be assigned to improve students' practical skills and engineering innovation awareness. For example, in the audio collection and editing experiment, students are required to create a sound that they recite or converse, add background music, and then perform some sound effects processing. If the computer is equipped with a CD burner, students can burn their own created sounds onto CD discs.

After mastering the basic knowledge and skills of multimedia, students can undergo engineering training in comprehensive application abilities. For example, students can independently choose comprehensive and innovative projects based on their own interests, then conduct overall planning and design, and use multimedia materials accumulated from previous experiments to complete the development of multimedia application software. This not only stimulates students' initiative in learning, but also enables them to design creative multimedia works or multimedia application software. Through the development of practical projects, on the one hand, students can reflect on whether the various conclusions made during the learning process are reasonable, and more importantly, it can exercise their personal skills, allowing them to play their role in the entire system's conceptualization design implementation operation process, and carry out effective engineering practices.

4. Construction of Engineering Education Practice Teaching System

4.1 Construction of Practical Teaching Faculty

The construction and implementation of the practical teaching system has put forward higher requirements for the teaching staff of practical teaching. It is necessary to strengthen the construction of the teaching staff of practical teaching and establish a "double teacher" structure team that can conduct both theoretical and practical teaching. The teaching staff of practical teaching is not just simple experimental technicians, but must have high-level theoretical course teachers and research personnel participate in the construction of practical teaching courses, in order to improve the overall level and quality of practical teaching.

4.2 Construction and Management of Practical Training (Internship) Base

The construction and management of practical training (learning) bases is also anS important aspect of ensuring the quality of practical teaching. Having advanced training (learning) equipment and a good training (learning) environment plays a crucial role in cultivating college students' practical, engineering, and innovative abilities. In the past two years, our college has further increased investment in the construction of internal and external training (learning) bases, taken various effective measures to strengthen the cultivation of students' engineering practical abilities, increased and encouraged students' hands-on operation time, and established the Hebei Iron and Steel Metallurgy Vocational Education Group as a platform to promote school enterprise cooperation education. At the same time, the school actively strengthens the management of on-site training (learning) bases, establishes and improves management systems, improves the utilization rate of on-site training (learning) bases, and promotes the open management of on-site training (learning) bases. Enterprises can establish production workshops in our school.

4.3 Establishment of a Practical Teaching Evaluation System

In order to ensure the teaching quality of the practical teaching system, it is necessary to establish a practical teaching evaluation system, which adopts various methods such as the construction and management evaluation of on-site practical training (study) bases, the evaluation of practical teaching courses, the selection of excellent experimental technicians, the training of individual and comprehensive technical application abilities (including course design, graduation design, etc.), and the monitoring of practical training in vocational positions to conduct comprehensive inspections. Especially through comprehensive practical training such as simulation projects and simulation cases, the evaluation of students' comprehensive ability to solve practical problems is conducted.

Modern engineering education is first formed to adapt to economic development and scientific and technological development, and its connotation has also undergone changes and expansion, which inevitably requires keeping up with the needs and changes of economic modernization. The biggest challenge facing the current practical teaching system of engineering education comes from the rapidly developing high-tech. To enable students to adapt to the requirements of modern enterprises in the future, the practical teaching content must reflect high-tech, modern management concepts, and modern economic activity characteristics.

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