THE EXPLORATION AND APPLICATION OF "PSPC-CDIO" MODE FOR INNOVATIVE PRACTICE

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ABSTRACT

Innovative practice ability refers to the ability to raise, analyze and solve new problems. The innovation training project is a significant part of the quality project launched by the Chinese Ministry of Education, which provides an effective approach to cultivate innovative practice ability of college students. Focusing on the goal of promoting innovative practice ability, a "PSPC-CDIO" (project driven, student dominated, practice and training, and comprehensive assessment based on CDIO) mode for cultivating innovative practice ability is proposed. The application of innovative teaching and training demonstrates that the effectiveness of the "PSPC-CDIO" mode.

KEYWORDS

Learning target, Engineering practice place, Active learning, Student assessment, Programmatic evaluation, Standards: Design-Implement Experiences, Active Learning

INTRODUCTION

Innovative practice ability refers to the ability of college students to raise, analyze and solve new problems, and cultivating the ability has become an important task of education in colleges (Yang &Yan, 2017). During the period of the 12th Five-Year Plan (from 2011 to 2015), the Chinese Ministry of Education implements innovation and entrepreneurship training program for college students. It includes three categories: innovative training, entrepreneurship training and entrepreneurial practice project. Among them, the innovative training project aims at inspiring innovative thinking, cultivating the innovative spirit, improving innovative practice ability, and laying the foundation for training innovative engineering talents.

Different from the class teaching, the teaching of innovative training focuses on students' individual characteristics, and encourages students to carry out practice training based on their research interest and professional knowledge. It has many similarities and common points with "CDIO" (Conceive-Design-Implement-Operate) engineering education, such as educational objectives, training methods, practice contents, and so on. Both of them encourage students to practice collaboratively, emphasize "education and learning via practice project", and resolve the contradictions between theory and practice in engineering education effectively.

The CDIO engineering education provides a good reference for innovative practice training of engineering talents in Chinese colleges, and several research works have been proposed in the literature. Shantou University initiated the “EIP-CDIO” (Ethics, Integrity, and Professionalism-CDIO) engineering education and personnel training mode. (Gu, Shen, & Li, 2008) presented the concept, connotation and implementation plan of “EIP-CDIO”. Tsinghua University utilized CDIO engineering education mode into practice courses, which regarded engineering education as a series of service engineering product manufacturing process, and organized learning activities of teachers and students with hierarchical structure (Gu, 2009). (Wang & Cheng, 2010) proposed the "three-in-one" training plan for knowledge, ability and quality of electronic information specialty based on CDIO. Li Tong (Li, Zhang, Wang, Liu, & Kang, 2014) proposed the “SE-CDIO” (Soft-Engineering-CDIO) engineering education mode for software engineering in terms of talent training syllabuses, curriculum systems, teaching methods and evaluation systems, and so on. (Xie, Jiang, Li, & Zheng, 2012) summarized the characteristics of teaching activities such as curriculum plans, teaching methods, practical experiences, and so on.

The development of engineering education and reform of innovative practice teaching raises two key problems to solve: one is how to combine innovative practice teaching with CDIO engineering education, and the other is how to construct a new practical teaching mode that contains CDIO educational philosophy and intrinsic characteristics. In view of the above problems, a new teaching mode of innovative practice called “PSPC-CDIO” is proposed, which is expatiated as “project driven, student-dominated, practice and training, and comprehensive assessment” based on CDIO. The main contributions of this work can be summarized as follows.

(1) The “PSPC-CDIO” mode is proposed for innovative practice training.

(2) A concept of “learning by doing” and “doing by learning” is introduced into the “PSPC-CDIO”.

(3) The “PSPC-CDIO” mode has been applied to practice training and achieved many good results, such as prototypes, demo systems, technical report, academic papers and patents.

The rest of this paper is organized as follows. Section 2 expatiates the conceptual meaning of “PSPC-CDIO”. Section 3 demonstrates the construction of the “PSPC-CDIO” mode. Section 4 demonstrates the application of “PSPC-CDIO”. Finally, conclusions are given in Section 5.

CONCEPT OF “PSPC-CDIO”

CDIO is the abbreviation of the following four words: conceive, design, implement and operate. “Conceive” is to define user needs, consider all kinds of constraints, improve concepts, technologies and business plans, and form clear thoughts. “Design” is to propose the schemes and methods for products, processes and systems. “Implement” is the process of transforming design into a product, including manufacturing, integration, testing and verification. “Implement” is to show the value of the products, processes and systems that have been realized, including system maintenance and optimization, and so on (Kang, Lu, & Xiong, 2007).

The CDIO engineering education mode lets students learn engineering from practical courses covering the life cycle of product development and product operation. Its essence is "learning by doing", which emphasizes the practices, encourages students to take active learning, and pays much attention to the cultivation of teamwork consciousness. It is a unique mode that combines practice education with theoretical education, which accords with the training objectives of innovative practices.

In the process of learning, assimilation and application of CDIO, the authors proposed a “PSPC-CDIO” mode, which is expatiated as “project driven, student-dominated, practice and training, and comprehensive assessment” based on CDIO, as shown in Fig.1. “Project driven” means taking the project objectives as the “goal” throughout all the process of conception,

design, implementation and operation. “Student dominated” requires highlighting the dominant position of students, giving full play to students’ subjective initiative and creativity, and encouraging students to complete innovation and practice projects collaboratively. “Practice and training” requires proposing problems and solve problems close to engineering practice, combining theoretical knowledge with engineering practice, and integrating technical solutions with product development effectively. “Comprehensive assessment” implements an all-wave, diverse and comprehensive examination and evaluation system, and takes the expert review as an important means of supervision and evaluation. “PSPC-CDIO” has constructed a comprehensive system of "engineering, teaching and practice" to integrate theoretical teaching and engineering practice so as to realize the coordinated development of knowledge, ability and quality.

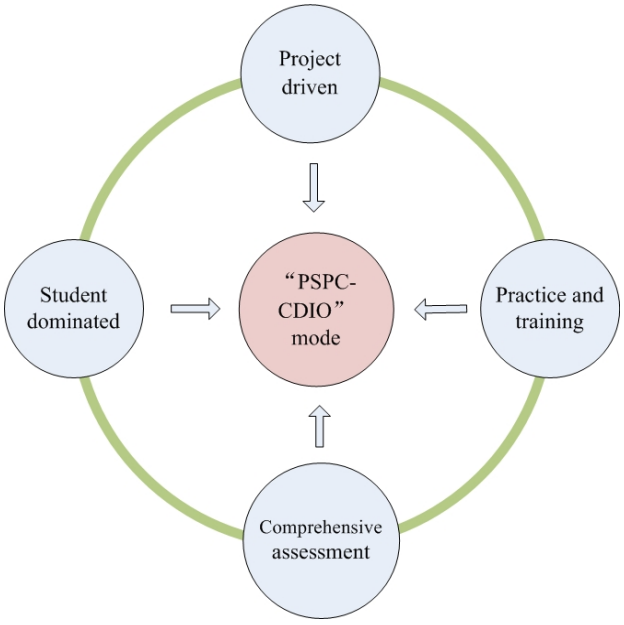

Figure 1. The concept of “PSPC-CDIO”

The “PSPC-CDIO” MODE

Project driven

According to the training objectives of different disciplines and the level of innovative practice ability of college students at different learning stages, a series of diversified, multi-level and open practice projects are rationally set up, and project-driven innovative practice is Launched (Wang & Hong, 2009).

(a)Taking task document of the practice project as "outline", which requires college students to implement projects abide by the plan and schedule strictly, to design, develop, integrate and test products strictly according to the technical requirements, to comply with the management requirements strictly.

(b)Taking research objectives of the practice project as "cable", this takes all stages of conception, design, implementation and operation, and covers all aspects of the cultivation of innovative practice ability. It integrates the basic knowledge, basic theories and basic methods, and combines innovative consciousness, innovative spirit, innovative thinking and innovative ability.

(c) Taking expected results of the practice project as "core", which means to evaluate intellectual labor of innovative practice quantitatively. The expected results mainly include

technical reports, academic papers, invention patents, prototype systems, products, and so on. Among them, the prototype systems and products are the concentrated expressions of practice project. The project achievement is the "realization" part after "conception and design". It is the specific object of "operation", and it is also an important basis for project evaluation.

Student dominated

“Student dominated” means “student-centered”, which requires highlighting the dominant position of students, giving full play to students’ subjective initiative and creativity, and encouraging students to complete innovation and practice projects collaboratively (Yang &Yan,2015). It is mainly embodied in the following three aspects.
(a) Topic self-selection. Students start from their hobbies, and choose the project based on their research interest, learning background and specialties. “Topic self-selection” fully respects students' interest and willingness to learn and creates a free and relaxed atmosphere for practice teaching.
(b) Practice collaboratively. It means “donging by ourselves”, which requires working out project objectives, schedule and product plan, formulating research methods, test plans and technical routes, and complete product development, integration, testing, testing and verification via close teamwork (Jiang, etc., 2017).
(c) Self-management. College students usually form research teams and select a team leader and implementation of self-management under leader responsibility. “Self-management” requires college students to develop detailed research plans, optimize the task assignment, establish management regulations and form an efficient management mechanism, and arrange time and energy to deal with the relationship between innovative practice and curriculum learning.

Practice and training

Taking project as "traction", that is, to raise questions, analyze problems close to engineering practice. “Practice training” covers all stages of "conception, design, implementation and operation", and throughout the project implementation, node assessment and completion of the whole process. Practice training adheres to "student dominated", and lets students participate in the project widely and deeply.

Comprehensive assessments

The innovative practice projects implement a multi-dimensional and comprehensive evaluation system, including internal reporting system and expert evaluation system. The project team carries out regular reporting system and holds one or two project meetings once a week. The progress of the research is reported by the students, and the teachers follow up the progress of the project by listening to the presentation, checks the completion of research work, identify problems and provide solutions in time. The expert evaluation mainly focuses on the examination and acceptance check of the project. The experts carry out a comprehensive evaluation based on the technical summary report and research achievements obtained, and give one of the four different grades, i.e., excellent, good, qualified and unqualified comments. Expert evaluation plays an important role in improving the quality and effectiveness of innovative practice project.

Application of “PSPC-CDIO”

In the past three years, the author has guided five innovative training projects, as shown in table 1, among them, there are four national innovation training projects and one provincial innovation training project. Based on the research achievements of innovative training projects, five academic papers have been published and eight invention patents have been applied. Particularly, the “intelligent single-police system” has been reported by CCTV and “Science and Technology Daily” in China. Take the “intelligent single-police system” as an example to expound the teaching practice and experience of “PSPD-CDIO”.

Table 1. Innovative practice Project

No.	Project title	Project hierarchy	Discipline/ Specialty	Grade	Total numbers of students	Semesters	Project achievements
1	Control system design and flight test for quadrotors	National level	Aeronautical and astronautical scientific and technical	Junior	3	1	Published 2 papers and applied for 2 patents
2	Design and implement ation of intelligent control system for micro UAV	National level	Aeronautical and astronautical science and technology	Junior	2	1	Published 2 papers and applied for 1 patents
3	Design for a novel stratospher ic airship	National level	Aeronautical and astronautical science and technology	Sopho more	5	2	applied for 2 patents
4	Space Spiderman -A new space debris acquisition device	National level	Aeronautical and astronautical science and technology	Sopho more	4	2	applied for 1 patents
5	Intelligent single-police system	Provincial level	Armament science and technology	Sopho more	5	2	Published 2 papers and applied for 1 patents

Project selection

The project should be innovative, applicable and feasible, and fully embody "user needs" and "student centered". In view of the current severe situation of anti-crime and the development of police equipment, the students start from their research interests and choose the project titled “intelligent single-police system”. The “conceive” of the project is taking “intelligent single-police system” as the research object, considering the coupling relationship of man, equipment and environment, and designing a self-organizing network, modular and intelligent individual soldier system, which can enhance the capability of reconnaissance, communication and cooperation, and enable individual police to have stronger offensive capabilities, better synergy and faster variability. Students should write project applications, prepare application materials, and report the project idea by themselves to obtain approval through "project recommendation", "project pre-trial" and "expert review".

Project implementation

The whole process of project implementation adheres to "project traction" and "student dominated", and the practice work is carried out according to research schedule strictly. The research team was formed through the bilateral selection and free combination, including a team leader and three crew members, which implements self-management under the leader responsibility. There is a clear division of work and close collaboration among team members. The whole process of project implementation fully embodies "independent practice". The research team determined the technical route and test plan, designed the system solutions, tested and verified the designed system collaboratively.

The overall scheme of the project is designed as shown in Fig. 2. The system consists of computer subsystem, helmet subsystem, communication subsystem, energy subsystem, navigation subsystem and weapon subsystem, which has the functions of ad hoc network, video, audio, text communication, and so on. In order to test the feasibility and reliability of the system, a series of tests were carried out, and the design plan is constantly improved according to the test results.

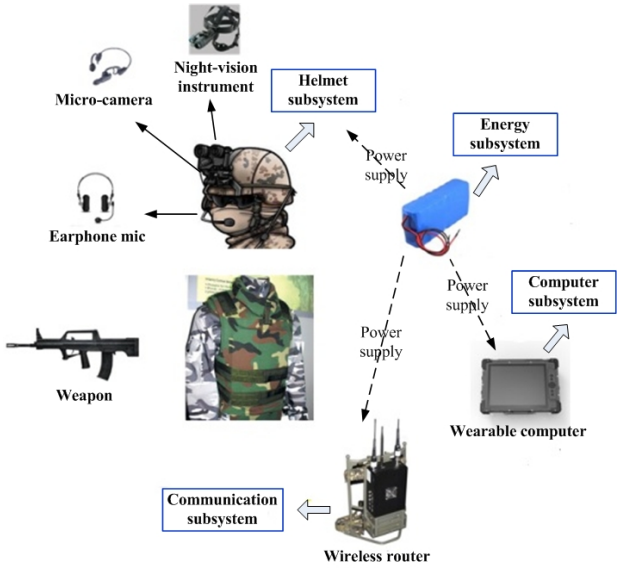

Fig.2 The sketch map of intelligent single-police system

Project evaluation

The research team developed a set of intelligent single-police system, published an academic paper entitled “Design and experimental research of a rescue assistance system based on a wireless network”, and applied for two national invention patents.

The project is evaluated as excellent through communication review, results report, on-site demonstration, and so on. The “intelligent single-police system” was highly commended by experts and was reported by CCTV, “science and technology daily” and other media.

Project assessment also pays attention to the implementation process as well as the expected results. In addition, innovative practice projects are included in training programs and teaching plans, and quantitative evaluation is given from the aspects of practice hours and credit recognition.

CONCLUSIONS

This paper introduced CDIO engineering education into innovative practice teaching to promote teaching reform and prosed a practice teaching mode called “PSPC-CDIO”, which is expatiated as “project driven, student-dominated, practice and training, and comprehensive assessment” based on CDIO, and it is applied to the innovative practice teaching. The teaching practice demonstrated that the “PSPC-CDIO” mode is effective for cultivating and improving students' innovative practice ability.

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