The Application of CDIO in the Practice Teaching of College Students

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Abstract. According to the requirements of practice teaching, in order to solve the problems existing in the Vocational and Technical Education in our school, this paper proposes a new method of Vocational and Technical Education using the CDIO.Against the background of practice teaching, based on the CDIO, this method designed the training objectives, curriculum system, teaching methods, learning methods, assessment and improvement system of cadets majoring in mechanical manufacturing technology. The effectiveness of the teaching method was verified by the application of the method in the major of mechanical manufacturing technology for one semester.

Keywords: CDIO; practice teaching; Vocational and Technical Education

1 Introduction

CDIO (that is to Conceive, Design, Implement, Operate) engineering education concept, which is the new result of international engineering education reform in recent years, was jointly proposed by four internationally renowned universities such as the Swedish Royal Institute of Technology and MIT in 2004[1]. The reform has been implemented in many universities at home and abroad and achieved good results [2]. In 2016, scholars Vu T ruong and Bao N LE researched in the implementation of CDIO in Day Tan University, used the CDIO project to consolidate students' teamwork ability and realized the balanced development of theory and skill training [5]. In 2017, E A Boiko, P V Shishmarev etc. introduced the current situation of implementing CDIO for thermal energy major of Siberian Federal University. The CDIO-based curriculum implementation plan and subject project content are provided to analyze the development experience and development prospect [6]. In 2018, Aji Prasetya Wibawa etc. studied data structure courses and found that students lacked a correct understanding of relevant data structure theories. Compared with traditional teaching methods, CDIO teaching can improve students' practical ability and innovation ability, and has better learning effect [7]. To sum up, the concept of CDIO aims to take the whole life cycle of conception, design, implementation and operation of a product or process as the carrier, and cultivate the comprehensive ability of students on the basis of teaching professional knowledge. The teaching content includes basic professional theory, practical operation skills, innovation ability and team cooperation ability [3]. This idea has a great inspiration and reference for the implementation of practical teaching in Vocational and Technical Education colleges, making up for the defects of the integrated

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teaching method , improving the course structure, and improving the post capacity and innovation ability of sergeant students.

According to the requirements of practical teaching and the problems existing in the current practical teaching training in our school, this paper proposes a new method of practical teaching based on CDIO concept. This method takes practical teaching as the background and CDIO engineering education concept as the basis. The training objectives, curriculum system, teaching method, learning method, assessment and improvement system of college students have been revised and designed [8], and the effectiveness of this method has been proved.

2 Current status of practice teaching for college students in our school

2.1 Shortage in the method of "Integrated Theory and practice" teaching

At present, the practical teaching in our school is based on the teaching method of "Integrated Theory and practice". This method organically combines theoretical teaching and practical skills training. Through specific practical operation, we can understand the esoteric theoretical knowledge, which is widely recognized by the sergeant students. However, there is a disjunction between theory teaching and practice teaching in the practical application of the teaching method. Reflected in the teaching organization, theory and practice teaching, not fully integrated. Professional theory did not play a due role in guiding practical training, and practical training did not promote the digestion and absorption of theoretical knowledge, theory and practice failed to form a positive interaction.

2.2 The design of course structure is not reasonable

At present, the courses learned by students in our school are relatively independent, and the professional curriculum arrangement lacks comprehensive and systematic design. Both theoretical and practical training links only include the content of this course, and students lack the opportunity to integrate and apply what they have learned. For example, the post courses of our mechanical manufacturing technology major are Turning Technology and Practical Training, Fitter Technology and Practical Training and Welder Technology and Practical Training. The three courses are organized separately and lack of comprehensive training, which is not conducive to the of student’s comprehensive application and the cultivation of innovative ability.

2.3 Teaching feedback mechanism is not perfect

At present, the teaching and training effect of students in our school lacks a perfect long-term tracking and feedback mechanism, and the teaching and training effect is often only measured by the assessment results of graduation and completion, which is not related to the actual work and growth of the students after they come to the company. Although the school regularly collected the performance of the students in the company to test the teaching effect on a macro basis after the students were assigned to various company units after the teaching task, these feedback results did not promote the improvement of teaching training and teaching quality.

2.4 Mismatch between teaching content and post ability standards

At present, the teaching posts in our school are relatively fixed, and there are few opportunities for training in the company. The teachers cannot deeply understand the real situation of the company and the demand for post ability. As a result, the teaching content lags behind and mismatch the post ability standards, the targeted cultivation of talents is not clearly, and the teaching and training principle of "consistency of combat training" cannot be realized in the practice teaching.

3 The feasibility analysis of practice teaching under the CDIO concept

3.1 The training objectives of CDIO are consistent with the practice teaching and training objectives

The teaching concept of CDIO is contained in its 12 standards and syllabus. It aims to achieve the following three goals: To enable students to master profound basic knowledge of technology; To enable students to lead the creation and operation of new products; To enable students to understand the importance and strategic implications of technological research and technological development for society,as shown in Table 1.The training goal of this teaching concept is consistent with the goal of practical teaching training to train high-quality, professional new mechanical talents who meet the needs of modernization and the future society.

Table 1. CDIO Teaching Standards

CDIO standards	Concrete content
Teaching Environment	Encourage the use of engineering practice venues and laboratories,which ability to support students in learning product,processes and system building capabilities through practical learning,learning relevant professional subject knowledge and social work environment
Teacher Development	Improve teachers' personal social practice ability and ability to build products, processes, and systems
Learning Check	Assess students' learning effectiveness in personal, learning, and practical abilities

3.2 The practice teaching under the CDIO concept supplements the deficiencies of the integrated teaching method

The integrated teaching process takes the project as the main line and proceeds step by step according to the project drive. In the implementation process, the conception and design of the project are completed by the faculty, and the students only participate in the implementation and operation of the project. At the same time, in the integrated teaching method, students' theoretical knowledge is passively accepted, and its knowledge digestion effect is not good. The practice teaching method under the CDIO concept emphasizes the whole life cycle of the whole product (project) from research and development to operation as the main line, integrates theoretical teaching, practical teaching and engineering design, allows students to participate in

the whole process, changes their learning process from passive to active, and cultivates students' comprehensive design thinking ability. Therefore, this method can effectively make up for the problems of students' weak engineering application ability and lack of comprehensive innovation ability cultivated by the teaching method.

3.3 The practice teaching method under the CDIO concept advocates teachers to learn from the company

The vocational and technical education should cultivate high-quality technical and skilled talents for society. Therefore, in addition to requiring the teachers to have a solid theoretical foundation, more importantly, they should master strong professional practical skills. However, because colleges overemphasize the educational level of teachers, the practical teaching ability of teachers is weak. The practical teaching method under the CDIO concept emphasizes teaching and learning. The whole process of conception, design, implementation and operation of products (projects) is completed with the participation of teachers and students at the same time. This method will force teachers not to be confined to classroom teaching, but to go into the company for research and learning, master the actual needs of the company, and update and adjust the teaching content in real time.

4 A new method of practice teaching under the CDIO concept

To sum up, this paper proposed a new practice teaching method under the CDIO concept (SZ-CDIO for short), which is guided by the actual task requirements of the company and organized and implemented with the goal of training high-quality and professional new military talents in line with the modernization of the company and the needs of future society. This method emphasizes system design and breaks the course barriers of divided periods and courses. Meanwhile, in the teaching process, all the professional knowledge that students need to learn and master is developed around the competition requirements. The following takes the mechanical manufacturing technology major of our school as an example to introduce the teaching method of SZ-CDIO systematically.

4.1 The culture objective of SZ-CDIO

The SZ-CDIO teaching method focuses on "return engineering", which does not return to the traditional engineering practice of small parts manufacturing, manual operation and mentoring, but joins in the systematic engineering practice dominated by modern society, group operation and element coordination. The students of mechanical manufacturing technology are mainly from the technical support teams of the company. Their responsibility are equipment maintenance and rush repair. This requires students to have basic theoretical knowledge of mechanical manufacturing process and professional practical operation skills of turning, fitter, welder and other mechanical manufacturing process. According to this requirement, this paper, guided by the SZ-CDIO teaching method, established training objectives suitable for the major of mechanical manufacturing technology, as shown in Table 2. On the basis of the current training objectives, "interpersonal skills" and "CDIO ability under actual competition environment" are added, aiming to enable students to think about the comprehensive emergency repair problem under the competition environment , and realize the overall ability improvement from task conception, design to implementation and operation [9][10].

Table 2. The culture objectives of SZ-CDIO for mechanical manufacturing technology major

general target	sub-target
1.Military and political foundation	1.1 The Basic Principles of Marxism 1.2 Thought on Socialism with Chinese Characteristics for a New Era
2.Professional technical knowledge and ability	2.1 Basic theoretical knowledge of machinery 2.2 Knowledge of machining process 2.3 Hydraulic transmission principle and typical equipment hydraulic system maintenance and repair skills 2.4 Common low voltage electrical components and control system maintenance and troubleshooting skills 2.5 Turns, fitters and welders skills
3.Ability and quality of the post	3.1 Engineering reasoning and problem solving skills 3.2 System thinking ability 3.3 Personal skills and attitudes 3.4 Professional ethics and quality
4.Interpersonal skills	4.1 Teamwork ability 4.2 Communication ability 4.3 Daily training management ability
5.CDIO ability in a competition environment	5.1 Environment cognition and behavioral ability 5.2 The comprehensive ability of conception, design, implementation and operation of Emergency repair 5.3 Emergency repair organization and management ability

4.2 SZ-CDIO curriculum system

The teaching method of SZ-CDIO strengthens the application of knowledge. Its emphasis is not on allowing students to master knowledge and achieve high scores, but on the internal quality and external ability that make them competent for their posts [4]. Therefore, the key point of curriculum system optimization is to adapt to the diversity and professional requirements of emergency repair training ability. The construction idea of SZ-CDIO curriculum system is to integrate the existing curriculum resources and form an integrated curriculum system with training objectives as the main idea. According to the cultivate objectives based on SZ-CDIO of mechanical manufacturing technology major, the curriculum system is reconstructed based on the experience of the competition, and a curriculum system including basic courses, professional courses and comprehensive practical courses is formed. Knowledge objectives, ability objectives and quality objectives are integrated into each teaching link [11]. Figure 1 shows the SZ-CDIO curriculum system applicable to the major of mechanical manufacturing technology.

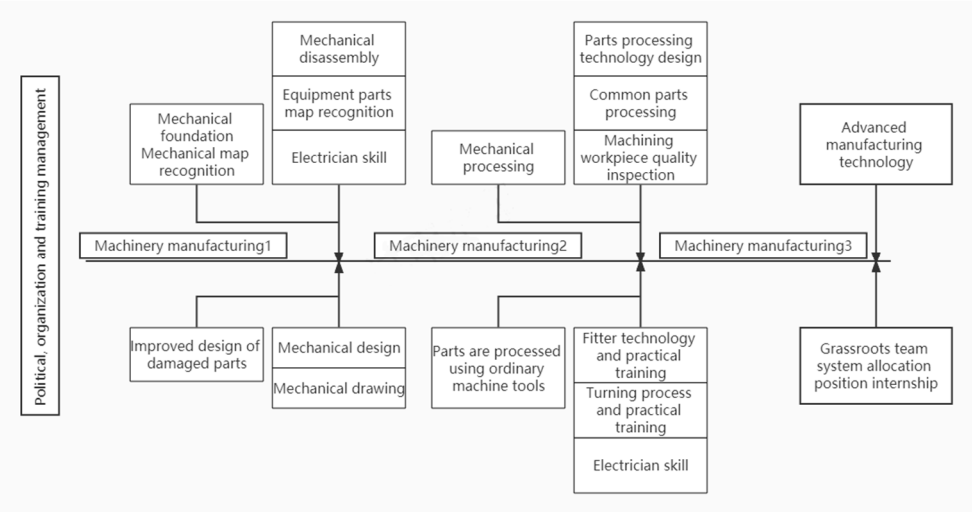

Fig. 1. SZ-CDIO curriculum system for Mechanical Manufacturing technology Major

The basic and professional courses of the SZ-CDIO curriculum system are close to the job requirements, and the original course content is deleted partly in accordance with the principle of "practical, effective and adequate", so as to connect the course content with the post ability standard, aiming at improving the students' professional and technical ability and post capacity. The comprehensive practice course mainly takes practical projects as the carrier, systematically designs the teaching situation, and cultivates students' interpersonal skills and CDIO ability under practical environment based on the CDIO engineering training concept.

4.3 SZ-CDIO practical teaching design

In the teaching method of SZ-CDIO, the design of practical teaching focuses on equipment maintenance support projects under actual application conditions.

The reform of the practical teaching design of SZ-CDIO aims to improve the CDIO ability of students majoring in mechanical manufacturing technology in the actual application environment, that is, the ability to make use of the existing skills, equipment and equipment to carry out emergency repair within a limited time in the actual application environment. The focus is on damage repair, maintenance control, spare parts supply support, direct support maintenance and other support training under actual application conditions. Among them, the design of actual application projects needs to consider whether the designed project can cover the skill standards of machinery manufacturing and distribution technicians, whether it can load the required knowledge and skills, whether its structure is enough to reflect the characteristics of engineering system and other factors. In the process of project implementation, students should be centered, and students should complete the whole process of "Conceive-Design-Implement-Operate" by themselves from conception and design to manual processing of parts to final assembly [7].

4.4 SZ-CDIO evaluation system

The SZ-CDIO assessment and evaluation system, combined with the evaluation characteristics of sergeant vocational and technical education, is mainly optimized from the following aspects:

(1) The evaluation objects are diversified. Students, teachers, personnel training plans, curriculum plans, teaching hardware and software facilities, etc., are all taken as evaluation objects to measure the effectiveness of the teaching mode comprehensively.

(2) The evaluation subject is diversified, students, faculty and teaching management personnel participate in teaching evaluation and supervision in an all-round and multi-level way.

(3) Diversified evaluation methods. The basis of SZ-CDIO teaching model and subject courses are mainly based on the result evaluation which combines qualitative and quantitative evaluation, while the comprehensive practice part is mainly based on the qualitative evaluation in the whole cycle of engineering operation, and the assessment evaluation changes from the result evaluation to the process evaluation.

(4) The evaluation content should be diversified, a multi-dimensional evaluation system should be constructed, and the teaching effect should pay more attention to the evaluation of students' comprehensive literacy, focusing on the improvement of ability; In the evaluation of teachers, it focuses on the application of teaching methods and the promotion of teaching level.

5 Teaching effect

Taking the students of Grade 2020 of mechanical manufacturing technology major of our school as the curriculum implementation object, we conducted a one-semester study on the SZ-CDIO teaching mode. The data in the teaching process are analyzed statistically from the perspective of teachers and students.

(1) Teachers' perspective

The SZ-CDIO teaching mode weakens the role of teachers in the teaching process, highlights the dominant position of students, and enables students to take the initiative to learn in the whole learning process. Through observation, the students of this class are significantly more interested in learning than other classes. At the same time, the students of this class have a serious attitude towards learning and a strong sense of collective honor and competition.

(2) Students' perspective

After the teaching of the semester, the results of the students' graduation joint examination were summarized and analyzed, and the students' course learning effect, course teaching satisfaction and aspects needing improvement were investigated through questionnaire. The summarized results are shown in Table 3:

Table 3. Comparison of graduation joint examination results

Year	Achievement（%）				
	Excellent（Over 90）	Good（80~89）	Medium（70~79）	Pass（60~69）	Fail（Below 60）

2020	4.7	23.7	38.1	23.8	9.7
2021	9.7	28.5	47.6	9.5	4.7

At the same time, in the course teaching satisfaction questionnaire, the conclusion is that most students expressed that they have learned the process of turning processing through the study and practice of this semester.As shown in the Table 4, 7.1% of the students said that they like and adapt to the teaching mode of SZ-CDIO adopted in this study semester; 10% of the students think that some practical operation projects are somewhat difficult and need to reduce the difficulty; 3.3% of the students said that the practice time in teaching is a little short, the hours should be increased; Most students believe that this kind of teaching mode enhances the learning participation and enthusiasm; 93% of the students said that practical ability has been improved through the study of this semester; 61% of the students think that the project team works well, while 12% think that the team lacks the sense of cooperation. At the same time, in the questionnaire, we also found that everyone expressed that they needed to improve their innovative thinking and do more things in practice. Most of the students had a clearer understanding of their own creative level and learning situation, and made clear the direction of their future efforts.

Table 4. Analysis of questionnaire survey results

Content	Proportion
They like and adapt to the teaching mode of SZ-CDIO adopted in this study semester	7.1%
Some practical operation projects are somewhat difficult and need to reduce the difficulty	10%
The practice time in teaching is a little short, the hours should be increased	3.3%
Practical ability has been improved through the study of this semester	93%
The project team works well	61%
The team lacks the sense of cooperation	12%

To sum up, the popularization and application of the SZ-CDIO teaching model can arouse students' interest in learning this major course, and at the same time improve their ability of inquiry learning, innovative thinking, practical operation, problem finding and solving, cooperation and communication to a certain extent.

6 Conclusions

According to the requirements of practice teaching, this paper constructed the SZ-CDIO teaching method, and explored the teaching method from the aspects of training objectives, curriculum system, practical course design and assessment system, etc., which provided a strong support for promoting the SZ-CDIO teaching method in the major of mechanical manufacturing technology. The effectiveness of the teaching method was verified by the application of the method in the major of mechanical manufacturing technology for one semester.

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