The Practical Exploration and Experience of project-based learning

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ABSTRACT

In this paper, combined with the cultivation characteristics of the high skilled talents in high education institution, the new innovation of Pneumatic transmission and control curriculum is explored based on the principle of CDIO concept. The idea is to aim at CDIO theory as the guide, the project-based learning as a carrier, to cultivate students' ability of engineering practice and the spirit of team cooperation, and to enhance the practical level of the be training personnel.

KEY WORDS

Method of project-based learning, Teaching reform, Design-Build experience, Active learning

0 INTRODUCTION

In 2008, our University became the one of first batch research experimental universities to implement CDIO. As a convener of the machinery engineering group, College of Mechanical Engineering, Yanshan University attaches great importance to this reform. In our college the reform and innovative of teaching mode was carried out and traditional curriculum system was reorganized. On the basis of broad and deep surveying the enterprises and interview with some experts around the typical tasks, the curriculum system of the Fluid power transmission and control was rebuild. In the Pneumatic transmission and control curriculum, CDIO concept is introduced. In this paper the Pneumatic transmission and control curriculum reform process and the experience of teaching method are explored by project-based learning.

1 THE PROBLEMS EXISTING IN THE PNEUMATIC TRANSMISSION AND CONTROL TEACHING.

Pneumatic transmission and control is a major professional course in the Fluid power transmission and control, the aim is to enable students to understand and master pneumatic drive and control technology, to know well the basic working principle of pneumatic, to learn the basic analysis methods and basic experimental skills. Analyzing and solving problems skills and the manipulative abilities of students will be enhanced through this studying. But there are still some problems in the actual teaching implementation process.

1.1 Practical project case is less in the textbook

The most of the existing contents of Pneumatic transmission and control textbooks are outdated, which lack of complete engineering examples. The key points of the knowledge in the books are scattered and lack of systematic and coherent between chapters and sections. After finishing of studying the students still have poor practical project case concepts and cannot complete the design of the actual pneumatic system.

1.2 the teaching methods is simplex

Pneumatic transmission and control course was taught often in the multimedia classroom. Teachers did the presentation while explaining, the students watched and thought. This teaching method has made great progress than before, but there are still some drawbacks. First, the student cannot be synchronized exercises and easy to lose the rhythm of learning. It is also difficult for teacher to know the students whether or not mastery of the extents of the course; the second is teacher need to bow to demonstrate the operation of the computer on screen, and he is easy to ignore the students situation of studying and the classroom discipline; the third is what the teacher demonstration, the students learn what, the teaching methods is still with a "spoon-fed" mode, not conducive to student learning for active learning and exploration.

1.3 Teamwork spirit cannot be cultivated

Aspects of the practice design of Pneumatic transmission and control course for students are often done by students independently, with little discussion among them. If they encounter some problems, they will directly ask the teacher unthinking. The students have a strong sense of individual operations and lack of teamwork cooperate spirit.

2 PROJECT TEACHING REFORM OF PNEUMATIC TRANSMISSION AND CONTROL COURSE BASED ON CDIO CONCEPT

2.1 The connotation and definitions of CDIO project learning

'Project learning' is a new inquiry learning mode in a certain time to solve the problem. It makes students to integrate into a meaningful process of completing task, enables students to actively learn and build knowledge autonomously. To improve the actual ability of students achieved by training up and the knowledge is the highest goal. Evaluation of the results of the study will only focus on the learning process, rather than the results of learning value.

The beginning of project-based learning is to give the students a work, to complete one or more of the tasks required to produce the final results, such as the completion of a design, build a model, the completion of a device, or a computer simulation. Completion of the project is usually the results of a written or oral report, summarizing the results of each step to produce and submit the results achieved.

Depending on the degree of autonomy of the students, deGraaf and Cormost put the project into following three items [de Graaff,E.,and Kolmos,A.(2003)]:

Project task: Student teams use the method specified by the teacher to complete the project developed. This project will motivate the students and the ability to develop in terms of the effect is minimal, most of the works belong to the traditional teaching syllabus.

Discipline Project: Subjects range will be appointed by teachers. The used method roughly for teachers designated is usually the subject common method. And the specific projects are selected by the students and the specific how to complete the project methods also be designed by the students themselves.

Subject project (Problem project): Students essentially independent select projects and to determine the method of the project completion.

Project-based learning requires students to form a team to accomplish no definitive answers job. It requires students to develop strategies to solve problems on their own, and according to the result of every step to continuously evaluate and adjust methods used in the work. The general scope of a project is larger and it can contain several problems. In addition, for the project-based learning, its key points are final results of obtained by students. The main requirements are application previously acquired knowledge to solve problems through knowledge acquisition. Project-based learning focuses on the application and integration of knowledge [Huang Chunguo]. (2005)]

2.2 the implementation of the project pedagogy

Because the traditional teaching model has many shortcomings, it is difficult to meet the enterprise requirements for the practice of talents. So the idea is based on the understanding of CDIO teaching reform, focus is on to train students to explore the basics of engineering, personal skills, team skills and engineering capabilities.

In the implementation of the reform process, we follow the following principles in the design of the project: ①with curriculum as centered; ② with special emphasis on the essential concept of the discipline principles; ③ requirements to get some new knowledge, rather than just the application of existing knowledge; ④To some extent, the initiative is carried out by the students, rather than " according to a recipe to cook " type of exercise; ⑤ to select a combination of practical research and engineering projects. Ensure that students can complete the task in the limited time through independent and collaborative learning; and to give full play to the students to create, to develop an imagination of space, and students can learn by analogy method.

Therefore, taking into account the actual situation of student achievement in teaching practice, we put the project into two categories, one is designated by the teacher to concentrate on the

contents of teaching curriculum and syllabus prescribed; another one is let students to self-selected projects and implement strategies in order to mobilize their enthusiasm.

CDIO educational model requires students to learn and practice based on the full life cycle of the project. The project is a carrier while to pass on basic knowledge and to master basic skills for students. Combined with "Pneumatic transmission and Control" course objectives and characteristics, as well as the actual situation of the students in the curriculum, we extract out of 10 typical projects, which are derived from engineering practice and combined with Pneumatic transmission and Control technology-related knowledge. The specific projects are as shown in Table 1.

Table 1 Pneumatic transmission and control typical projects

Project Number	Name of project	Subtask description
Project 1	Pneumatic system design for pneumatic bending machine	X - D diagram; Logic diagram; pneumatic circuit diagram; Bending machine assembly CAD drawing; Bending machine prototype
Project 2	Pneumatic system design for pneumatic label making machine	X - D diagram; Logic diagram; Pneumatic circuit diagram; Using auxiliary valve to remove obstacles
Project 3	Pneumatic system design for pneumatic vacuum spreader	X - D diagram; Logic diagram; Pneumatic circuit diagram, PLC program design; The realization of PLC control system
Project 4	Pneumatic system design For channel type pneumatic bending machine	X - D diagram; Logic diagram; Pneumatic circuit diagram; Pneumatic pressure control circuit; The relay control circuit; Channel type pneumatic bending machine CAD drawings
Project 5	Pneumatic system design for Semi automatic blanking machine	X - D diagram, logic diagram, pneumatic circuit diagram**,** PLC program design; the realization of PLC control system
Project 6	Pneumatic system design for blast furnace Bell style charging device	Using cascade pneumatic circle method to remove the obstacle; Logic diagram; Pneumatic circuit diagram; PLC program design; The realization of PLC control system
Project 7	Pneumatic system design for yeast cake making machine	Using process control chart method to remove obstacles; Logic diagram; Pneumatic circuit diagram
Project 8	Pneumatic system design for pneumatic manipulator	Karnaugh map; Logic diagram; Pneumatic circuit diagram; The design of the pneumatic check system
Project 9	Pneumatic system design for double cylinders distance programmable	X - D diagram; Logic diagram; Pneumatic circuit diagram; The design of the many reciprocating

	control system	control circuit
Project 10	Pneumatic system design for automatic silo reclaimers	X-D diagram; Logic diagram; Pneumatic circuit diagram; Optional distance control circuit design

The 10 projects are typical teamwork items. The students are set in an actual work environment, so that they have direct experience of whole process of project. The project includes project conception, design process, until to complete the pneumatic line drawing and last modifying. In the process of project the students explore and apply comprehensive knowledge, exercise teamwork spirit, learn basic project organization and management. The CDIO ability is also trained during process of project for students.

3 THE IMPLEMENTATION OF THE PROJECT AND SUBMISSION METHODS

In order to better carry out the project-based learning, we give a specific implementation method of the project. The first is to divide students into several groups. Each project group consists of four or more students. A person is set to the head of group. Each person in the group has a specific division of labor. The task for each student is decided by the students themselves who is responsible for different system design, calculation, experimental systems building, PLC programming system design and experimental testing tasks. For the project report on the research, we have proposed a basic requirement which including: project name; division or contribution of group members, and a research report. The specific implementation process is shown in Figure 1 [Huqing Fang, Cheng Korah.(2003)].

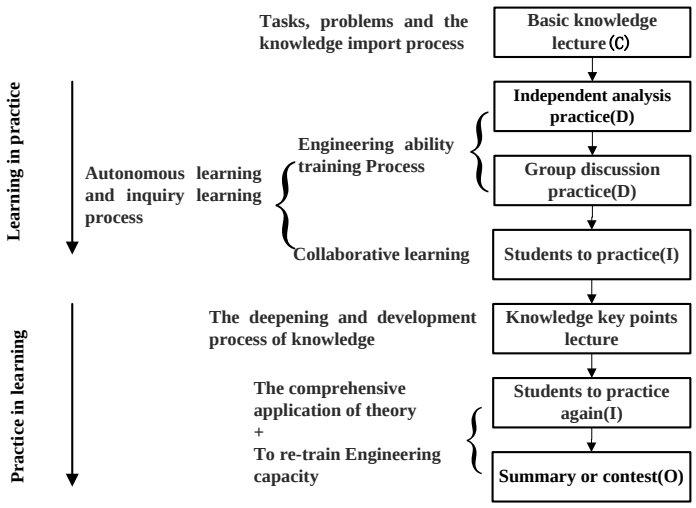

Fig.1 CDIO teaching mode implements process

Task Description stage (C): Task description stage is the first step in the project began, the teacher firstly explains the basics knowledge, imports tasks and problems of project, and gives students a clear mandate to complete this project. Task discussion stage (D): Task discussion phase (D): After receiving the project task document, the students study independently the knowledge and skills needed to complete the project tasks. Under the leadership of the team leader, they need to independent analysis or to concept, design and

implement route in the form of team discussing. Task implementation phase (I): in accordance with the design, engineering specifications, students complete project tasks. In practice, the students will face a lot of problems. At this time, the students were grouped again. The teacher then counsels the students to complete deepening and expanding of the knowledge. Summary and evaluation phase (O): when the project is substantially complete, students prior to summary and evaluate the drawings of they designed in their group, to find errors or deficiencies and to make a further improvement. Final teacher evaluate the score of the project.

In the teaching process, teachers should do a "Project Management" role. Team leaders do a "project leader" role. Team members do an "engineering and technical personnel" role. By assigning responsibilities, students are familiar with and deep into the engineering environment, so their ability to solve practical problems is developed. At the same time, let the students learn to support each other through constant collision and communication, and to make progress together. The target of real "learning in practice and practice in learning" is achieved.

4 THE PROJECT APPRAISAL SCORING RULES

In order to mobilize the enthusiasm of students, based on student attendance, completion of the project aspects and research reports, etc., the instructors give a comprehensive assessment score of each student's project results. Scoring rules include: The student of group self-score is 20 points. It is been scored each other by this group of students, and finally handed over instructor by the head of this group after signature. For this score each student average points are no more than 16, the point difference between the highest and lowest is not less than 5points. Key point is to investigate the contribution of student in the process of the project. Instructor give score is 30 points based on student attendance and usually the performance and quality of complete drawings. The average points are less than 24 for each group of students for this score, and the difference between highest score and lowest is not less than 5points. The last 50 points are decided by results of the student oral defense, it includes: filed on-site defense of project is 20 points (after completion of the project in testing and simulation analysis, scores are given based on the quality of the project is completed, the definition explain the answer questions accuracy to the project), another 30 points is end of project which is contains project definition to explain and answer questions the accuracy and quality of the report submitted drawings, as well as the size of the project work and so on. The student who is not to participate in the project design, the results score is 0 points.

5 EXPERIENCE OF TEACHING BASED ON CDIO PROJECT-BASED LEARNING

Through the implementation of project-based learning, we received a lot of experience, specifically in the following areas:

5.1To make the project work smoothly, the first is to spend more effort and time to make up for some of the blank

Taking into account compared with conventional lecture-based teaching, knowledge blanks could be generate in the process of project-based learning content. It is necessary for teachers to give students a training in need to fill this gap. For instance, at beginning of the implementation phase of the project, taking into account the PLC programmable controller equipment in our lab experiments which is provided by REXROTH Company, so we organize the students of doing the project to learn how to install and use programming platform software and programming methods.

On the basis of the students have mastered the X-D schematic illustration to design the on pneumatic distance programmable control system, and we organize students to learn the process control chart method and Karnaugh map method to design system. Thus students understand deepening in the process control method and learn how to remove obstacles signal in the pneumatic control system. The students also used to learn the correct way to determine the feasibility of the pneumatic line and to check the correct of the pneumatic line.

5.2 Due to issue is a mostly practical project, students' intrinsic motivation is effectively stimulated

Due to practical projects in close contact with the practical application of the community, so students can apply their knowledge to do some job in project-based learning. It is truly reflects the leading role of the teachers and the principal part position of the students. In the implementation process, the students not only use textbooks, but also use of resources beyond textbooks. The ability of learning collaboration, discussing and exchange ideas between students is developed, so that the students go into a more favorable atmosphere for learning situations. Through the successful production of the project products, the students obtain successful experience. The comprehensive theoretical and practical application ability are developed, and the overall professional quality of students are improved

Compared with the traditional acceptance learning, project-based learning pay more attention to cultivate the habit of the students' problem awareness, critical thinking and the ability to generate new knowledge and the quality of the independent learning ability and the team cooperation for the purpose and goals. Emphasis on the properties of the learning process is to explore, rather than to cram their students. It requires learners to achieve the subjectivity involved in the learning process. The whole learning process at the same time is carried out in problem scenarios.

5.3 To improve the level of the teachers in a project-based learning

The teacher is no longer the sage on the platform. The teachers are focused on to do more guidance and demonstration, and less to do more didactic teaching. Teacher and students together identify problems together, and teachers are not in as expert guidance. Teachers do more performance-based assessment, and do less knowledge-based evaluation.

5.4 Students acquire skills of 'learning by doing'

A change can be seen from their own experience. One student wrote: "Through this project-based learning, I was not only deepened the understanding of Pneumatic control theory and the theoretical knowledge, but also I learned how to cultivate the spirit of innovation, thus continue to overcome weakness of myself and to surmount myself. It can be learned well because it is applied to practice. I spent a lot of efforts in the project design, even at the breakfast time we still thinking about design issues. During this time I also exercised my own will, so I didn't flinch in the face of difficulties. I believed everything had a solution. As long as I took the time to find the information that I needed, to think independently, to discuss with my team when met some questions, there was no problem that I can't solve. However, I thought more important was that I developed a diligent thinking habit. In the experiment, and the design process, I needed to continue to modify, to improve, which not only allowed me to recognize the importance of how careful to do a job, but also I got a lot of "innovation" inspiration. Secondly, during the project-based learning I used the knowledge specialized courses, previously learned such as Pneumatic transmission and control theoretical basis, but also to learn new knowledge, such as PLC programming, Computer control, though I had never spent special time to study their application, but in the process of learning with questions I had found very efficient to study them, which was another harvest what I did in this project design. "

Another student wrote: "After finished the design of the pure pneumatic control, relay control and PLC control of these three experiment program loop lines, we began the process of realization in the experimental rig. It actually spent two and a half days time for us and only accounted for a small proportion in the curriculum design, but this hands-on of myself experience was memorable. And the combine of the theory and practice it was once again be proved it was correct to teaching reform. Through doing experiment ourselves, we grasp a lot knowledge and skills, and also saw a lot of the books that we had not been learned, also enrich our knowledge on technology.

In the process of the building pneumatic control circuit, the electrical control circuit and PLC control loop, we encountered a lot of problems that are not found in the theoretical, for example, for double pneumatic control five-pneumatic control valve on both sides are under no pressure how to located problem; electrical control with Intermediate relay to realize self-locking and interlock and eliminate the problem of multiple barriers; to define and set Rexroth IndraWorks PLC programmable logic controller software applications initial set and reset problems. In short, through the experiment we got a preliminary understanding and knowledge for the details of the course, obtained a number of methods how to solve problems in our future work. Through this project-based learning, our ability of the independent thinking and problem solving fully be exercised, and the knowledge learned will benefit me for life. the practical ability of how to discovery, present, analyze and to solve problems will benefit me in the future of learning, work and life. Also the experiments that we obtained will laid a very solid foundation for our doing other projects as well as in the future. "

To sum up, the student occurred such a change, that is, from original only know that comply with the order, changed into self-directed learning; from the previous reliance solely teacher, change into the independent study; from only know the original memory and repetition, change into the development towards discovery, integration and show respect progress; from original listen and react, changed into in terms of communication and responsibility; from only concerned with the results of the original and the process of change in the direction, changed into in the attention; from original theoretical study, changed into in the direction toward the theory.

5.5 Promote the Reform

Based on CDIO project learning applications can help teachers to implement the overall teaching and to promote curriculum reform. The problems of the teaching divorced from practice are solved on Pneumatic transmission and control courses. Through project-based learning, we revise the teaching programs again. The new teaching program aims students in training so that they feel they can get more help from teachers and to see more links between theory and practice. The students incline to adopt more independent learning strategies themselves and to collect information. They ask for help when needed and verify the work done by them self, rather than do much by rote. We also see that project-based learning can enhance the ability of students work in teams, model building, applying the knowledge to analyze problems and other aspects of a positive role. At improving in interaction between student and teacher, in the respect of teaching fun and enthusiasm for teachers and other investment and reform of teaching methods, a good effect is obtained. The results of the implementation of education reform have very important significance.

6 CONCLUSION

Through theory and practice of project-based teaching on Pneumatic transmission and control curriculum, teachers and students have yielded good results. The use of project-based CDIO learning method allows students to continue to learn through direct experience and knowledge obtained. From which it enables students to experience the joy of learning, and ultimately learn to study consciously. The self-directed and innovative talents are trained successfully. The practical ability of how to find, present, analyze and solve problems for students can be improved through project-based learning. Experiences gained will benefit all students in the later study, work and life. It also laid a solid foundation for their future to meet the challenges of other projects.

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