Research on Programming Practice Based on CDIO Concept

Yongli Wang
Chengdu University of Information and Technology
Sichuan Province, P. R. China

Abstract—Programming ability is not only a skill in the future workplace, but also an industry quality. Combined with CDIO engineering education concept, the training of programming design ability based on practice driven was proposed in this paper. The organic combination of theory teaching and practice teaching, the organic combination of knowledge learning and quality, ability to ascend, the organic combination of in-class and after-class, form the systematic practice driven culture mode. Students’ interest in programming and the ability of program design were improved through this training.

The learning effect was good in courses related with the programming design after the implementation with CDIO. Students generally felt that the programming ability has improved, following the teacher also felt that programming ability of students was better than before the implementation of the practice driven of CDIO.

Keywords—programming ability, engineering education, practice driven

I. INTRODUCTION

Programming plays an important role in the knowledge system of computer science. Programming ability is the basic quality and skill that computer majors and even some non-computer majors must master. In the process of programming, the ability of reading comprehension, analysis and thinking, using platforms and tools, abstract expression and modeling, comprehensive problem solving and other abilities are trained. It is very important to help learning the follow-up courses. So how to cultivate students’ programming ability and interest in programming and have the ability of sustainable development are very important and necessary.

Students begin to learn programming, they often fail to debug the correct program because of compilation errors, encountering complex program problems, the thinking is not clear, the ability to find errors is poor, and so on. All these make the students fear the difficulty of programming, doubt their ability of programming, even give up their efforts in this area, it is difficult to learn programming well, and also affect the follow-up course learning. Secondly, the ability of programming needs long-term systematic and continuous training. It needs step-by-step training, module training, integrated training, practice in practice, and experience in the project. Students feel the sense of achievement, have confidence in themselves, and improve the ability of programming and long-term sustainable development of students through practice-driven integrated training.

II. CDIO ENGINEERING EDUCATION

CDIO engineering education model is the latest achievement of international engineering education reform. It takes the life cycle from product development to product operation as the carrier, and enables students to learn and acquire engineering ability in an active, practical and organic way. The CDIO training syllabus divides the abilities of engineering graduates into four levels: basic programming knowledge, personal ability, interpersonal team ability and engineering system ability. The syllabus requires comprehensive training to enable students to achieve their intended goals at these four levels. The CDIO integrated training program is designed by combining mutually supportive professional courses with clear individual, interpersonal skills, product, process and system building capabilities. The integrated curriculum plan forms an education system with overall effect greater than the sum of each part. This education system is composed of clear and mutually supportive elements. Each element has its own definite function. All elements work together to ensure that the expected effect set by the specialty is achieved.

Under the guidance of this innovative concept, the curriculum group has comprehensively adjusted the teaching plan and syllabus, and put forward the training system of programming ability based on practice-driven and the learning methods of specific courses. From the first course "Introduction to Engineering", the practice-driven teaching concept has been penetrated into daily teaching, so that students can understand and master the basic concepts of programming from multiple perspectives and ways. In the process of solving problems, students can understand and master the basic ideas and methods of program design.

III. TRAINING PLAN AND IMPLEMENTATION OF PROJECT DRIVER DESIGN ABILITY

A. Training Plan of Project Driver Design Ability

The programming ability is a long-term, sustained and continue to strengthen the process of four years continuous line. It includes an introductory course, a subject course, a professional course and a summative design - engineering practice project which highly intersects the learning effect of ability. After understanding and investigating the
opinions and suggestions of engineers with practical experience in relevant practice units, the course group reorganized the course system for training students' programming ability. Specific courses include Introduction to Engineering, C Language Programming, Data Structure, Database Principles, Object-Oriented Programming, etc.

C language programming is introduced in the first year; Students mainly experience complex systems and teamwork. Through the process-oriented programming based on the console, the basic coding ability and programming ability can be trained from simple experience to complex experience. Object-Oriented Programming and 4-week Object-Oriented Engineering Practice Course in the second school year; Software Engineering and Algorithms and Software Integrated Design in the third school year; Engineering Practice in the fourth school year, students use their knowledge to solve practical problems.

The process of acquiring knowledge and improving students' ability is a process of practice, recognition, re-practice, re-recognition and recycling. The acquisition of students' programming ability and problem-solving ability can not be accomplished at one time, but through repeated recycling and spiral upward process.

Therefore, the implementation of the program design ability curriculum system is a process of improving year by year, which is driven by practical projects for 1-4 years. These first-level projects can be implemented in stages, united and cooperative, and harvest the ability of programming, software analysis, implementation and control, such as classroom assistant management system and C language learning support system, which are familiar to students and come from students' life, or related to companies, institutions and industries, such as meteorological business system, communication system, etc. To meet the requirements of CDIO standard, the concrete practice process is shown in Figure 2-1.

![Figure 2-1 Project driven process](image)

First of all, starting from the first grade, the relevant first-level projects will be launched to assign tasks, explain requirements, and knowledge and skills that need to be stored and trained, so that students can have a perceptual understanding and enter the corresponding curriculum learning and ability training.

Secondly, at the end of each semester, it enters the sub-project development of the first-level project after decomposition, and then compares and evaluates the students' works, puts forward suggestions for improvement and incorporates new functions.

Finally, we carry out inquiry learning, introduce the new curriculum, continue to learn relevant courses in the new semester, reserve relevant abilities, and enter the relevant parts of the first-level project for application and comparison. In this way, the design, development, exhibition and evaluation of the whole first-level project will be completed. Driven by 4 years of integrated practice, the ability of program design, coding, code maintenance, algorithm, compilation and operation of the program and the ability to cooperate with people are acquired.

B. Course Implementation of Programming Ability Driven by Practical

The program design ability training plan is finally implemented in daily teaching. In the specific implementation process, the main line is "application system, function module, basic unit". The organic combination of theoretical teaching and practical teaching, the organic combination of knowledge learning and quality, ability improvement, and the organic combination of in-class and out-of-class will form a systematic talent training model.

1) Practice-driven curriculum implementation

In order to achieve the knowledge and skills required for the first-level project, relevant courses are needed to support it. Therefore, in peacetime curriculum training, the curriculum group requires teachers to strengthen the integration of knowledge and skills training; Through practice-driven, we can decompose the required abilities and stimulate students' interest in learning; through practice-driven, we can cultivate students' learning ability, programming ability, ability to cooperate with others, communication ability, display ability, etc. At the beginning of the course, assignments are arranged so that students can learn, practice and solve problems with tasks. At the middle of the course and the end of the course, they participate in the corresponding engineering practice, submit the corresponding works, and test the learning effect.

For example, in the course of C Language Programming, teachers begin to arrange a relatively small project, such as the simulation of ATM system, which requires the realization of welcome interface, login function and access function. shown in Figure 2-2.

![Figure 2-2 ATM system](image)
Teachers guide students to think about what knowledge reserves are needed if these functions are implemented in computer language; secondly, what knowledge points and skills are involved in these functions at present. In the middle of the course, these knowledge points and technologies are comprehensively applied to enable students to submit their works and organize discussion and evaluation. Finally, in view of the problems existing in the works, suggestions for later improvement and knowledge and skills that should be reserved are put forward, and relevant concepts of software engineering are introduced to enable students to have a perceptual understanding, which can be slowly applied to subsequent engineering practice.

At the end of the whole course, we enter Engineering Practice 1 to guide and train students' programming ability and software design ability through topic selection, requirement, design, implementation and application delivery, so as to make reserve for the following first-level projects.

In the second and third academic years, the same operation is done in the courses of object-oriented programming, database design and software integrated design. New courses, new engineering practices and new functions are iterated repeatedly. In the Fourth academic year, all functions of the project are integrated.

2) **Practice drives the combination of in-class and out-of-class learning**

In-class is the foundation, after-class is the improvement, only in-class is not enough, after-class should be consolidated and improved in time; using the network storage of campus network, students can download relevant courseware, resources, submit electronic homework; using the College "Process Assessment Platform", MOOC, micro-classes and so on to carry out corresponding expansion, practice and self-test; secondly, encourage students to actively participate in various activities in the school. At the same time, it is emphasized that we should strengthen the study of other courses, such as mathematics, English and so on, which are of great help to the study of programming and the improvement of programming ability. Finally, students should learn and acquire corresponding engineering ability and literacy in an active, practical and organic way.

IV. SUMMARY

In a word, through the formulation and implementation of the plan of integrated programming ability based on practice-driven, teachers’ dominance and students' subjectivity can be brought into full play, students as the center, and various teaching and practical links can be fully utilized to improve students' programming ability; students' self-learning ability and programming ability can be trained; students' interest in programming is the most important. It is also the strongest driving force.

After several years of efforts and attempts, under the guidance of team teachers, students have achieved better learning results through integrated case-based and project-based learning; students generally believe that programming is not as difficult as imagined, overcome the fear of difficulties, enhance self-confidence and interest in learning, enhance self-learning ability, analyze problems, solve problems, and cooperate with others. With the continuous improvement of students' satisfaction, the teachers of other courses feel that the basic programming ability of the students trained after the curriculum reform has been improved, which lays a good foundation for future study. Through several years of training, the employers are also satisfied with the students.

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