Research on Teaching Methods of Python Programming in Vocational Colleges based on CDIO

Xia Ghen[a*], Hongxia Wu[b]

Department of Computing, Sichuan Science and Technology Vocational College, No. 1, University Road, Huahai Avenuet, Shigao Town, Meishan City, Sichuan Province, China

[a] 825182196@qq.com, [b] 82953066@qq.com

*Corresponding author

Keywords: CDIO, Python programming, Vocational, Programming teaching

Abstract: In view of the problems such as outdated information technology course content, backward teaching concept and programming teaching not keeping up with the needs of The Times in higher vocational colleges, according to the CDIO theory and practice project, the nature, objectives, content and requirements of the course are clarified, and the project teaching of Python programming course is piloted. Each project is based on the three steps of "plan, Action and reflection" to continuously improve and optimize classroom teaching. Finally, the teaching effect is evaluated through classroom observation and process documents collected. The implementation effect is good. Students have developed a strong interest in programming, and learned Python independently after class. Their performance in class has been more active and confident, and their teamwork and external presentation skills have been cultivated to some extent.

1. Introduction

Programming technology is the foundation of information technology, is the professional ability of social demand. In order to solve the problems mentioned above, it is necessary to explore new engineering teaching ideas and find new teaching methods.

CDIO engineering education theory is the latest achievement of international engineering education reform in recent years. A multinational research team composed of four universities including MIT and The Royal Swedish Institute of Technology received a huge funding of nearly 20 million US dollars. After four years of exploration and research, the concept of engineering education[1], CDIO stands for Conceive, Design, Implement and Operate. It takes the life cycle from product development to product operation as the carrier[2], allowing students to learn engineering in an active, practical and organic way between courses. It is conducive to improving learning efficiency and practical innovation ability[3].

At present, domestic CDIO research is still concentrated in the field of higher education, but it also begins to penetrate into vocational education[4,5], which can be applied to different vocational ability education disciplines to guide the teaching of programming courses in higher vocational education.This paper tries to introduce CDIO into higher vocational programming teaching, taking Python programming teaching as the pilot, not only to enable students to better master Python programming ability, but more importantly to cultivate students who can study independently and cooperate in an intelligent society, so as to meet the needs of social employment in the new era.

2. CDIO teaching philosophy

2.1. Origin and development of CDIO

The core of CDIO is to learn theories and strengthen practice in the process of conception, design, implementation and operation of products in the real world. "Conception, design, implementation and operation" are the four stages of CDIO: in the conception stage, requirements and technologies are defined, the development and application of the whole life cycle of products

  DOI: 10.25236/aeiit.2022.035

are taken as the teaching background, and learning objectives are defined; In the design phase, describe the plan, scheme and algorithm to be implemented. In the implementation stage, it is to truly transform the design into products, including compilation, testing and other processes; During operation, optimize and upgrade the product, including evaluation and suggestion. CDIO believes that in order to cultivate all-round application-oriented talents, students should be helped to learn how to design value-added products in a modern and cooperative environment and make clear the whole process and overall system of the production of such products.

2.2. CDIO teaching philosophy

The teaching philosophy of CDIO has three general objectives, namely, to cultivate students' abilities in three aspects: first, to master basic technical knowledge more deeply; second, to lead the construction and operation of new products, processes and systems; third, to understand the importance and strategic impact of research and technological development on society. First of all, engineering education always emphasizes the technical foundation. CDIO recognizes that if students want to master deeper knowledge and better understand concepts, they must strengthen the study of the technical foundation. Second, students lead the construction and operation of new products, processes and systems to prepare students for their careers. This teaching philosophy aims at personal abilities, attitudes and interpersonal skills. Personal abilities include ways of thinking, such as analytical reasoning and problem-solving skills, lifelong learning and education, systematic thinking, critical thinking, creative thinking, etc. Attitudes include integrity, responsibility, curiosity, the courage to take risks and flexibility, etc. Interpersonal skills are mainly related to team cooperation. Finally, the development of society cannot be separated from the contribution of any field and any type of work in solving problems. Therefore, research and technological development must match social responsibility and develop towards sustainable technological direction. In short, CDIO's teaching philosophy firmly believes that if conception, design, implementation and operation are taken as the background of engineering education, and the cultivation of personal ability, attitude and interpersonal skills is integrated into the same teaching plan through a clear plan, these objectives can be well satisfied.

2.3. CDIO teaching mode

CDIO teaching mode is divided into three categories: (1) a total of products and systems design and implementation, including design and implementation project mode, cooperation mode, design of extracurricular project design project, test and operation mode, etc., this model to consider the connection between the teaching plan and teaching environment design, both short-term and long-term demand; (2) Consolidation of subject knowledge, including classroom laboratory mode, independent learning mode, speech mode, presentation mode, distance learning mode, etc. (3) knowledge discovery, this mode supports students to carry out research projects, mainly by enabling students to conduct research with the equipment of research laboratory. The teaching mode of CDIO emphasizes the experience of design-implementation, and students learn by building products, processes and systems. The task of design-implementation must be carefully planned so that it is both an independent learning event in itself and part of an orderly planning of the design-implementation experience throughout the teaching program.

2.4. CDIO teaching methods

The teaching method of CDIO integrates personal skills, interpersonal skills and the ability to build products, processes and systems into the learning process of subject knowledge through active learning and experiential learning. For students who have not yet chosen engineering as their learning field or career, this learning method is easier to accept. Active learning refers to students' direct involvement in thinking and solving problems. In the process of practical operation, application, analysis and evaluation, new ideas are thought, and information seldom needs to be passively received.

(1) Muddy card method. Muddy card is also known as doubt card for teaching. It collects classroom feedback to determine students' lack of understanding. (2) the method of conceptual

problems, is a multiple concept problem, choice, is a teacher and students in the class of instant q&a, used to observe students correctly understand the teaching content, (3) optional topic method this method put forward by the royal institute of technology in Stockholm, the purpose is to enhance the narrative links and large group counseling. (4) Project-based Teaching Method Project-based teaching method relies on real world or specific conditions, problems, in order to find solutions to problems. (5) Case teaching method. Case teaching method is mainly to explain the specific experience of practical engineering to students. In addition to narration, cases can also provide detailed background, such as initial budget, material resources and human organization in the task process.

2.5. CDIO teaching evaluation

CDIO's teaching evaluation is learning-centered, that is, as a part of the whole teaching process, it promotes learning in an atmosphere where students and teachers learn together. Instructional evaluation is used to monitor learning, emphasizing correct answers, and is often competitive and individualistic, while the latter uses instructional evaluation to promote and diagnose learning, emphasizing the production of better answers and learning from mistakes, and the learning process is cooperative and supportive. The teaching evaluation of CDIO focuses on collecting the data of students' proficiency in subject knowledge, personal ability, interpersonal skills and the ability to build products, processes and systems. The process of teaching evaluation mainly includes four stages: the standardization of learning effects, the consistency of effects and evaluation methods, the collection and analysis of data by various methods, and the improvement of teaching and learning by using evaluation results.

3. Teaching design for Python programming

3.1. Analysis of Python programming courses in vocational colleges

This course has the following characteristics: First, it is flexible and changeable. Second, it has strong operability. Third, focus on process.The goal of Python programming courses in vocational colleges is to help students understand the important role of Python-like programming languages in people's production and life today, understand the features and norms related to programming, and be able to use Python to complete specific tasks and solve various problems in real life through diversified teaching forms. CDIO standard 2 points out that knowledge, ability and attitude should be listed as the expected results of engineering education, that is, curriculum objectives should be consistent with engineering practice. Knowledge and skill objectives Reinforce technical base knowledge. Able to build Python compilation environment, abide by Python code specifications, and master common Python syntax knowledge. Strengthen problem solving skills. (2) Process and Method objectives to cultivate the ability of autonomous learning. Through limited classroom teaching, students are trained to explore Python independently after class and form their own learning methods. Practice systematic thinking, abstraction and conceptualization of problems, and then implement Python solutions;

Course content: The course content specifies the knowledge and skills required for the course. At present, higher vocational Python programming course has not been unified teaching material, but because on the one hand, the higher vocational education college information technology course standard "rules on the programming class belongs to the information technology course, on the other hand, the higher vocational students and high school students in the same stage, in Python programming course content, on the basis of combing teacher when carries on the concrete teaching practice, Appropriate content can be selected according to the learning situation, and teaching can be organized according to CDIO teaching methods to achieve specific teaching objectives. According to the selection of course content, the requirements of Python programming courses in vocational colleges can be divided into two levels: basic requirements and higher requirements. The basic requirement is students' mastery of Python knowledge taught by teachers in class. The higher requirement is students' ability to solve business problems by applying Python design concepts and

methods. Both levels require the presentation of progressive relationships while being consistent with the CDIO competency outline.

3.2. Chinese word segmentation and project teaching

Preliminary analysis of teaching. After learning the basic knowledge of Python and understanding the basic principles of Python program language, students in vocational e-commerce classes need to be connected with their vocational needs immediately. This is also the background environment of engineering education that CDIO emphasizes: "The life cycle of product, process and system conception, design, implementation and operation". On the one hand, teachers need to use projects to help students connect theory and practice, and stimulate students' interest in learning and desire for creation. On the other hand, students need to understand the methods and principles of solving practical problems in Python through the context created by the project to facilitate further learning.

Teaching strategy formulation. (1) Knowledge list: in order to minimize the time consumed by teachers in explaining knowledge in class, reduce the burden of □students to memorize knowledge points, and use more classroom time for creative thinking activities. The teaching environment is established. The teaching place of this project is in the training classroom of the e-commerce class, where there is a teacher's machine and a multimedia projector. The topic of this project is Chinese word segmentation, mainly using the teaching method, concept problem method and task-driven method for teaching. Through the demonstration of Chinese word segmentation codes for existing texts, students were randomly selected to answer conceptual questions, especially for the difficult and important problems in teaching, word segmentation tasks were assigned to be completed by group discussion, so as to strengthen students' problem awareness. Reflections on instructional design. The Chinese word segmentation project is the first teaching practice of this research, and there are more or less improper thinking in the teaching design. The following reflections are made :(1) the difficulty of the project; (2) Progress control of the project.

3.3. Word cloud map project teaching design

After the completion of the Chinese word segmentation project, students have a preliminary understanding of the concept of text analysis and know how to use Python to write programs to achieve simple text analysis. The Chinese word segmentation project eventually requires students to input text analysis results into a document, which is clearly not the best way to present it. The wordcloud project is based on a number of different Python libraries, the main one being wordcloud, but it can also be combined with other different libraries to achieve more effects, such as PIL, matplotlib, etc. The so-called "word cloud" means to put the words of interest in an image, so that the position, size and font of the words can be controlled artificially. Usually, the size of the font is used to reflect the frequency of the words. The higher the frequency, the larger the font in the word cloud. After the training of Chinese word segmentation project, students have a general understanding of how to learn Python program language independently, and on the basis of the initial harvest, they are interested in further learning Python. Key points: Parameter setting and grammar structure of WordCloud library. Difficulties: Use wordCloud library in conjunction with other Python libraries to better visualize text analysis results.

The word Cloud Map project is the second teaching practice project of this research. With the successful or unsuccessful experience of the last project, there will be some progress in the overall grasp of the project. But after all, the project itself involves the comprehensive use of multiple Python libraries, which is a cognitive leap for students, and it is completely impossible for teachers to predict what kind of details they will encounter in the implementation process of teaching design. Therefore, there are the following points to reflect on the project-based teaching design of ci cloud atlas :(1) the knowledge point of Python has a large span; (2) Whether the class time can be fully utilized.

3.4. Project-based teaching design of word cloud map generator

After the teaching of "Word Cloud Map" project, students have mastered the Python

programming implementation methods from text analysis to visual display, and have a certain understanding of using Python to solve practical problems. The teaching content of the word cloud Generator project is mainly to learn the usage of Tkinter library and the design idea of graphical user interface. The teaching goal of the word cloud Generator project is to let students finally package the results of the first two projects into the software made with tkinter library. The formative evaluation of cloud Map Generator project is still completed in the process of "conception, design, implementation and operation". The evaluation basis is different from the previous two projects, and the task completion degree and team report performance still need to be evaluated. The word cloud generator project is the last teaching project of this research, because it involves the process from code compilation to application implementation, so it is quite difficult to implement. In the teaching design of this project, the difficulty of the content was taken into consideration and some trade-offs were made, but the real acceptance ability of students was not investigated too much.

4. Implementation of Python programming teaching in vocational colleges

4.1. Teaching implementation plan

The teaching practice object of this research is e-commerce class one in a higher vocational college. There are 39 students in the class. The information technology course is the professional course of the students in this class. Before the author started teaching practice, they had already contacted Python, learned some basic knowledge about Python, and had certain programming skills. In daily life, some students have tried to use Python to solve some simple problems, which can be said to have practical needs. Teaching implementation environment: Students of this e-commerce class have their own training classroom, in which there is a teacher's computer and a multimedia projector. Students bring their own laptops in class. Teaching implementation time: From the middle of January 2020 to the end of December 2020, we will give two hours of Python programming class to 39 students of e-commerce class from 9:55-11:35 a.m. every Thursday. The three projects will have a total of 6 weeks and 12 hours. The teaching content is Chinese word segmentation "Word Cloud Map" and word cloud Generator.

4.2. Chinese word segmentation project teaching implementation

Project-based teaching implementation plan: The first project of teaching practice is Chinese word segmentation. The teaching goal is to enable students to further understand the usage of Python teaching effect analysis. They can use Jieba library to word segmentation for any text, and output the results in the form of goals to the document for storage. Prior to this, students already have some knowledge of Python programming. It is planned to reflect on classroom teaching and continuously improve project-based teaching design by investigating and testing the implementation effect of the project's teaching design, so as to accumulate experience for the next ci Cloud Map project.

According to the teaching process design of Chinese word segmentation project, practical teaching activities are carried out. The main task of teaching is word segmentation of the text of "Set man" and counting the words with word frequency greater than 5 times. The specific links of teaching strictly follow the CDIO process, and each stage has clear teaching and learning objectives. In addition, the teaching method, conceptual problem method and task-driven method are used comprehensively to help students better carry out projects, connect the theory and practice of Python, and stimulate students' interest in learning. In the conception stage, first of all, guide students to understand the meaning and principle of Chinese word segmentation through discussion, which is also to create a real working situation for students, stimulate students' interest in further learning; Finally, students can understand and practice different jieba library methods according to the List of Python grammar knowledge provided in advance. In the design stage, students are required to make a text analysis of The Trap according to the effect shown in the case, and divide it into two tasks to help students better digest the grammar knowledge of Jieba library. In the design

stage, students need not be eager to write codes, but to understand the structural logic of programming language. Through group discussion, they can draw algorithm flow chart together, and then convert the flow chart into Python language to determine the program structure.

4.3. Ci cloud map project teaching implementation

Plan: the second project of teaching practice is wordcloud, and the teaching goal is to let students learn to use Python wordcloud library to make Chinese word segmentation results into wordcloud based on the first project. The problems in the project should be overcome in the implementation of the project, and the teaching design of the project should be further modified. Action: The word cloud map project is based on the Chinese word segmentation project, with the practical experience of the last project. The teaching link is to let students experience the CDIO process of products, processes and systems in the real working environment, so as to give full play to students' personal ability, professional ability and interpersonal skills.

In the conception stage, the questions left after the last project are solved intensively, that is, the contents of Muddy cards submitted by students are analyzed, and the old knowledge of students is consolidated with several concept questions and code fill-in-the-blanks. Through the process of question answering and consolidation, the concept of word cloud is introduced, and then students are asked to draw word cloud by referring to the case provided before class. Finally, it shows the wordcloud map realized by Python code, and mainly explains the usage of wordcloud library. In the design stage: it is possible to make the simplest wordcloud with the wordcloud library. If you want a more personalized and attractive wordcloud, you need to combine the methods of other libraries. In this stage, the author assigned two tasks, one of which required students to properly adjust the parameters of wordCloud library, and the other required students to combine Python library and Matplotlib library. Implementation stage: According to the experience gained from the practice of the last project, the teaching time of the conception stage and the design stage should be well controlled, so that students can spend more time on the code implementation in the implementation stage. Operation stage: students should improve the level of task reporting, not only can successfully complete the task, but also learn to open the source code, explain their programming ideas to others

4.4. Project teaching implementation of word cloud map generator

Plan: The third teaching practice project is word cloud map generator. The teaching goal of this project is to finally encapsulate the results of the first two projects into the software made with Thinter library. The Python syntax knowledge of this project is based entirely on the Thinter library, which is Python's own graphical user interface design tool. At the stage of conception, the author firstly solved the remaining problems on Muddy cards. Then, the author checked the students' preview results through conceptual problems combined with the source code of the case project. Based on the feedback, the author began to explain the basic usage of Thinter library, such as Frame, Label and Buttion. Listen and practice under the frame. Design phase, write a graphical user interface program, the code is no longer like before the project, according to the logic of the linear relationship between operation, different grammar between blocks is nonlinear, it requires students to have basic system thinking ability, this phase will require more time to students, many discussions with other students program structure, grammar questions asked to teachers. In the implementation phase, students will walk around the class and instruct them how to program pseudo-code into Python code. According to the graphical user interface designed in the last stage, students should clear division of labor in the group and complete different functional modules respectively. After completing their respective tasks, students should summarize the code, communicate, negotiate and unify the code standards, and then test the program together and record bugs. In the operation stage, students were organized to report tasks, and suggestions were given for the problems or failures encountered by students in the implementation stage.

5. Conclusion

Guided by CDIO and based on the specific content of Python programming language, this study takes the three projects of Chinese word segmentation cloud map and word cloud map generator as teaching background, and then carries out teaching practice and teaching effect analysis. After a semester of theoretical research and practice test, It is preliminarily proved that CDIO-based Teaching of Python programming in vocational colleges has certain effects. Here are the main conclusions:

(1) The integration of CIDO teaching mode to break through the time and space constraints, the development of CDIO-based Python programming curriculum teaching activity design framework for vocational colleges, taking into account the individual differences of students, to achieve the combination of students' theoretical knowledge learning to comprehensive innovation practice skills training.

(2) CDIO-guided vocational programming teaching training objectives, combining the TEACHING mode and method of CDIO with the core literacy of vocational information technology discipline, provide detailed teaching design ideas and methods.

(3) The teaching situation of integrated programming project based on CDIO teaching concept is created, which gets rid of the disadvantages of traditional information technology classroom teaching to a certain extent and provides guidance for front-line teachers to carry out personalized programming teaching.

(4) The integration of CIDO teaching mode to promote the improvement of teachers' professional quality and teaching ability, promote the continuous improvement of curriculum quality, comprehensively improve teachers' professional quality and curriculum innovation design ability, optimize and improve the curriculum quality evaluation system, providing beneficial ideas for the teaching reform of programming engineering specialty.

Acknowledgements

The authors greatly appreciate the following sponsors for their support to the study: Soft Science Project of Science and Technology Department of Sichuan Province, "Research on Cooperative Innovation Capability of Mixed Ownership Enterprises in Sichuan Province" 2020JDR0232.

“Intelligent NUMERICAL control system based on physical motion control principle” 22RCYJ0005.

References

[1] Chengai Liang. Research on Project-themed Curriculum and Teaching Mode of Vocational Education [D]. Southwest University, 2012:37.

[2] Jian Huaguo. Emphasis on Engineering Education to Improve Engineering Practice Ability of Engineering Students [J]. Journal of Chongqing Institute of Technology (Natural Science Edition), 2007(04):124+5.

[3] Xiuyao Chen. Research on vocational Education Reform based on CDIO Model [J]. China Modern Educational Equipment, 2012(19):82-83.

[4] Xiangqing Zhu, Junwan Hu, Hui Zeng, Honghua Chen. Research on micro-project-driven Teaching Method in CDIO Engineering Education Model [J]. Experimental Technology and Management, 2012(11):16

[5] Zhongchao Zhao , Genming Zhou, Chunli Tang . Research and Discussion on Heat Transfer Course Teaching Based on CDIO Concept [J]. Higher Architectural Education, 2014(01):79-82.