Discussion on course design of "Programming and Problem Solving" based on OBE-CDIO

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Abstract: Based on the OBE-CDIO model, this paper discusses how to design the course to achieve the goal of students' ability training by taking the course "Programming and problem Solving" as an example. On the basis of analyzing the curriculum objectives and students' needs, the student-centered teaching mode is realized through the research of course content design, teaching method selection and engineering case development. Through the questionnaire survey of the students in the course, some experience about this course is gained, and further research directions are proposed.

Key words: OBE; CDIO; Programming and problem solving; Engineering case; Ability training

1. Introduction

As modern education methods, OBE and CDIO emphasize student-centered, practical problems, practice and experiment, etc., which have been accepted and applied by more and more schools and teachers. In today's digital age, program design and problem solving are important practical skills. Therefore, how to effectively design and implement this course so that students can acquire skills and knowledge of practical application value and be able to successfully apply these skills and knowledge in practical work is an important issue that needs to be discussed in the teaching reform.

This article will focus on how to design the "Programming and Problem solving" course based on the OBE-CDIO method, hoping to help readers think about how to effectively cultivate students' programming and problem solving abilities, and contribute to cultivating high-quality talents needed by the future society.

2. Overview of the OBE-CDIO education model

2.1. OBE

From the 1980s to the early 1990s, educational reform based on learning output emerged in basic Education in Western countries, which is called Outcomes based Education (OBE). In his book The Output-based Model of Education: Controversies and Answers, author Spaetty defines OBE as "the clear focus and organization of the education system around ensuring that students gain experiences that substantively succeed in later life." He believes that in the OBE education model, it is more important whether students have learned knowledge and can successfully transform knowledge into competitiveness, rather than blindly pursuing the form of teaching. In addition, some experts believe that OBE is an educational process based on achieving a specific learning outcome for students, with the educational structure and curriculum viewed as a means rather than an end. If they do not contribute to the development of students' specific abilities, they must be reconstructed. In the OBE education system, the ability and level that students should achieve upon graduation are the key factors that educators need to consider when making lesson plans. Compared with the traditional content-driven and input oriented education, OBE education model can be regarded as an innovation of education paradigm

2.2. CDIO

CDIO engineering education model is a new result of international engineering education reform in recent years, which is a synthesis of Conceive, Design, Implement and Operate. It takes the life cycle from product research and development to product operation as the carrier, allowing students to learn engineering in an active, practical and organic way that connects courses. CDIO training program divides the ability of engineering graduates into four levels: basic engineering knowledge, individual ability, interpersonal team ability and engineering system ability. The program requires comprehensive training methods to enable students to achieve predetermined goals in these four levels. Since 2000, the transnational research composed of four universities, including MIT and Royal Institute of Technology of Sweden, has been funded by Knut and Alice Wallenberg Foundation with a huge amount of nearly 20 million US dollars. After four years of exploration and research, the CDIO engineering education concept has been founded and an international cooperation organization named after CDIO has been established. In 2008, the Higher Education Department of the Ministry of Education issued a document to set up the "CDIO Engineering Education Model Research and Practice Research Group"; In 2016, "CDIO Engineering Education Alliance" was established on the basis of the former "CDIO Engineering Education Reform Pilot Working Group" of the Ministry of Education. So far, dozens of world famous universities have joined the CDIO organization, and students trained according to the CDIO model are welcomed by society and enterprises.

3. Selection of classroom teaching content based on OBE-CDIO

OBE (Outcome-based Education) and CDIO (Student-centered Engineering education) are two modern educational methods used to design curricula to help students acquire skills and knowledge that they need to use in real-world work. Here are suggestions for instructional

content choices based on OBE-CDIO:

First, it is very important to clarify the learning outcomes of the course, as it helps teachers and students define the course objectives and provides clear criteria for assessment and feedback.

Second, focus on practical problems, allowing students to learn programming and problem solving skills while solving practical problems. Make students aware of different applications, such as Web applications, desktop applications and mobile applications, etc., and ask them to develop applications with practical applications.

Third, emphasize teamwork, let students work together in teams to complete projects, and emphasize the importance of solving practical problems, let students work with each other, collaborate, and understand how to solve problems together.

Fourth, coding specification is the key to ensuring readability, maintainability and scalability of code, so emphasizing coding specification is very important for students to learn programming and problem solving skills.

Fifth, students are encouraged to carry out project development and practice in combination with practical problems. In the project, students can use different programming languages and tools, such as Java, Python, JavaScript, Visual Studio and so on.

4. Combine engineering cases with teaching knowledge points

This course is based on the concept of OBE-CDIO, and introduces complete engineering application problems into the experimental course of the course. In the past, most of the in-class experiments were based on the knowledge points in theoretical courses, and different engineering applications were selected as experimental objects. However, this method lacks coherence for teaching, and many experimental contents are far from the real engineering contents.

This course innovatively introduces “virtual underwater robot teaching simulation platform” for in-class experiments, so that students can experience the function of theoretical knowledge points in a practical engineering application. The platform can simulate the operation process of underwater robots, use object-oriented programming, and write control statements through Python language. It can use the for and while loops to realize the movement and rotation of the virtual underwater robot and the opening and closing of the robot arm.

5. Student feedback

5.1. Questionnaire design

At the end of the semester, this project will conduct statistics on the implementation of the course through questionnaires. A total of 82 questionnaires were distributed to grade 21 students of School of Artificial Intelligence, Guilin University of Electronic Science and Technology. 82 were recovered and 82 were valid, among which 65 were male students and 17 were female students.

5.2. Questionnaire results and analysis

Through the statistics of the questionnaire results, it is found that:

(1) Most of the students had no exposure to basic programming training before college, and only 12 (14.6%) had programming experience in high school. This may mean that most students will need to learn programming from scratch in their first year of college, which requires more time and effort to adjust to new disciplines and tools. It may also mean that courses need to be designed with more consideration for the fact that most students do not have a foundation in programming to help them better understand and master programming knowledge.

(2) Among the students with programming experience, 11 (91.7%) acquired programming knowledge through the Internet. This indicates that the Internet is a very important resource for students to acquire programming knowledge, which may be one of the reasons why these students can quickly adapt to and master relevant knowledge when learning programming in college.

(3) In question 6, 6 people chose 1,22 people chose 2,35 people chose 3, 15 people chose 4, and 4 people chose 5. According to the answers, it can be seen that most students have a certain understanding of the requirements of their abilities for the jobs they want to work in the future. The number of people in option 3 is the highest, which indicates that most students have some understanding of the ability required for the job. The small number of students in option 1 indicates that only a small number of students have no knowledge of the abilities required for the job. To sum up, most of the students have a certain understanding of the requirements of personal ability for the job they want to work in the future, but the specific requirements need to be strengthened.

(4) In question 7, 68 students (83.4%) are satisfied or very satisfied with the teaching content and experiment content of this course, and only 1 student (1.2%) is very dissatisfied, indicating that the overall feedback is positive. This also shows that the teaching content and experiment content of this course are attractive and interesting to a certain extent, which can arouse students’ interest and enthusiasm, which is conducive to students’ better grasp of the knowledge and skills.

(5) In question 8, according to the survey results, the majority of students (40) think that adding experimental links in the theory course is very helpful to the mastery of knowledge, 23 think it is very helpful, 13 think it is helpful. Only a small number of students (6) think that it is not helpful or very helpful to knowledge mastery. This shows that students generally believe that the experimental session can deepen the understanding and application of theoretical knowledge and improve the learning effect.

(6) In question 9, according to the results, most of the students think that the links between all the courses they have learned are not very close, of which 15 (18.3%) think that the links are loose (choice 2), 21 (25.6%) think that the links are general (choice 3), and 27 (32.9%) think that the links are close (choice 4). Only 16 students (19.5%) think that the connection is very close (5). This may indicate that teaching content and curriculum need to take more consideration of wholeness and connectedness, so that students can better understand and grasp

what they have learned and apply it to practical problem solving.

(7) In question 10, according to the answers, most of the respondents (65.6%) believe that the courses they have learned are helpful to the improvement of their practical ability, and a considerable proportion of them choose the higher option (37.8% choose 4,31.3% choose 5), indicating that they think the courses are very helpful to the improvement of their practical ability. Only a very small number of people (4.2%) think that the courses are not helpful.

(8) In question 11, according to the survey results, the vast majority of students (about 70%) think that the courses are helpful to the improvement of system analysis ability, among which 41 people (about 50%) choose 4, indicating that they think the courses are of considerable help to the improvement of system analysis ability. Only 2 people (about 2%) chose 2, indicating that they think the course is of little help to improve the ability of system analysis, while no one chose 1, that is, they think that the course is of no help to improve the ability of system analysis.

(9) In question 12, according to the answer results, most of the students think that the courses they have learned are helpful to the improvement of their team ability and practical ability. Among them, 25 people choose the highest score of 5 as helpful, while only 8 people choose the lowest score of 2 as not helpful. This indicates that the majority of students believe that the courses can help them improve their teamwork and practical skills, which are very important for their later work and life. However, there are also some who think that the course is less helpful in improving these aspects, which may be related to the specific content of the course and the teaching method.

(10) In question 13, according to the data, 79 people (98.8%) believe that project-based development can improve their competitiveness more than traditional examinations, while only 3 people (1.2%) choose traditional examinations. It can be concluded that most of the respondents believe that project-based development is more conducive to improving their competitiveness than traditional examinations. It also shows that students are more inclined to improve their skills and abilities through practice and practical projects, rather than just evaluating their learning outcomes through traditional examination forms.

6. Summarize

According to the above findings, most students have no exposure to programming before college, only a small number of students have programming experience in high school, and most of the students who have programming experience obtain programming knowledge through the Internet. In addition, most of the students think that adding experimental links in the theory course is helpful for mastering knowledge, and most of the students are satisfied with the teaching content and experimental content of this course. The students also believe that the course is helpful for the improvement of practical ability and systematic problem analysis ability, and also believe that the course is helpful for the improvement of individual and team practical ability. Of the two methods of traditional examination and project-based development, most students believe that project-based development is more conducive to enhancing personal competitiveness.

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