The Reform and Practice of Python Program Courses Combining OBE Concept and Empowerment Education

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Abstract. Python program course is an important basic computer course for non-computer major students. In this paper, according to the characteristics of the non-computer major students, the method of combining OBE concept and empowerment education is used to reform the Python program course. The reform mainly includes identifying the outcomes of this course, changing teaching content-driven into learning outcome-driven, classroom teaching and evaluation system reform. This paper mainly puts forward a kind of teaching mode based on output-oriented and improves course teaching effect.

Research Background

Python program course is an important basic computer course for non-computer major students, not only teaches students foundational knowledge, more important training students’ computational thinking and capability to analyze and figure out problems by computers in order to solve complex engineering problems in practice, which is the talents training goal of the curriculum. Under the emerging engineering education and OBE concept, around the personnel training goal, the course teaching goal is based on “computational thinking” and incorporate ability of information technology and professional and training to improve course attraction and challenges, which lays the foundation for cultivating students the interdisciplinary mind and information technology application ability. All manuscripts must be in English, also the table and figure texts, otherwise we cannot publish your paper.

OBE Concept Overview

OBE (outcomes-based education) is based on the educational mode of learning outcomes, first appeared in the United States and Australia's elementary education reform [1]. OBE concept is to make the educators think about the legitimacy and effectiveness of "what to teach" and "how to teach," focus on the learning output, and emphasize that based on the students expected learning outcomes and effects organize, evaluate teaching activities [1-2]. Many universities have implemented teaching reforms based on OBE since 2014. For example, literature [3] illustrates that the teaching methods and effect based on OBE engineering education mode are better than those based on the content in ShanTou university; literature [4] proposes that changing teaching content-driven into learning outcome-driven by introducing the concept of OBE into Java program course, to improve the quality of teaching and talent training; Literature [5] researches the optimization design of practice teaching and diversified evaluation mode at three-levels-ladder which concludes basic skills, comprehensive application ability, engineering practice and innovation ability with OBE.

Therefore, by introducing the concept of OBE into Python program reform to improve course teaching effect.

Computational Thinking and Empowerment Education Overview

Since then Professor YiZhen Zhou, of Carnegie Mellon University in the United States in 2006, has put forward the concept of "computational thinking." The Steering Committee in university
computer course teaching of The Ministry of Education has organized colleges and universities to explore the form and connotation of computational thinking many times, determined the core task that training the ability of "computational thinking" as computing foundational education and cleared that program courses based on "computational thinking" as training objective should reflect the program design ideas and methods, to cultivate students using a computer to analyze and solve problems [6]. With the development of computer science and the coming era of artificial intelligence, Academician Chen Guoliang made further description towards the application of computational thinking in basic computer education, that computational thinking is a fundamental ability that everyone must grasp in the modern society [7]. At the same time, The Ministry of Education has launched "Engineering Education Professional Certification" and "Emerging Engineering Education" research since 2016 and 2017, of which the former one emphasizes student-centered, output oriented, students’ knowledge, ability and accomplishment training. One of the important categories of Emerging Engineering Education construction is to integrate computer technology into various fields of engineering, to cultivate students' knowledge integration of computing and own major. Thus, from the "computational thinking" to current "Engineering Education Professional Certification" and "Emerging Engineering Education", they aim to train students’ ability, which kind of education reflects empowerment. Reflecting student centered by empowerment, learners will have more learning initiative.

**Python Program Course Facing Problems**

Tianjin University Renai College has started classes for non-computer major including engineering, economy, art, in Python program since 2015. After many years of teaching exploration and reform, there are some aspects following, in which carrying out the teaching reform and reaching the phased objectives: (1) Designing the teaching contents according to the requirements of different majors. (2) Organizing the integration of "theory + practice” in teaching process to fully embody "theory into practice, practice throughout the whole teaching process.” (3) Trying the diversified teaching method with SPOC (Small Private Online Course) mixed teaching mode and introducing related cases to enhance students' enthusiasm and initiative of program design course. (4) Curriculum evaluation is from a single model to the whole process assessment.

But as the continuous improvement of the demand in technology such as Big Data, Artificial Intelligence, program design becomes one of the basis of the technique in modern information society, and the understanding of computing problems and program design predominantly shift from the knowledge validation problem solving to the oriented actual problem solving by computing. This fundamental change reflects the impact degree of information technology on human life and work. How to carry out teaching activities according to the social demand and student's learning needs, and under traditional teaching concept, there are still some problems to be solved in teaching implementation: (1) The inner link between talents training goal and course orientation. Python program design course for non-computer major students is a basic computer course. The course orientation usually focuses on the knowledge form the book but ignore the cultivation of the students' ability and accomplishment. (2) The relevance between teaching content selection and training ability. Under the traditional teaching concept, students pay more attentions to the summary, collation and application of knowledge, and teachers pay more attentions to the systematic, preciseness of knowledge structure and reasonability of course arrangement which ignores the characteristics of the students as the main body to study and the ability to serve the future society. (3) The difference between the teaching progress and learning outcomes. In the process of teaching, teachers are required generally complete the teaching mission in accordance with the established teaching progress, while ignoring that students may change studying attitude in the learning process. (4) The correlation between the course evaluation and students learning ability evaluation. Even though the course evaluation changes single examination such as final test into the processive evaluation, which forms a relatively complete evaluation system, lacking diverse learning evaluation system towards students.
Above all, this article reforms and practices the "Python program course" based on the theory of OBE combined with empowerment education. Contrapose to the future society needs towards non-computer students, the article goes as "clear course expected learning outcomes-achieve learning outcomes evaluation."

The Reform and Practice of Python Program Courses Based on OBE

Expected Learning Outcomes

OBE concept emphasizes that the learners' learning outcomes are expected to be ahead of the teaching contents and the course objective targets the graduate's ability [3]. Given that this course for non-computer majors' students, this course include not only the basic knowledge and algorithm, but also Python third-party library application, so that the students could master preliminary programming design skills and learn how to solve the problem in the subject field. Based on that, it identifies and categories professional curriculum goals for engineering majors and forms reasonable course objective according to "learning-outcomes." Table 1 shows Python program design course expected learning output.

Table 1. Python Program Design Course Expected Learning Output.

| Course Objective | Main content                                                                 |
|------------------|------------------------------------------------------------------------------|
| Knowledge Objective | SO1 master Python program design basic knowledge, including basic methods, basic data structures, basic program control structure |
|                   | SO2 control function, basic algorithm, advanced data structures               |
|                   | SO3 master the methods of external data processing                           |
| Skill Objective   | SO4 have basic programming ability, solve problems by computer independently  |
|                   | SO5 have analysis ability for different solutions to solve the problem, and select the optimal solution under the constraint conditions |
|                   | SO6 solve basic disciplines problems by mathematics and professional knowledge |
| Quality Objective | SO7 self-learning via network resources and constantly expand the knowledge   |
|                   | SO8 understand the importance of teamwork, individual work and team cooperation |
|                   | SO9 basic communication and presentation skill                                |

Scientific Organization Teaching Content

"Python program" course is based on the theoretical knowledge in order to solve the actual problem. It emphasizes on the thinking and training to solve the problems by computer and focuses on the programming ideas and methods. Through learning this course, students master program theory and ability to comprehensively solve practical problems via programming, besides communication and teamwork skill.

In order to achieve expected learning outcomes, this course will be categorized the teaching content as basic part, ability and application part. Each level shall in accordance with the expected goal give the different teaching modules, the teaching content as shown in Table 2. Each module has corresponding design tasks, for examples, from M1 to M3 modules correspond to draw all kinds of simple graphics, fractal curve, special graphics, etc.; from M4 to M5 modules shows scientific computing, such as linear equations and matrix calculation, and natural language processing, etc.; M6 module includes simulation problem of shopping cart, web crawler, etc.

Table 2. Program Design Course Teaching Content Units.

| Level       | Teaching module           | Course content module                                      | Skill objective                                      |
|-------------|---------------------------|------------------------------------------------------------|------------------------------------------------------|
| basic part  | M1: Know Python course design | Program design basic methods, basic data structures, basic program control structure | Knowing the course, inspire interest in program design |
| Ability part | M2: read and write simple code | basic grammar knowledge, control structure, function library | Knowing program design structure, read and write simple code, cultivate computational thinking |
|-------------|--------------------------------|-------------------------------------------------------------|--------------------------------------------------------------------------------------------------|
| M3: write basic python code | Use control structure, basic algorithm, the basic third-party libraries | Master basic program design methods, coding independently to solve simple questions, training logic and precise thinking |
| M4: solve basic questions by programming | Basic algorithms, advanced data structure, scientific computing of third-party libraries | Understanding the problem modeling, basic problems solving in the life by using the Python third-party libraries |
| M5: solve complicated questions by programming | Function, advanced data structure, file, arrays, data processing, data visualization | Individual professional ability literacy, data acquisition ability training, Data analysis, learn to solve complex problem by computer |
| Application part | M6: solve professional questions by programming | Recursion, network access to data, text, word frequency analysis, simple data computing | Can solve professional problems by combining the major and computer knowledge, teamwork and communication skills |

**Elaborate Research Teaching Methods and Means**

Program course teaching point is to let students transform knowledge into ability and master the general way to solve problems by computers to cultivate computational thinking [9]. Guided by OBE concept, the teaching process should embody ability as the goal, make students the center of teaching, and implement personalized teaching.

Therefore, combining with the teaching target of this course, with the help of modern education teaching technology, establishing diverse teaching modes which includes intensive teaching + flipped classroom, RAPTOR + algorithmic programming, leading by example-," and guiding students in accordance with "ask questions-analysis problem-solve the problem" approach to active learning [9], in order to stimulate learning interest and improve teaching effect.

On the teaching methods, in order to achieve the goals, the author after three years of teaching exploration attempts to summaries the "four-stages' teaching method in the teaching process, that knowing, reading, writing and solve problems. Each phase corresponds to each teaching content module to achieve expected goals of learning outcomes. The first stage is to know the programming charm. Lecture introduces Python primary knowledge and programming methods by "graphic" cases to show the programming charm, so that improves the students' learning interest, for examples drawing up simple geometric shapes, triangles, squares, pentagons, hexagons. The second stage is to read and write simple programs. By dismantling case, explaining code, deducing the process of problem solving, through “lectures + flipped classroom" and “instantiation” mode with putting forward from easy problems to difficult, students are guided to understand the way to solve problems by programming and learn how to write simple codes, so that cultivates them understanding and computational thinking. For instance, starting from drawing up the simple geometric shapes with eight lines code of triangle graphics, then ten lines code of square graphics, twelve lines code of pentagon, and fourteen lines code of hexagon graphics. The third stage is to write programs. This phase aims to train the students how to understand the programming logic structure and cultivate students' logical thinking and preciseness. Writing programs starts from simple questions and increases the difficulty gradually to let students understand the logical process of program and the connotation of program construction, so that trains students’ ability to independently analyze and solve questions. Students are encouraged to have the mind of “more than
one solution” to cultivate them innovative ability. Taking Turtle draws triangle graphic as an example, first drawing by sequence structure, then by loop structure, and drawing three color triangle by list, finally Random library draws random color and random position of triangle step by step. The fourth stage is to solve the problems. After understanding the methods to solve problems by computer, students are required to master them in this phase. According to expected objectives of the course outcomes and students own goals, this phase includes three parts that solving simple questions, complex questions and professional questions. Solving simple questions is with the framework of "RAPTOR + algorithmic programming” teaching model to strengthen the students’ thinking training and further understand and learn the ways to solve primary problems by programming. Solving complex questions designs in the form of task, which requires students to learn and search relevant information according to the demands of the task, build mathematical model and study the scheme and steps according to the problems. Besides solving complex questions demands students to try to figure out the problem with design different algorithms, and develop thinking, analyze and evaluate the result; Solving professional questions mainly combines with students' professional background to design task, which contributes to discuss the mission requirements, function module and tasks implementation for students.

"Four-stages" teaching method can not only realize expected course output, but also let every student can learn something according to the students' personal interests in this course and expected goals, which is the core teaching concept based on OBE's program design.

Curriculum Evaluation Methods

The “results” of OBE oriented teaching course is not only limited to the students test scores, but rather to emphasize that the students in the learning process prove true capability, eventually achieve expected output results. Therefore, curriculum evaluation method is further improved on the existing evaluation methods from different levels (classroom teaching activities, homework and test scores) and different dimensions (knowledge, skills, quality) for students learning output to form formative and summative assessment. As shown in Table 3 programming course evaluation methods. The formative assessment is the main method of the knowledge objective evaluation including class test and homework test, refer to basic concepts and methods of program design, ability target evaluation including formative assessment and summative assessment, which prior one includes homework programming and project practice, mainly focus on the problem analysis and solution. Scheme analysis in the practice process is one of the important way to form summative assessment. Quality objective evaluation mainly includes class discussion and presentation, which focuses on communication and team work.

| Evaluation aspects | Study goal | Formative assessment | The weight | Summarized assessment | The weight |
|--------------------|------------|----------------------|------------|----------------------|------------|
| Knowledge Objective| SO1        | Class preview, detection, random testing, after-class unit test, homework | 20%        |                      |            |
|                    | SO2        |                      |            |                      |            |
|                    | SO3        |                      |            |                      |            |
| Skill Objective    | SO4        | Homework, project practice, examination evaluation | 15%        | Project practice      | 5%         |
|                    | SO5        |                      |            |                      |            |
|                    | SO6        |                      |            |                      |            |
| Quality Objective  | SO7        | SPOC online self-learning, unit test, homework | 5%         | SPOC discussion, group discussion, project presentation | 5%         |
|                    | SO8        |                      |            |                      |            |
|                    | SO9        |                      |            |                      |            |

Final Examination (50%)

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The Achievements of Teaching Reform

Based on the concept of OBE curriculum teaching reform, it gets rid of the traditional knowledge-orient teaching, and inspires the students to explore and innovate. The implementation of diversified teaching mode and the "four stages" teaching method maximum arouse the enthusiasm and initiative of students and cultivate students’ comprehensive ability, so that students gain a sense of achievement. Break the traditional evaluation system, encourage students to participate in, improve students' abstract logical thinking, creative ability, which is in order to lay the foundation for students' professional ability development, scientific literacy and program design of general education.

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