Research and Practice of Computer Basic Course Reform under the Background of Emerging Engineering Education

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Abstract: Emerging Engineering Education is a new direction of engineering education in colleges and universities proposed by the Ministry of Education of China. The basic course of computer is of great significance to the construction of Emerging Engineering Education in Colleges and universities. But at present, there is a general contradiction of " Fundamentals - Class Hours - Contents" in basic computer teaching. Taking Foshan University as an example, this paper designs and studies computer basic teaching from four aspects. Firstly, from the aspect of course teaching content system, It mainly includes the combination of calculation and program, calculation system, algorithm thinking, information literacy, system thinking, computational thinking, etc. to form the optimal set of university computer course teaching content for the construction of Emerging Engineering Education. Secondly, in terms of teaching means and teaching methods, we use MOOC and other advanced teaching means to construct an ideal classroom to solve this contradiction. Thirdly, we build an online judeg system to attract, encourage and strictly require students to study and practice computer basic courses. Fourth, we encourage and guide students to participate actively in science and technology competitions, and cultivate their computational thinking by solving specific problems. Through more than two years of practice, it shows that the above methods are effective. Students' ability to solve problems by computer has been well trained, and their computational thinking has been greatly improved, laying a solid foundation for the training of innovative engineering talents.

1. Introduction

With the support of Guangdong Provincial Government and Foshan Municipal Government, Foshan University is developing a high-level university of science and engineering. There is a long way to go to build a high-level university of science and engineering from a general local university. For the basic computer courses, it is necessary to change in the new orientation because of the change of the orientation of school and student training. At the same time, the certification standard of engineering education requires students to have the ability to predict, simulate and solve complex engineering problems by using information technology. The content of computer courses is required to provide an information technology support for solving professional problems, so that students can have the ability to use information technology to solve complex professional problems. However, this ability is not clearly reflected in the computer basic curriculum system, which is often ignored in the teaching process. The lack of this supporting role may lead to the questioning of the necessity of offering basic computer courses for non-computer majors.

In early 2017, the Ministry of Education put forward the concept of Emerging Engineering Education[1]. It is different from traditional engineering disciplines, emphasizing information technology to drive industrialization. Compared with the traditional engineering talents, the future emerging industries and new economy need high-quality compound "Emerging Engineering

Education" talents with strong engineering practice ability, strong innovation ability and international competitiveness. They should not only have a profound academic background in a certain discipline, but also have the characteristics of "interdisciplinary integration". They can not only use their knowledge to solve existing problems, but also learn new knowledge and technology to solve future development problems, and play a leading role in future technology and industry.

Traditional science and engineering disciplines are not enough to cope with the changes of the times, so we need to reconstruct some core knowledge and upgrade the old knowledge. In this process of construction, a large number of information technologies with programming as the core are needed to support various specialties. It is necessary to construct a new computer basic course teaching system which is suitable for the construction of Emerging Engineering Education.

The main significance of this paper is to explore and design a new teaching method of computer basic course system, course content and computer basic course in high-level university of science and engineering in line with the concept of Emerging Engineering Education construction under the background of rapid development and application of new information technology such as cloud computing, big data, Internet of things and mobile Internet. It focus on training the computing thinking and innovation ability of students majoring in science and engineering, and laying a solid foundation for the future application of computing means in the field of work, research and innovation. And the target is to construct a set of computer basic course teaching mode, to contribute to the high-level science and engineering universities and Emerging Engineering Education construction.

2. Current Situation Analysis

Our university has always attached great importance to computer basic teaching. At present, the curriculum system of computer basic teaching, which is unified by the computer basic teaching department, is roughly divided into three categories according to the specialty: liberal arts, economic management and science and engineering. The basic computer courses of liberal arts include two courses: university computer foundation (Access database) and Internet multimedia application. The basic computer courses of economic management include computer technology civilization and the application of Excel in business. For science and engineering, they are university computer foundation and programming (C language or Visual Basic). From the original orientation of students'training in local colleges and universities, the original computer basic teaching mode can better meet the needs of students and generally meet the teaching requirements of university computer basic courses proposed by the University Computer Teaching Steering Committee of the Ministry of Education.

In China, with the research and continuous promotion of the University Computer Teaching Steering Committee of the Ministry of Education, it has been nearly 20 years since computer basic courses were offered to all college students. It has undergone several evolutions and developments. In the past two or three years, the principles of using computational thinking to reform basic computer courses in universities have been clearly defined. There is also a general consensus that computational thinking should be taught in university computer courses. Computer courses in universities, which mainly focus on the cultivation of computational thinking, have gradually become the same basic courses as mathematics, physics and foreign languages. C9 universities, represented by Tsinghua University, Nanjing University, Zhejiang University and Harbin University of Technology, jointly issued a joint statement[2] on the transformation of university computer courses with computational thinking, which laid a good foundation for the reform of university computer-oriented computational thinking education.

However, due to the contradiction of " Fundamentals - Class Hours - Contents", people still have some confusion about the curriculum content system oriented to computational thinking. As a result, the teaching content of many colleges and universities still stays at the so-called "narrow instrumentalism" level[3]. Or stay at the level of gathering the knowledge of preface and introduction of computer courses. It can't satisfy the need of teaching reform of general education of

computational thinking in university computer course under the new situation. The so-called "Fundamentals - Class Hours - Contents" contradiction refers to: First-year students have different computer foundations. Some students have good computer foundations, while others are relatively weak. It is difficult to determine what content to teach in order to make students accept and benefit from it. Computer science is the fastest growing discipline in the past 60 years. The rapid expansion of knowledge and content is inconceivable. How to choose teaching methods for so many contents has become a difficult problem. In order to ensure that students majoring in science and engineering learn their own subject knowledge, it is impossible to devote too many hours to the "university computer" course, and they are also facing the pressure of constantly reducing classroom hours.

At present, we are building a high-level university of science and engineering, which is a good opportunity for our college computer basic teaching to transform to the advanced stage of cultivating computational thinking. This paper will focus on solving the contradiction of " Fundamentals - Class Hours - Contents" from the aspects of curriculum system, teaching content, teaching methods, evaluation system and scientific and technological competitions.

3. Computer Basic Course Design

3.1 Design of Computer Basic Course System.

Under the background of high-level science and engineering universities and Emerging Engineering Education construction, as well as the rapid development and deep application of information technology, what specific courses will be included in the basic computer courses for science and engineering students? How many hours and credits are reasonable for each course? When will students benefit most? How can we not only guarantee the cultivation of students'computational thinking, but also not occupy too many teaching hours of specialized courses? How to integrate basic computer courses with professional courses so that students' computational thinking and computational ability can be applied in practice? All of these need to be designed as a whole. Table 1 gives the design of computer basic course system for Emerging Engineering Education in Foshan University.

Table 1 Computer Basic Course System

Course Name	Credit	Open Semester	Professional Orientation
Computer Fundamentals	4	1	Industrial Engineering, Medicine, Environmental Science, Chemistry
Programming (C/C++/Python)	4	2	Civil Engineering, Machinery, Automation, Mathematics, Food Engineering, Electronics, Environmental Science, Biomedicine
Computer Aided Design	2	4	Machinery, Electronics, Automation, Civil Engineering, Environmental Science, Chemistry
Principle of Single Chip Microcomputer	3	5	Machinery, Automation, Electronics, Biomedicine
Management Information Systems	3	7	Industrial Engineering, Mechanical Engineering, Civil Engineering
Introduction to Artificial Intelligence	2	1-8	Public elective courses

3.2 Teaching Content Design of Computer Basic Course.

Under the background of continuous time compression, what should be included in the teaching content of computer basic courses for high-level universities of science and technology and Emerging Engineering Education construction based on computational thinking? This paper designs a set of

computer basic course teaching contents including: calculation and program, calculation system, algorithm thinking, information literacy, system thinking, data abstraction and computational thinking, network computational thinking, etc[2,4,5].

Calculation and program. Firstly, computational means have become the third means of scientific research besides theoretical and experimental means. The integration of computing and society is getting deeper and deeper. Its essence is to express different social phenomena or problems as forms that computers can handle, namely symbolization, computation and automation. Secondly, "calculation" refers to seeking and designing algorithms or programs for specific problems, in order to enable machines to automatically calculate and obtain results instead of human beings. Program should be a generalized concept and an important means to realize the complex functions of a system. That is, the ever-changing combination of basic machine actions with different users'use purposes. Computing system is a system that can execute any program. The concept and content of "calculation and program" is the most important to the formation of students'computational thinking.

Calculation system. Firstly, there are similar thinking modes in computing systems and real systems, such as division of labor-cooperation and collaborative thinking, parallel and distributed thinking to improve resource utilization efficiency, etc. At the same time, they support the emergence of innovative complex thinking modes, such as various intelligent systems, which are essentially computing-based systems. Secondly, the understanding and use of computing tools will affect people's thinking habits, and then affect our thinking ability, has become an important source of innovation.

Algorithm thinking. The key lies in: which algorithms are taught to students of science and engineering specialty who have weak foundation and limited time, how to teach algorithm thinking, how to establish the basic thinking mode of algorithm research, and how to make students understand the relationship between algorithm and problem and environment.

Information literacy. Nowadays is the information society. Everyone is inseparable from information. A person's ability to acquire, process and use information will affect his future work and life. Therefore, information literacy is the basic literacy that everyone should have in the information age. Information literacy includes the literacy of data management and utilization, the literacy of network connection and utilization, the literacy of information publishing, the literacy of arranging and publishing works and achievements, and the literacy of information security, how to protect their own data and facilities.

System thinking. The concepts of the system, scientific methods of the system, problem domain modeling and structural thinking of the system, software domain modeling and object-oriented thinking of the system, object-oriented programming, implementation of modules and systems, discussion of structural problems of the system, reliability and security of the system, etc. will be taken into account.

Data abstraction and computational thinking. It mainly includes: why data is also productivity; from database to data mining; why abstraction-theory and design are needed; concrete method of data abstraction-understanding-distinguishing-naming-expression; basic method of design-form-construction and automation; basic method of theory-definition-axiom-theorem and proof.

Network computational thinking. Mainly includes: from machine network to information network; markup language; innovative thinking based on the Internet; social network-group interaction network; network society and network computing methods.

4. Teaching Method Design of Computer Basic Course

4.1 MOOC+SPOCs+Flip Classroom.

At present, the conventional teaching method of classroom instruction + after-class experiment can not meet the need of cultivating students'Computational Thinking in an all-round way. This paper adopts the mode of "MOOC + SPOCs + Flip Classroom"[6] to continue the reform of teaching methods. MOOC(massive open online course) refers to courses open to all students in society; SPOC

(small private online course) refers to courses open only to students in a certain class of a school[7]. MOOC + SPOCs refers to the establishment of a special online open course SPOC based on the same MOOC course in schools. It is a large-scale synchronous SPOC implementation mode based on MOOC. MOOC+SPOCs solves the problem of collecting and sharing three-dimensional course teaching resources, realizes learners'multi-channel learning, repetitive learning, free learning without space-time restrictions, fragmented learning, and realizes learners' self-learning, mutual learning and group learning. The purpose of MOOC+SPOCs is not to replace offline classroom teaching, but to release offline classroom teaching space as much as possible so that teachers can have time to explain the most wonderful content in offline classroom. If ordinary content is left for online students to study by themselves, teachers can have time to organize students'active learning, seminar-based collaborative learning and exhibition. Show and comment teaching and learning. The goal of "MOOC+SPOCs+Flip Classroom" is to enable students with strong abilities to go further and learn more content; to enable students with weak foundation to go more solid, to watch learning repeatedly, and to watch different lecturers teach the same content for learning[8].

4.2 Ideal Classroom Construction.

In order to meet the learning characteristics and needs of non-computer majors, this paper puts forward the strategy of "getting something, not getting something" for complicated programming languages[9]. At the same time, it puts forward its own unique teaching methods for many knowledge points in programming language. In the classroom of multimedia environment, the teaching method of "showing the programming process" is adopted, and students'participation is encouraged to improve students' ability to analyze and solve problems. A method of constructing an ideal classroom of computer basic course is explored from the aspects of content, operation method and implementation technology.

4.3 Evaluation System of Computer Basic Course.

The evaluation system of basic computer courses is mainly carried out from two aspects, one is the evaluation of basic concepts, basic theories and basic skills, the other is the ability to solve practical problems by using computers. Online Judge (OJ) is an online system used by ACM to test the competing programs in programming competitions. Its main functions include: question bank management, user management, online submission procedures, online question determination, online ranking and so on. Users submit the source codes of various languages (such as C, C++) online. The system compiles and runs the source codes automatically, and detects the correctness of the source codes by using the preset test data of the system. It mainly provides a platform for ACM/ICPC contestants to practice, test and communicate with each other[10].

This paper independently develops an OJ judgment system in C language. The most important feature of the OJ system is that the topic begins with the introduction of language, and for the students without foundation, it starts with the basic training, laying a solid foundation for programming. On the one hand, using OJ system can greatly reduce the workload of teachers'correcting homework, so that teachers can focus on teaching and improve teaching efficiency; on the other hand, students can know the right and wrong in the first time, and according to the evaluation results given by the system, the procedure can be revised and submitted again. OJ system can count the number and ranking of test questions completed by each student, and stimulate students'interest to a certain extent. Compared with traditional classroom, OJ system greatly improves students' programming ability.

5. Construction of Students' Science and Technology Competition System Oriented to the Training of Computing Thinking

This paper establishes and improves the selection and training system of school-level information-related science and technology competitions for university students of science and technology. It takes the national information-related science and technology competitions of university students as an opportunity, integrates the scientific research projects of project team

teachers, promotes and encourages students to participate in science and technology competitions, and improves the practical ability and innovation of computational thinking, enhance the sense of teamwork. Starting from the first year of College Students' study of computer foundation and programming foundation, students with strong interest in programming, strong self-learning ability and outstanding achievements are selected for intensive training in programming, aiming at the Blue Bridge Cup Programming Competition and ACM Computer Programming Competition.

6. Conclusions

This paper establishes a computer basic course system, course content, teaching method and evaluation system for the construction of high-level science and engineering universities and Emerging Engineering Education, which is based on the cultivation of students'computational thinking. It also establishes a selection and training mechanism for students majoring in science and technology to participate in Information Science and technology competitions. The results of this paper have been tested by more than 7000 students of science and engineering majors in three grades since 2016, and good teaching results have been achieved. Through the study of basic computer courses, students'programming ability has been greatly trained, which provides a solid foundation for the cross-integration of computer science and other engineering disciplines and for the training of innovative engineering talents in the future.

Acknowledgements

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