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Teaching Mode of Basic Computer Courses Using Theories and Methods of Computational Thinking

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Abstract

In view of the university computer culture foundation of college course, it is proposed that learners use efficient thinking methods to think. They must get rid of the prejudice of traditional teaching "narrow tool theory", based on computing thinking and university computer culture foundation. This paper proposed how to guide learners to use computing thinking to solve related problems in classroom teaching, introduced the application of computing thinking in computer classroom teaching, and proposed a curriculum with "computing thinking" as the core. The teaching method provides a new model for the university computer basic education with the goal of improving students' thinking ability.

Keywords: Computing Thinking; Computer Science; University Computer Culture Foundation; Teaching Mode

1 INTRODUCTION

Computing thinking is very important in the knowledge structure of college students. Computer science is not just about presenting artifacts such as software and hardware to our lives, but more importantly, the concept of computing, which is used by people to solve problems, manage daily life, and communicate and interact with others. computing thinking training can not only enable students to understand the realization mechanism and constraints of computers, but also help students to carry out scientific and technological inventions and technological innovations. More importantly, students are required to carry out in-depth knowledge of their own information through their own thinking. Processing and processing to generate new and useful information and improve information literacy.

As the introductory course for university freshmen, "University Computer Culture Foundation" is aimed at more non-computer major students. We should make students touch the calculation methods and models through the teaching of this course, and try to stimulate students' scientific exploration in the computer field. interest. Therefore, computer science education is given to people of different academic backgrounds, so that they can familiarize with and master various ideas and methods of computer science, become a way of thinking through training, and can use consciously and effectively as an education in the face of problems.

At present, the application and promotion of computing thinking in teaching and training is gradually unfolding. Some computer educators have begun to promote the cultivation of computing thinking ability in the teaching process [1-4]. In the same year, the National Science Foundation (NSF) also launched a major basic research program (Cyber-Enable Discovery and Innovation (CDI)) that involves all disciplines and is based on computing thinking. Further expand the cultivation of computing thinking to various research fields in the United States [5]. In China, Academician Sun Xiaoguang clearly pointed out in the article "The Revolution of Computer Science": The most fundamental and long-term thinking of the (computer science community) is computing thinking. Professor Wang Fiyue from the Institute of Automation of the Chinese Academy of Sciences took the lead in introducing the "computing thinking" advocated by

international peers into China, translated the article "computing thinking" by Professor Zhou Yizhen[6], and wrote the related paper "computing thinking and Computational Culture".

2 Teaching Mode Based on Computing Thinking

Although computing thinking research is not very mature, there are still many deep-seated problems that need further research. In today's "University Computer Culture Foundation" teaching, there are the following problems in computing thinking teaching:

(1) Unconscious computing thinking teaching. Because computing thinking is not valued for a long time, but because on the one hand, the essence of computer application is problem solving, on the other hand, the computer problem solving method is the method of computing thinking, so the majority of computer educators are unconsciously and subtly implement computing thinking. teaching. We need to carry out computing thinking teaching consciously and systematically.

(2) The importance of computing thinking to the cultivation of talents is not recognized from a strategic perspective. Due to the lack of understanding of the importance of computing thinking, it is widely believed that computing thinking is one of the computer application skills. It is not realized that this constitutes the three major thinking of human beings together with theoretical thinking and experimental thinking. It is the talent of the 21st century. Basic skills; without understanding the development and transformation of computer science, it will affect the development of other disciplines and will change the face of computer-based teaching. Therefore, the computing thinking should be promoted from the computer application ability from a strategic height, and it should be taught as a basic skill of human beings.

(3) Focus on the teaching of technology and application, ignoring the teaching of "culture" and "thought". Since the end result of computer applications is a software or system, people pay attention to the teaching of technology and applications, pay attention to the process and details of software and system development, and ignore the thinking that leads computer applications. Of course, the content of computing thinking is not something that a course can undertake. computing thinking teaching needs to be used throughout all university computer foundation courses. In the basic computer teaching of universities, the ability to develop computing thinking requires a series of computer application courses to support and expand, such as data technology and applications, multimedia technology and applications. These courses guide students to apply computing thinking to solve problems in a variety of professions. But the university's first "Computer Science Foundation" course is a key to the development of computing thinking.

In the "University of Computer Culture Foundation" course, almost every concept corresponds to a computing thinking method. For example, Cache is a preset and cache method, and multi-core processor is a parallel external method; in the program design chapter, various commonly used algorithms and methods for solving various problems, such as iterative method and recursive method, are computing thinking methods; In the multimedia chapter, each project is a collection of multiple computing thinking methods.

3 University Computer Culture Foundation Course with computing thinking

For the university's introductory course "University Computer Culture Foundation", it is full of a lot of computing thinking cases. For example, the comprehensive display of computer applications has essentially played a role in cultivating the mindset of computing thinking; the development process from abacus to computer is the process of continuous expansion of computing thinking; computer systems use abstraction and decomposition to control complex tasks and complex designs. The system; the representation of data in the computer is the method of expressing the problem; the operating system is the case of solving the problem of the computer itself with the idea of computing thinking; the use of office software is a basic, low-level computing thinking; online retrieval, online shopping, Online shop is a computing thinking

activity with typical traditional thinking; designing a database is a process of abstraction and decomposition; designing an animation can be seen as a problem of modeling and simulation. We initially constructed the curriculum content with computing thinking as the core, and moved the focus of teaching to the word “culture”. We can even name it “Introduction to computing thinking”. Below, the general content of the course is introduced from the status, nature, and tasks of the course.

3.1 The Status, Nature, and Tasks of the Course

This course is the first computer foundation course for freshmen after entering college. Starting from the three pillars that promote the progress of human civilization and the development of science and technology, the course introduces the definition, essence and characteristics of computing thinking and the important influence of computing thinking on other disciplines. Then, starting with the fundamental problem of the discipline, namely "ability", introduces the relevant content of computational theory, including computational complexity, Turing machine, quantum computing and so on. Finally, introduce the computer's algorithm base, programming language, Python programming, computer hardware and software foundation and so on.

3.2 Basic Requirements of the Course

The course requires students to understand the basic content of computing thinking, understand the limitations of human and computer skills, understand the general steps of computing thinking to solve problems, understand the role of computing in the problem-solving process, and initially master the Python programming language. Programming.

3.3 Teaching Content

(1) Basic knowledge of computing thinking: the three pillars of scientific discovery, the rise of computational disciplines, the role of computational disciplines; what is computational science; what is computer science; what is computing thinking; the main research content, the main features (what is it) , it is not what), the impact of computing thinking on other disciplines.

(2) Computational theory: Computable problems, downtime problems, computational complexity, etc.; Turing machine, von Neumann computer model, stored program calculation, basic composition principle, etc.; non-traditional computing model (quantum calculation, molecular calculation, light Calculation, etc.).

(3) Algorithm basis: the basic concept of the algorithm (definition, classification, expression), algorithm design method (iterative method, recursive method, random method, heuristic method, etc.), algorithm analysis (worst case analysis, average situation analysis)), basic algorithm introduction (sum, quadrature, max/min, sort, lookup, basic graph algorithm, etc.).

(4) programming language: structural problems of programming; language syntax and semantics; low-level programming language (machine binary instruction code, symbolic assembly language, etc.), high-level programming language (C, Fortran, C++, Java, Python, etc.). Ancient Chinese scholars believe that when a problem can be solved on an abacus, the problem is solvable. This is China's "algorithmizing" thinking. As a deterministic symbol system, programming language can improve students' training of formal thinking. Programming is a typical computing thinking course. It involves a large number of algorithms. Enumeration, recursion, and backtracking are typical examples of computing thinking. Process-oriented and object-oriented programming are also computing thinking.

(5) Python programming basics: Introduction to Python language, Graphic Visual - Introduction to VPython, scientific computing package Numpy, Matlab function Matplotlib (library), installation package NetworkX, bioinformatics software platform Cytoscape. Basic elements: programming procedures, comments, operators, variables and functions, data types and transformations, strings, lists and arrays, dictionaries, decision structures, loop statements, comparisons, parameters,

recursion, iterations, random numbers, etc. Python programming examples: basic input/output, defining functions, creating files, linear programming, for loops, calling files, array calculations, and more. In the teaching process, let students fully understand how the computer can do and can't do anything from an algorithmic construct, and then write the program in the machine to experience the computing thinking.

4 SUMMARY

Carrying out computing thinking teaching in the course of "University Computer Culture Foundation" is not to subvert the original course content, but to improve and optimize it based on the original course content. The original course itself is carrying out unconscious computing thinking teaching. It only needs to combine the computing thinking with the original content, and the unconscious is active, positive and conscious.

(1) Principle recommendations for teaching methods

The two important characteristics of the computer science, "constructiveness" and "energy", are reflected in the teaching of the foundation, which is abstraction and automation. Abstraction is a process of transforming a complex problem into many simple sub-problems by means of reduction, transformation, recursion, embedding, simulation, and so on. Automation is to make full use of the speed and storage advantages of the computer to solve the problem. For example, the specific content of the program design is the algorithm diversification and machine realization mechanism, both of which are very effective for training computing thinking. In teaching methods, respect students' different cognitive styles and promote diversification of ideas. The goal of the course is not only to develop students' operational skills, but also to enhance students' computing thinking skills by emphasizing the diversity of ideas. A variety of solutions can be used for a problem. Teachers can let students develop their thinking, try to design multiple solutions and choose the best.

(2) Experimental teaching reform

Reform experimental teaching content, enrich experimental design, and build a multilevel experimental content system consisting of verification, application and innovation. Students are required to understand the basic principles of computer science through experiments, strengthen the understanding of the basic concepts of the subject through the exercises, and focus on improving students' thinking ability. In the process of teaching, students should be guided to analyze and solve problems to deepen their understanding of the principles of computing thinking. Through abstract and automated intensive training, students can form ideas for problem solving and expand computing thinking in the learning process.

In each experiment, it is necessary to clarify the experimental requirements and ask questions, and guide the students to seriously think and try to find a variety of solutions, using computer equipment and its mechanism performance, to get the correct results. The design mode of experimental teaching is shown in Figure 1.

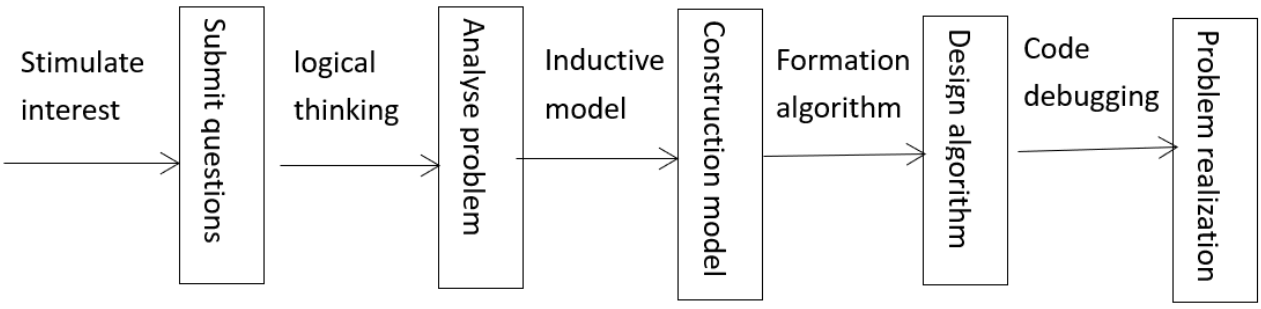


FIGURE 1 DESIGN MODE OF EXPERIMENTAL TEACHING

It is not the real purpose of experimental teaching that students follow the procedures in the textbooks. The purpose of arranging experiments is not only to verify the machine realization process of the program, but also to cultivate students'

computing thinking ability, and to guide students to expand knowledge and improve application ability through experiments. In the specific implementation, an online test system can be used to evaluate each experiment and as a usual score.

(3) Specific implementation plan

The University Computer Culture Foundation is a compulsory course for all students. The course consists of three basic modules: basic computer knowledge, basic skills, and network, database and multimedia. There are many courses, less time, and different levels of students.

In the fall semester of the past two years, we have selected a number of professional students to explore the computing thinking in the teaching of the University Computer Culture Foundation. The practical results show that the students have great plasticity and potential. They neither weaken the use of computer software, but also introduce the training of computing thinking and programming algorithms, which enhances the connotation of the curriculum and the reform is recognized by students. Of course, the computing thinking work should be fully promoted and classified and implemented in the subsequent courses. The workload is very large and faces challenges. The reform of computing thinking teaching is a systematic project. It is not a one-step thing. It requires constant learning, research, exploration, practice and optimization. There is a long way to go.

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