Cultivation of Solving Problems with Computing Thinking

Yahui Hu¹, Lei Xiao¹, Ling He¹ and Qiqing Fang²

¹Computer and Network Section, Air Force Early Warning Academy, No.288 Huangpu Road, Wuhan, Hubei
²Air defence early warning equipment department, Air Force Early Warning Academy, No.288 Huangpu Road, Wuhan, Hubei
Email: hyh5800@163.com

Abstract. Aiming to solve many people do not know how to use computers to solve practical problems in life and work, we design a series of detailed steps to analyze, design, represent, program and verify with computing thinking. We demonstrate our steps in detail with an example to help them which will encounter similar problems in the future.

1. Introduction
Computing thinking was first proposed by Professor Zhou Yizhen in communications of the ACM in March 2006. She believes that computing thinking is a series of thinking activities covering computer science, including problem solving, system design, and human behavior understanding, etc. with the basic concepts of computer science [1]. At present, many people have introduced computing thinking into the teaching of computer science [2-5]. Taking the course of university computer foundation as an example, according to the teaching syllabus and personnel training requirements of our college, by learning the basic knowledge of computer specialty, students' ability to solve practical problems by using computers, and students' computing thinking and information literacy are cultivated. How to give full play to the benefits of computing thinking and make students better accept the computer teaching is a hot research topic. In view of the problems existing in the current computer education, combined with the author's many years of teaching experience, aiming at training students' computing thinking, this paper attempts to reform and innovate the teaching mode, so as to improve students' ability to master computer knowledge and improve their ability to solve practical problems.

Take the university computer foundation as an example. As a required course for freshmen, a questionnaire survey was conducted before class. There are few operations and applications of computers in middle school, as shown in Figure 1. According to the results of the questionnaire survey, many students mostly use computers as entertainment activities such as playing games and watching movies. A few students have set up information courses in middle schools and learned the basic operation and basic programming procedures of computer office software. Most students hope that through this course, they can systematically learn computer programming language, become computer programming experts, and even use computers to solve practical professional problems, rather than just meet the basic operation of computer office software. It can be seen that the students' mastery level of computer technology is uneven, and the enthusiasm and urgency to learn and master the basic computer skills are strong, which puts forward high requirements for the arrangement and implementation of computer teaching.

Content from this work may be used under the terms of the Creative Commons Attribution 3.0 licence. Any further distribution of this work must maintain attribution to the author(s) and the title of the work, journal citation and DOI.
Published under licence by IOP Publishing Ltd
2. The Practical Process of the Training of Computing Thinking

2.1. The Connotation and Essence of Computing Thinking
According to Professor Zhou Yizhen, computing thinking is a process of thinking that defines and solves problems, and expresses its solutions as a form that can be effectively executed by people or machines. Strictly speaking, computing thinking includes logical thinking, algorithmic thinking, decomposition, generalization and pattern recognition, modeling, abstraction, evaluation, etc. For example, if we want to use computers to solve the classic problem of 100 chickens and 100 coins, we can use the exhaustive algorithm through analysis, and the idea of divide and conquer is used to solve the number guessing game. For different problems, according to the nature and characteristics of the problem, first abstract the problem model, use reasonable algorithm to decompose, generalize, model, summarize, finally form a reasonable algorithm model, describe the algorithm process with program flow chart, N-S diagram, pseudo code, pad diagram, natural language and other ways, then use appropriate programming language to solve the problem, and finally through verification Evaluate the validity, correctness and rationality of the algorithm.

2.2. The Practical Process
Take Baiqian to Baiji as an example to solve problems by using computing thinking. The process is divided into several steps, such as problem introduction, problem analysis, problem abstraction, mathematical modeling, algorithm representation, program implementation, experimental verification, algorithm evaluation, optimization algorithm, etc.

2.2.1. Problem. Zhang Qiujian, an ancient Chinese mathematician, once put forward the famous question "one hundred money for one hundred chickens" in the book "the book of calculation". The question is described as follows: five yuan for a rooster; three yuan for a hen; one yuan for three chickens; one hundred yuan for one hundred chickens. How many roosters, hens and chickens are each?

2.2.2. Analysis. For this problem, we can try to combine a variety of chicken numbers, and choose a variety of chicken number combinations that meet the conditions, that is, the exhaustive algorithm. For example, how many cocks can I buy for 100 yuan? In the same way, how many hens and chickens can you buy for 100 yuan?

Thinking: Set the number of cocks, hens and chicks as X, y and Z respectively
Test set: 0<=x<=n; 0<=y<=n; 0<=z<=n
Condition: x+y+z=n; 5*x+3*y+z/3==100

2.2.3. Modeling. Suppose the number of cocks, hens and chicks is x, y, Z, respectively. There are two formulas:
x+y+z=100
5x+3y+z/3=100

2.2.4. Algorithm. Take pseudo code as an example to analyze the algorithm:
for x,y,z=1 to 100
  If 5x+3y+z/3==100 then
    Print x,y,z
  End if
next

2.2.5. Program.
for x in range(1,101):
  #Suppose we can buy y hens
for y in range(1,101):
    #Suppose we can buy Z chickens
    for z in range(1,101):
        if x+y+z==100 and 5*x+3*y+z//3==100 and z%3==0:
            print("cocks:%d, hens:%d, chickens%d"%(x,y,z))

2.2.6. Verify. Through the experimental verification, the results are as follows:
Cocks:4, hens:18,chickens:78
Cocks:8, hens:11,chickens:81
Cocks:12, hens:4,chickens:84

2.2.7. Evaluation. Algorithm time complexity is O(n³).

2.2.8. Optimization. The problem of buying chicken for 100 yuan has been solved, but is there any other better algorithm to solve it?
    Optimization time complexity:
    #Suppose we can buy x cocks
    for x in range(1,21):
        #Suppose we can buy y hens
        for y in range(1,34):
            #Suppose we can buy z chickens
            z=100-x-y
            if z%3==0 and 5*x+3*y+z//3 ==100:
                print("cocks:%d, hens:%d, chickens%d"% (x,y,z))
    Algorithm time complexity is O (n²).
    The time cost before optimization is 0.01707901650068699 and after optimization is 0.000202147583800883327, which is 84 times faster than the previous algorithm.

2.2.9. Summary. This paper analyzes and summarizes that this kind of problem is solved by exhaustive method, trying to meet all kinds of solutions. For example, the number of Narcissus, prime number, chicken and rabbit in the same cage and other problems are all reduced to the exhaustive method. Set the formula that meets the conditions, and find all the solutions to the problem through multiple cycles.

3. Conclusion
In view of the weak computer foundation of the freshmen in the teaching, especially the problem that they are at a loss in computer programming, this paper uses computing thinking to solve the problem, and carries out intensive training, so that the students can summarize and summarize the methods of similar problems themselves, so as to cultivate the literacy of computing thinking.

4. References
[1] Wing J M. Computing thinking[J]. Communications of ACM, 2006, 49(3): 33-35.
[2] Chen Guoliang, Dong Rongsheng. Computational Thinking and basic computer education in universities [J]. Teaching in China University, 2011 (1): 7-12
[3] Zhu Junbo, Gong peizeng, Yang Zhiqiang. Teaching reform of recursive algorithm based on Computing Thinking [J]. Computer education, 2017 (7): 30-33.
[4] Dong Rongsheng. The structure of computing thinking [M]. Beijing: People's post and Telecommunications Press, 2017
[5] Wang Chunmei, Wang Shuyan. Training of Computing Thinking Ability in the course of compiling principles [J]. Contemporary educational practice and teaching research, 2016 (11): 147-148