

# The Research of Data Structure Teaching Based on Computational Thinking

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**Abstract:** In recent years, how to cultivating and developing students' Computational Thinking during the teaching is a hot topic in the field of education. This paper analyses the teaching status of the course of "Data structure", discusses the relationship of the Data Structure and Computational Thinking, describes some ways to prove the quality of teaching such as designing the case, training the thinking and teaching mode reform. The results show that the teaching of Data Structure based on Computational Thinking can effectively promote students' enthusiasm for learning and enhance students' ability to solve problems.

## 1. The current status of data structure teaching

"Data Structure" is one of the core curriculums in computer or related majors. It's a base course in computer related specialty, which plays an important role in the whole course system, it is not only theoretical but also practical, its content is abstract and dynamic. Over the years, students generally think that the course is difficult. Why? According to the survey, there are three reasons for this phenomenon.

First, the course of Data structure is generally offered in the second or third semester. When the students do not have any experience in system development. For them the course which has so many abstract and systematic contents is very hard. To understand the knowledge, students have to write a large number of codes. So, slowly, many students develop a fear of difficulty which leads to a loss of interest and confidence in their studies.

Secondly, in the traditional class, the teacher is the main focus, he is the authority. The students must obey the teacher. The only thing that the students can do is to remember what the teacher said and to do some validation experiments according to the requirements of the experiment outline. This popular and standardized teaching model ignores the individual differences of students, resulting in some people "not enough" and some people "not eating enough". Over the time, students lose their enthusiasm for learning courses.

Finally, Due to the limitation of school time, most of current teaching just conveys the core content to their students without the knowledge background and thinking process, just like compression cookies. It roughly disconnects the specific environment in which the knowledge depends. So the study is simple, rough and shallow. There is no creative, critical mental input in the learning process. Most students do not know the usefulness of learning data structure, Which Cause blindness in learning.

## 2. The relationship of data structure and computational thinking

Since Professor Zhou Yi-zhen, Carnegie Mellon University, put forward the concept of "computational thinking", the international and domestic education fields have set off an upsurge of research on computational thinking<sup>[2]</sup>. Computational thinking, as one of the three major thinking sciences of mankind, uses the basic concepts of computer science for problem solving, system design, and human behavior understanding<sup>[3]</sup>. In recent years, the scholars believe that the computational thinking is one of the core qualities of information technology disciplines. Therefore, improving students' computational thinking ability is one of the core goals of computer teaching<sup>[5]</sup>.

Data Structure is a very important core course for computer related majors. Its content includes the definition of abstract data types, the implementation of operations, and the realization of related algorithms. Almost every module in the course contains one or more computational thinking methods. The computational thinking methods contained in the algorithm and some concepts in Data Structure are summarized as shown in Table 1. The goal of course teaching is not only to teach students the basic knowledge and application ability of computer, but also to improve students' ability to analyze problems and solve problems. This is also the ultimate goal of computational thinking. Therefore, Data Structure is an important carrier of computational thinking and an important training tool for computational thinking. The reform of "Data Structure" teaching based on computational thinking, integrating the training of thinking with the training of professional ability, is the direction of current computer teaching reform<sup>[6]</sup>.

Table 1 the computational thinking methods

the content of Data Structure	computational thinking methods
the definition of storage node	abstract, automation
the traverse of binary tree	recursion, automation
the traverse of graph	recursion, focus separation
the algorithms of the shortest path	heuristic reasoning, optimization
comparisons of sorting algorithms	compromise
function	encapsulation

### 3. The Data Structure teaching based on computational thinking

It is a challenge to train Computational Thinking which be used to improve students' ability to analyze and solve problems in the course of Data Structure. In order to cultivate thinking in class, we need to re-examine the teaching objectives from a macro perspective, organize the teaching content based on computational thinking, improve the classroom and enhance students' thinking training in the process, and deepen the reform of teaching mode with advanced information technology in accordance with the changes of the times. In order to achieve this goal, the author has made the following attempts during the Data Structure teaching.

#### 3.1. Design thoughtful and interesting teaching cases

The teaching of Data Structure guided by computational thinking requires teachers to provide students with a thoughtful environment, that is, to provide opportunities for students to participate in a meaningful thinking activity and encourage them to participate in such activities. This puts forward higher requirements for teachers. On the one hand, the teacher need to go deep into social practice, do some research in different areas of expertise, master some computer application examples; on the other hand, the teacher needs to study Computational Thinking and curriculum content carefully, refine the computational thinking behind the knowledge, design the teaching cases and guide students to explore knowledge, help the students to become a problem thinker. Make the class full of thinking and interesting. For example, linear list is the first abstract data type in Data Structure. In this chapter, we designed a simple outpatient registration system for students to understand the relevant properties of linear list. Follow that, students are divided into several groups. Each group will debate some contents of the system such as the object, the attributes of the object (number, name, sex, age, simple description of symptoms, etc.); the relationship (the element forms a linear list due to the number); and the characteristic of the list (except for the first and last patient, each patient has only one direct predecessor and one direct successor); operations (insert, delete, search) and so on. The knowledge of the linear list is integrated into the case. At this, we can stimulate the students' interest and cultivate the students' habit of thinking actively in study.

#### 3.2. Improving classroom effectiveness and strengthening computational thinking training

Thinking is formed with the penetration of knowledge, and ability is improved with the training of thinking. Therefore, in order to improve students' ability, it is not enough only to design such a

case, but also to do some effective computational thinking training such as diversity. For knowledge diversity, the teacher should try his/her best to provide many cases about the knowledge to students, and the students should learn to observe life and find more similar cases in life to carry out independent training. For algorithms, the diversity emphasizes multi-solution for the same problem. For example, when we create a new link-list, the new node can be inserted at the tail of the list, this method of establishing a single linked list is called “tail insertion method”. According to the different insertion positions of nodes, the new node also can be inserted at the head of the list. The difference is that the formed single-linked list is inverse, that is, the first element in the list is the last node that be inserted. The new node can be inserted at the head or the tail in the list. What about in the middle of the list? Obviously, it’s sure. In this method we must find the appropriate insertion position and then insert the new node. In short, there are many ways to create a single linked list according to the insertion location of the new node. Therefore, in teaching we should inspire students to think from multiple perspectives. Except that, the student should be encouraged to rewrite existing algorithms, so as to exercise the diversity and reconstruction of thinking.

### 3.3. Developing mixed teaching and deepening the reform of teaching model

Promoted by information technology, we integrate micro-class into traditional classroom, and redesign the teaching activities, so as to improve the teaching efficiency and learning effect. Since 2014, the author and his team have been devoting themselves to the research of mixed teaching<sup>[7-9]</sup>. First, they recorded micro-lessons, applied for the Wechat Public Number, constructed the learning community based on the Wechat Friendship Circle, and design the framework of teaching activities as figure 1. In this framework, we organize activities according to the process before, during and after class.

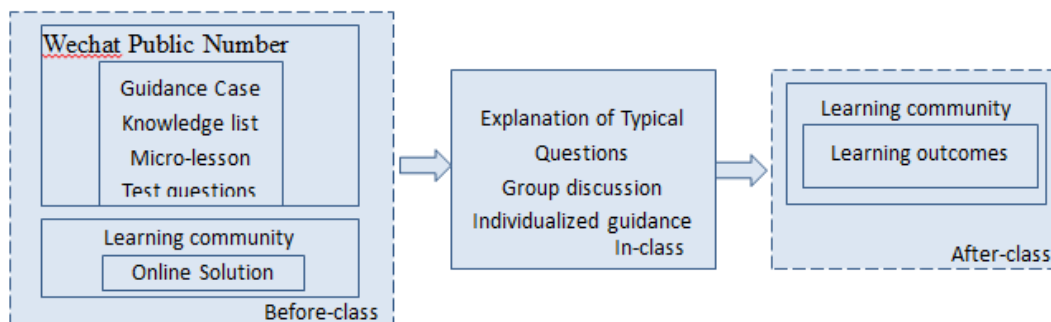


Figure.1 the framework of teaching activity

According to this framework, we implemented the teaching of data structure course in the software engineering major of grade 2017, and evaluated the teaching effect. The evaluation includes questionnaire survey, curriculum design and final test. Questionnaire survey focuses on students’ attitudes towards this course, programming ability, professional awareness, and the recognition of mixed teaching methods, and so on. Table 2 lists some questions in the questionnaire.

Table 2 some questions in the questionnaires

questions	options
Do you like programming?	(1)yes (2)no
How many hours do you spend writing programs per day?	(1)under an hour (2)an hour (3)over an hour
Do you watch videos of this course very day?	(1)yes (2)no
Is teamwork learning helpful to your study?	(1)no help (2)a little help (3)a great help
What do you think about data structure?	
How do you think about the current teaching model of the course?	

According to the results of the questionnaire survey, 80% of students prefer to learn courses on the WeChat platform. The students think that the WeChat shortens the distance between the teacher and students and provides a communication platform across time and space. In the teaching process, the role of the group leader is given full play, which mobilizes the enthusiasm of students in learning courses and increases their sense of achievement in learning. Some students said that the self-learning task is so heavy, so tired.

Course practice is an important teaching activity. The tasks of the design are arranged by the teacher in the middle of the semester. The students were divided into several teams. Every team has a leader. At the end of the semester, the leader will report the completion of the task, demonstrated the problems encountered in the process and the solutions, and reported the gains of the team. Comparing the curriculum design results of this year's students with the previous curriculum design, there have been obvious changes in three aspects. First, the number of course design topics has increased a lot. In the previous course design, 3-4 people completed a topic, and in this year, 2-3 people completed a topic. Secondly, during the course design process, the number of people who actively communicated with the teacher increased significantly. Finally, in the results presentation, the number of students speaking also increased.

From the longitudinal analysis of the final test papers, in the case of the same proportion of test papers, the average score is increase from 70points to 80points after the mixed teaching mode. The part where the score improved obviously is the program analysis and programming.

In short, the mixed teaching can not only retain the implicit knowledge transfer inherent in the traditional teaching, but also satisfy the individualized learning of the students. The appropriate flipping classroom stimulates the autonomy of students' learning. Continuous guidance has inspired students to think about problems from multiple angles. Shor and refined micro-classes realize the fragmentation learning of zero deposit, effectively expanding the learning space and time of students. Therefore, mixed teaching can helps students understand, digest, absorb and master knowledge.

#### **4. Summary**

Data structure is a professional basic course for computer related majors and one of the important tools for computational thinking training. How to carry out the teaching oriented with computational thinking? This paper elaborates on three aspects: case design, thinking training and mixed teaching. Of course, the cultivation of computational thinking is not a one-off event. It is impossible to complete the thinking training in one or two courses' teaching, and it needs to be continuously completed in the four-year university life. Therefore, the teachers should look at the taught courses from the perspective of computational thinking, pay attention to the implementation of the thinking and behavior of computational thinking training, as a breakthrough in the training of skilled talents, and improve students' ability to solve practical problems independently.

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#### **References**

- [1] QIU Jin, Wang Ping, XU Zhan. Journal of Southwest China Normal University (Natural Science Edition), 2013, 1(38):139-142.
- [2] FAN Wen-xiang, ZHANG Yi-chun, LI Yi. A review of research and development of computational thinking at home and abroad. Journal of Distance Education. 2018, 2:3-15.
- [3] LI Yan-kun, Gao Tie-gang. A Comprehensive Interpretation on the Computational Thinking Based on the Perspective of Thinking. Modern Educational Technology. 2017, 1(27): 68-73.

- [4] ZHANG Li-guo, WANG Guo-hua. Computational Thinking: A Key Issue of Cultivating Core Literacy of Information Technology. *e-Education research*. 2018, (5): 115-121.
- [5] GONG Jing, HOU Chang-lin, ZHANG Xin-ting. Study on the Computational Thinking Ability Development Model and the Teaching Program. *Modern Educational Technology*. 2018, 4(28): 48-54.
- [6] SI Ming, ZHAI Xiang-yang, LI Zhan-li, LI Hong-an. Teaching Practice of Data Structure by Highlighting Computational Thinking Training. *Research and Exploration in Laboratory*. 2018, 5(37): 195-201.
- [7] LI Feng-qing, HAN Xiao-ling. The Construction and Demonstration of Blending Teaching Quality evaluation system. *Chinese Electrochemical Education*. 2017, 11(370): 108-113.
- [8] LI Feng-qing. The Theoretical Basis and Teaching Design of Hybrid Teaching. *Modern Educational Technology*. 2016, 9(26): 18-24.
- [9] SUN Ya-hong. Exploration of Teaching Practice of Data Structure Course Based on WeChat Platform. *Microcomputer Applications*. 2018, 4(34): 10-12.