

## Data structure teaching method to cultivate students' innovation ability as the core

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**Abstract.** The target of this paper is to cultivate students' innovative ability. According to data structure teaching process, this paper proposed teaching design concept of double mainline firstly. Then, in order to reflect the innovative thinking to data structure course, this paper constructed three-layer teaching framework which included teaching content, teaching mode and teaching means. This paper also constructed 4 level staged practice teaching system which contain data structure experiment teaching, data structure course design, teaching innovation contest and scientific research project development.

### 1. Introduction

Data structure is an important professional basic course of computer science and technology and related. It has strong theories, abundant and abstract content. There are difficulties to apply theoretical knowledge to practice. The learning effect of this course directly affects the students' motivation and confidence to study related courses, and also influences the students' ability of the abstract modeling and programming design. The teaching pays attention to the students' theory understanding, cultivates students' abstract thinking, creative ability and practical ability. It makes students learn to store and process data effectively and design more efficient algorithm. Therefore, exploring the teaching mode which is suitable for the students' cognitive regular is a subject that we must study at present [1].

### 2. Construct the main teaching design concept of double

The course forms a set of double main teaching content organization form in order to combine the basic knowledge and application ability organically, one is explicit main line, and another is hidden behind of the first line and needs to be continuous highlighting and in-depth understanding.

The first main line is the learning and understanding of data structure, including the understanding from the simple data structure (linear structure) to the complex data structure. In order to make the line more clear, this course extracts the common issues of different kinds of data structure.

The second main line cultivates the ability to solve the actual problems, including analyzing application examples and solving classical issues (such as searching and sorting). The teaching method can adopt flexible methods such as curriculum analysis, big homework, online discussion, curriculum design etc..

The first main line discusses the basic operation, storage structure and implementation gradually. It also discusses complex data structure based on the simple data structure, so as to lay the foundation for the second main line. The second main line uses inductive approach. It aims to cultivate students' ability to solve practical issues by summarizing basics and lay the foundation for the related courses and the future research and practical work. Two main lines complement each other.

### 3. Constructing three-layer teaching framework

We make corresponding research and design on the teaching content, teaching mode and teaching means.

In order to introduce innovative thinking into the teaching of data structure course, a teaching framework of data structure course is designed here, as shown in Figure 1.

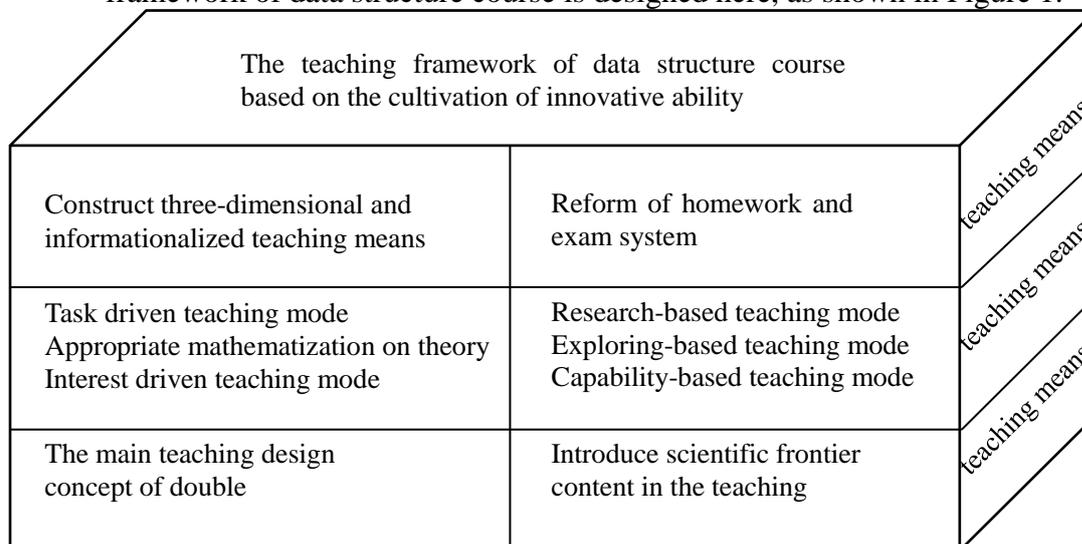


Figure 1 Three-layer teaching framework of data structure course

#### 3.1 Innovative thinking in the teaching content of data structure course

We need to pay attention to the introduction of scientific frontier content in the teaching process. The curriculum content's development is manifested in the following two aspects: 1) producing new data structure continuously (mainly in the logical structure); 2) using data structure knowledge to solve new issues continuously. The teaching link gives corresponding design and improvement aiming at these developments [2].

In the content teaching, we can introduce and explain emerging data structures at appropriate chapters. In the example teaching, we can introduce and analyze many emerging computer issues.

#### 3.2 Innovative thinking in the teaching mode of data structure course

##### 1) Research-based teaching mode

The research-based teaching of the university focuses on the combination of teachers' teaching and students' studying [3]. We put forward the research-based teaching mode, through which we can improve teachers' research level and cultivate students' research ability. This method requires teachers to carry out scientific design from seven aspects: inquiry path, teaching demand, questioning basis, teaching atmosphere, teaching form, teaching purpose and achievement evaluation [4].

##### 2) Exploring-based teaching mode

In the teaching process, we are trying to transform the traditional knowledge-based teaching mode into exploring-based and capability-based teaching mode. We can introduce questions of important content, frontier issues, or some research issues for students to discuss. We should explain analysis process and design process in addition to basic theory, so as to motivate students' exploring spirit.

##### 3) Capability-based teaching mode

In the teaching process, we can cultivate the ability to analyze and solve issues by building mathematical modeling consciousness and doing lots of work. We can cultivate the expression ability by writing experiment and curriculum design report.

##### 4) Task driven teaching mode

Task driven teaching mode provides students with a complete and real task, and makes students solve issues using the knowledge. It makes students obtain sense of achievement and motivates their desire for knowledge. At present, this teaching mode has been put into practice in the classroom teaching and is gradually improved [5].

5) Appropriate mathematization on theory teaching mode

This mode pays attention to the situation of the problem and the derivation of the algorithm or formula instead of showing the results directly. Students can construct a good structure of knowledge and form a good scientific literacy through it.

6) Interest driven teaching mode

Teachers should often strengthen students' interest to prevent them losing interest in the difficult knowledge. Teachers can use some practical cases which are closely linked to the focus of teaching, and as close as possible to the real life.

7) Double-track personalized cultivation mode for creative talents

This mode uses double-track during the process of computer science talent cultivation. We use "teaching and experiment" and "issue-based case study" in the teaching, use "examination papers and usual performance" and "computer test and report" in the examination. Both of the two test methods are admitted. Students can choose or adjust. This kind of personalized talent cultivation mode breaks through the traditional single assessment method, introducing innovative teaching elements.

### 3.3 Innovative thinking in the data structure teaching means

1) Constructing three-dimensional and informationalized teaching means

Three-dimensional teaching means includes four parts: multimedia electronic lesson plans, the algorithm dynamic demonstration system, online database of exercise and assistant teaching website.

2) Reform of homework and exam system

In the aspect of homework, we introduce many types of homework including comprehensive, interesting, ability-based and research-based homework. In the aspect of examination, we propose a new assessment which consists of three parts: the final examination (70%), usual performance (10%) and experimental results (20%).

## 4. Constructing the 4 level staged practice teaching system

Traditionally, the practical teaching includes two parts: the experiment section and course design which already cannot adapt to the current practical teaching situation. In order to motivate students' learning enthusiasm and improve their practical abilities, the project team constructed a 4 level staged practice teaching system for the data structure course, as shown in Figure 2.

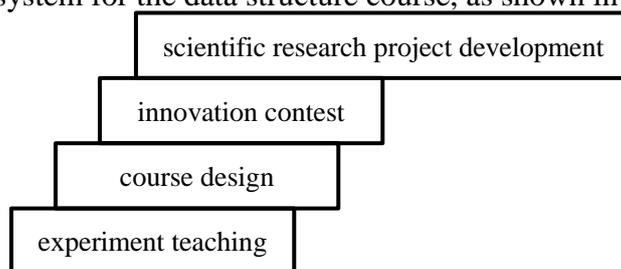


Figure 2 The 4 level staged practice teaching system

### 4.1 The first level: experiment teaching

Innovative experiments focus on cultivating innovative consciousness and ability, in which practical abilities and skills are important.

1) Innovative experiment teaching concept, improve experiment teaching content

Students should design homework, demonstrate homework and evaluate homework. Teachers and students can make further communication to improve the ability of creative thinking.

2) Keep pace with the times and update the experiment teaching means

The new experiment teaching method should explore many advanced teaching methods including independent study, inquiry study and cooperation study and so on. The network provides a good platform for our experiment teaching. Our teaching website contains rich teaching resources and software. We should respect and cultivate students' consciousness, independence and creativity, and give them independent learning time and space.

#### 4.2 The second level: course design

We are trying a different mode which is different from traditional course design in these links: subject, topic, thesis proposal, implementation and reply, mainly in the following aspects:

- 1) Encourage students to choose their own topics, and give guidance to students. The topic should have practical application background and be used in real life.
- 2) We require students being in groups of 3-5 people to complete the task. The team leader and team members should divide works clearly.
- 3) Teachers should cultivate students' ability to discover issues, solve issues, collect data and look up literatures.
- 4) Let them know the importance of communication and cultivate their team spirit.
- 5) Guide them to develop a system by identifying the target, collecting data, studying feasibility, coding and debugging, so as to motivate them to be interested in scientific research work.
- 6) Cultivate their ability of independent thinking and autonomous learning. Let them learn to think, arrange and utilize time, cooperate and communicate.

Students can understand the teaching content and expand the knowledge by designing the program, demonstrating the work, writing the report and relying.

#### 4.3 The third level: innovation contest

Innovation contest improves the students' ability to solve practical problems. Students can upgrade their course design work or design and develop a more creative work. It improves the ability of development and enhances their learning confidence.

#### 4.4 The fourth level: scientific research project development

After the third level, many excellent students will be invited to participate in the research project by various laboratories. Students can accumulate knowledge, and be ready to employment or further study.

### 5. Conclusion

In the teaching process, we will discuss the student-centered teaching method, pay attention to cultivate students' learning initiative, enthusiasm and independence, and improve the students' self-study ability. In the reform of the education methods, we should practice boldly, sum up experience, and innovate continuously. In the classroom teaching, teachers should pay attention to using diverse methods, and make students become the focus of the class. Teachers should play the role of answering students' questions, guiding students, and deepening students' knowledge.

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### References

- [1] Huigeng Yan, Wei Li, Yaozhong Li. Cultivation of students' innovation ability in Higher Vocational Colleges-Practice and exploration of "3T" mode[J]. Vocational and technical education in China, 2015 (17): 54-57.
- [2] Na Liu, Ying Lu, Chunlong Yao. Reform and exploration of the teaching method of "data structure" course[J]. China Electric Power Education: 2014 (1): 112-114.
- [3] Qinshan Fan, Yajun Yin, Jianping Chen. The innovation road in the implementation of research oriented Teaching[J]. Higher education in China, 2013, 5: 23-25.
- [4] Yongtao Song. Analysis on the mode of research teaching in undergraduate teaching reform[J]. Education and Teaching Forum, 2013 (32): 43-45.

[5] Dan Zhao. Discussion on the task driven teaching mode centered on the students' Autonomous Learning[J]. Education and career, 2013, 760(12): 98-99.