

Research-based Course Teaching of "C++ Programming" Combining the FKM Teaching Method

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Abstract—The research-based teaching thinking is applied to the C++ programming course teaching, combined with the FKM teaching method, the rapid acquisition of knowledge combine with knowledge exploration and research thinking, maximize the ability to cultivate innovative ability in classroom teaching. In the explanation of each knowledge point, start with deep logical thinking; first teach each chapter of knowledge points with the procedure-oriented idea, through the point - connection - network - expansion - scheme and other steps will be knowledge points through macro-structure and micro-interpretation. And then feedback the object-oriented knowledge, each knowledge point is the center of the class to form the FKM map of the C++ curriculum object-oriented knowledge. The abstract knowledge to the image intuitive, in line with the logic of thinking way of teaching, let the students out of the tedious grammar study, and then asks questions to inspire. The knowledge points in the book are regarded as the unknown fields, and the students are guided by the research thinking to rethink the knowledge points, to find out the problems, and to assist the research methods in order to cultivate the ability to solve problems.

Keywords—C++ Programming; Research-based Teaching; Teaching Method; FKM Teaching Method

I. INTRODUCTION

With the Ministry of Education issued “Several Opinions on Further Strengthening the Undergraduate Teaching in Colleges and Universities”, it is proposed that colleges and universities should actively promote research-based teaching and improve their innovative ability [1]. Therefor many colleges and universities have carried out research teaching and practice in order to achieve the purpose of cultivating students' innovation spirit and innovation ability. College students are different from graduate students, there is not a long time research project training system and process for them, and thus in the classroom teaching penetration of research-based thinking and exploration of inspiration for the future learning ability and innovation ability is a huge improvement.

The essence of research-based teaching is to enable students to learn thinking through the training of the research thinking method and carrier with their own ideas based on knowledge. Therefor teaching is divided into two steps (two

stages): the first step is knowledge teaching and skills training. The second step is through inspiration, answering questions, doubts, let students form their own thinking system through research thinking. Past teaching reform often focused on the first stage, including the reform of curriculum system, teaching materials, teaching methods and so on, and also achieved some results. But if not properly appropriate and timely inspiration to students during the acquisition of knowledge to how to form their own thinking and ability, students still need time and process to explore by themselves. Recently, research-based teaching has been paid more and more attention [2,3]. These two stages of learning is not isolated forward, if two stages of learning could be implement in the classroom teaching at the same time, the cultivation of students' ability will do more with less. Certainly, these two stages have different goal, and the methods will not be the same. In this paper, we will discuss the FKM teaching method and research teaching, through each classroom and knowledge point in the explanation. Let the students master the knowledge, and extend from the point of knowledge to the process of computational thinking, algorithm thinking.

C++ programming is a very important basic course for students of science and engineering. Because the C++ language has a lot of rules and flexible, object-oriented concepts are abstract and complex. The teacher in the teaching process from process-oriented begin, and then import the object-oriented programming method, students tend to fall into the C++ grammar rules. It is difficult to grasp the idea of programming. In fact, this is corresponding to the two stages of learning, the goal and ways of thinking are different, of course, learning methods should not be the same. While most of the students use only one learning method, the effect is not ideal, so that the majority of students lamented the difficulty of C++ programming courses. In this paper, according to the differences of these two stages, the author combines with the two different teaching methods for teaching methods of C++.

Based on a series of teaching reform projects and achievements of University of Science and Technology Beijing [4,5], the author puts forward the teaching method of FKM (Feedback Knowledge) which is suitable for object-oriented programming language learning, combining the research teaching ideas applied to course teaching of C++. FKM is the

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abbreviation of "Feedback", "Knowledge Logic Structure" and "Mind Mapping". Its essence is start from the logic of thinking, put the knowledge logical structure into the mind map, doing micro interpretation and mutual integration for the knowledge structure. Using the form "chart" to summarize the knowledge system, make the knowledge structure clear, taking the feedback method of the first learning echoes with the review, in order to effectively acquire knowledge from the deep understanding of knowledge. In this paper, applying FKM teaching method in C++ course is carried out through concrete steps. The realization method of "thin - thick - thin" in the teaching process, through the analysis of teaching content, after point - connection - net - expansion - scheme - feedback and so on step to construct the specific teaching process. This method is applied to the course, to enable students to quickly and firmly grasp the basic rules of grammar on the basis of practical training, with research inspiration and means of scientific research training, help them deeper understand the programming ideas. Not only to improve the students' interest in learning, but also increase students' understanding of knowledge and well train the ability to solve problems.

II. THE IMPLEMENTATION OF FKM TEACHING METHOD IN C++ COURSE

A. Implementation process of process-oriented

We choose "C++ University Foundation Course" [6] as the teaching material, using the FKM teaching method in the whole course of teaching. For students who have no programming experience, it is very difficult to accept the object-oriented at the beginning, but the function of C++ is a process-oriented programming. Therefore, most teachers used to teach the process-oriented first, then introduce the object-oriented knowledge, students tend to isolate two parts. They don't mastery of knowledge, or fail to grasp the essence of the object-oriented C++. This paper uses the FKM method from the learning of grammars from process-oriented perspective (as the order of the textbook), then feedback object-oriented, put the process-oriented into object-oriented, and make the students master the C++ object-oriented programming ideas. First of all, from the point of view of the process-oriented of the various chapters, the specific operation can be divided into the following steps :

1) Point

Extract the structure and backbone of the knowledge. For example, the knowledge points of each chapter point into:

Chapter 2: Lexical symbols and identifiers, basic data types, operators and expressions.

Chapter 3: Sequential control structure, selective control structure and cycle control structure.

Chapter 4: Definition of arrays, use of arrays.

Chapter 5: The definition of the function, the call mechanism of the function, the inline function, the overloaded function, the function of the default parameter value, the survival time of the variable, etc.

Chapter 6: The concept of pointer, pointer operation, the use of pointers, etc.

Chapter 7: User-defined types of data: enumeration types, structure types, and union types.

Chapter 8: Definitions of classes and objects, use of objects.

Chapter 9: Class inheritance and derivation.

Chapter 10: The concept and implementation of polymorphism, virtual function.

Chapter 11: Operator overloading.

2) Connection and Network

According to the knowledge structure, analyzes the internal relations, and integrates knowledge into lines to form a logical chain of knowledge. The vertical and horizontal connections are formed by a single knowledge chain, which is formed into a "network of knowledge"

3) Expansion and Scheme

Base on the knowledge framework in the previous chapter, expanding along each "context", adding the all details into every parts (mainly explain the key points and key "knowledge", the rest can self-study), to expand and rise to the overall state of knowledge.

B. Object-oriented implementation process

On the basis of the method allows students to quickly grasp the grammar rules of each chapter, which is very useful for the early learning of the programming language, the so-called advantage of its blade must first benefit. However, the training of programming ability can not only be limited to mastering the grammar rules, but also to master the programming ideas. Teaching materials [6] for beginners first by the process of transition to object-oriented programming ideas, once mastered the object-oriented knowledge, the first seven chapters are the component of the class, using class as the center to feedback and gather the knowledge of each chapter. The soul of the C++ language is object-oriented programming ideas. After this feedback, each chapter and then integrate object-oriented thinking, consider the object-oriented programming as the primary, re-understand the knowledge of each chapter, grasp the object-oriented programming ideas. The formation of the C++ object-oriented logic structure thinking map (FKM map) is shown in Fig. 1.

III. THE IMPLEMENTATION OF RESEARCH-BASED TEACHING

FKM teaching method can help students quickly build a knowledge framework, and master the programming language grammar, so that students are not trapped in the grammar rules, they can think about the ideas behind it. Therefore it should carry out deep analysis after teaching the FKM diagram to explain the knowledge points and before the feedback. It can use question type which is a question about one knowledge point and then let students think how to solve this problem. If exist a way to solve the problem, then use it, otherwise figure out the reason why it can't. After students thinking, teacher explain the knowledge to them, they will understand the knowledge much better, which is obviously better than the

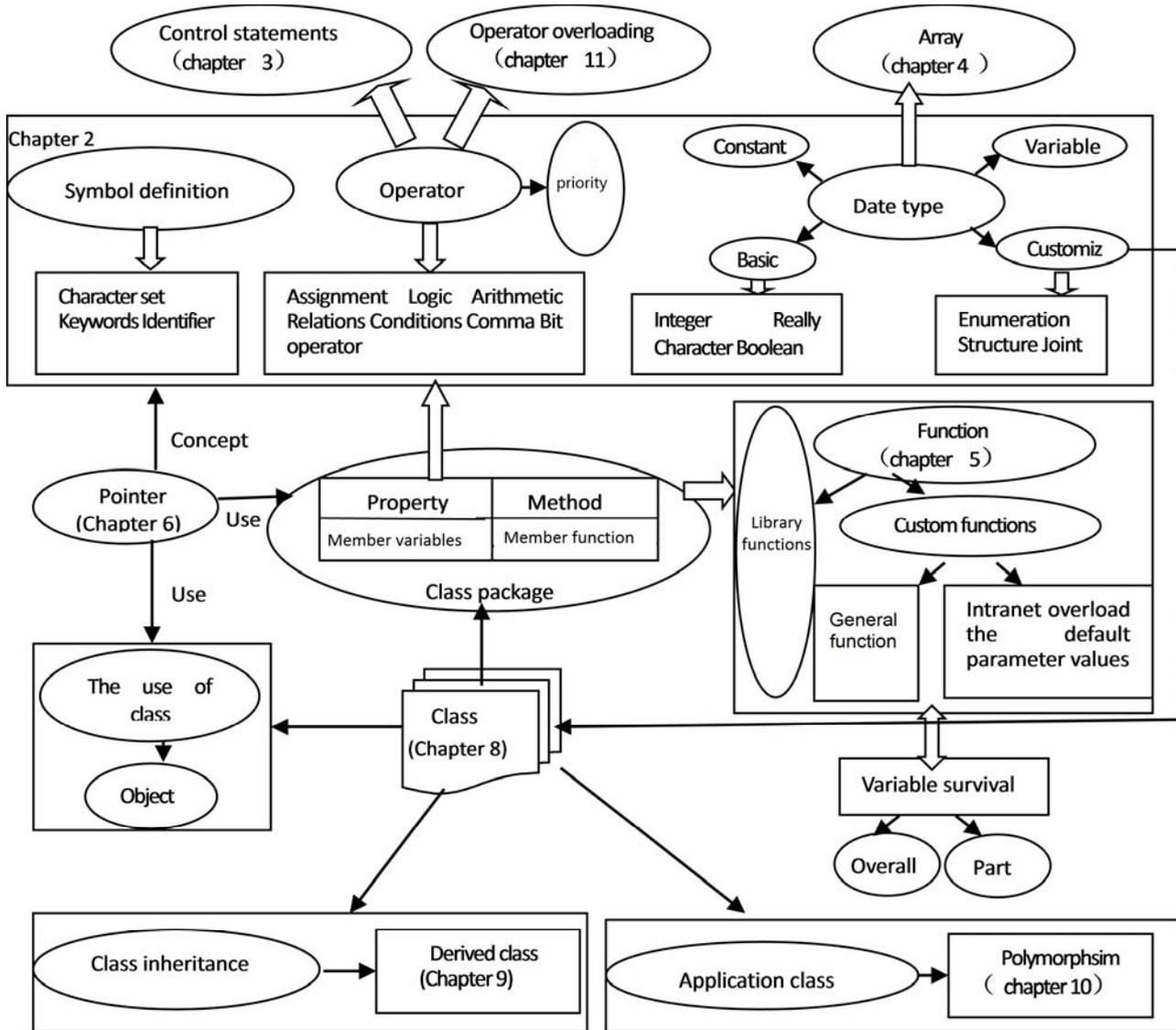


Fig. 1. C++ object-oriented FKM map

passive indoctrination. For example: when explain the function of the return statement, after grammar and the use points are explained, ask a question: The radius of a circle is given, is it feasible to let the function return two results of the perimeter and area? In this way, students will understand the “return” statement well and use it much better. Then, continue to inspire them: for the current knowledge of the “return” statement, it cannot be returned by two calculation results, then how to do it? This allows students to think further, some students may figure out quickly: need to create some grammar rules to achieve such a function, which is the best interpretation of the ability to innovate. The students who have been inspired like this have formed the habit of thinking unconsciously and use it when they learn all kinds of knowledge. Such as: why would such a rule of grammar? If not, what will happen? What are the disadvantages of such grammatical rules? How can we solve these problems? For example: there are some unknown problems to be solved, we need to use scientific research methods to explore and accumulate the research results into knowledge. Then, how does the existing knowledge from?

Why is this conclusion? Inspire students to think further: similarly, before the knowledge has become known knowledge, there are a variety of research and academic theory, through research, demonstration, and ultimately denied, certainly some certain part has become known knowledge, it is accumulated precipitation. In this way, let the students apply the ideas of scientific research.

Learn to think, find the problem, which is the first step in the development of research capabilities, and then to find solutions to the problem. To train the students to master the research methods and research methods in order to solve the current and future problems. For example: come to sequencing problem, explanation gives a sorting algorithm in class, and then let the students put forward their own algorithm, and then let them demonstrate their algorithm in computer class, when new problems come out, inspire students to think: which is better or the best? Let the students to do some research, to demonstrate the advantages and disadvantages of each method or algorithm are there any improvement methods; and then think: what is the evaluation of a standard algorithm (from the

performance, the computation time and storage space to inspire them)? Therefore let students write research paper to report their own algorithm and analyze the application of the algorithm, computational efficiency. Through this series of scientific research training process to train students' research ability. Increase the research weight of the achievement evaluation, the weight of final exam score, usual performance, research reports are set up to 50%, 30% and 20%, implement the research thinking.

IV. SUMMARY

Research based teaching was implemented in C++ Programming course. FKM method was combined in teaching to improve the efficiency to learn knowledge. Inspire students to think and find problems are penetrated during the course teaching. Students are encouraged to search the answers of the questions. And systematic research method was introduced and experimented with an executing report.

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