Study on Classification and Grading Teaching System for Computer Science and Programming Course

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Abstract: According to the problems existing in the teaching practice of computer education for undergraduates, and aiming at the cultivation of top-notch innovative talents, this paper deeply studies and constructs the Classification and Grading Teaching System for "Computer Science and Programming" series of courses. The teaching system takes classified cultivation and individualized teaching as the breakthrough point, implements scientific course classifying and grading according to the natural knowledge level and major developing requirements of students. It accurately sets course classification and grading teaching objectives, adopts online and offline hybrid teaching methods to fully integrate teaching and learning. In addition, the teaching system uses project-driven teaching method to improve students' ability to solve problems and innovate, and establishes formative curriculum assessment system. Teaching practice shows that the Classification and Grading teaching system can obviously improve the teaching quality and student satisfaction, which can be used as a useful reference for the teaching reform of other courses in computer education for undergraduate.

1. Introduction

"Computer Science and Programming" is one of the most important fundamental courses for most higher education popular majors, and it covers a wide range of classes and students in various majors. The course has become a classic and key course of Computer Education for Undergraduates. Because the course covers a wide range of knowledge, focuses on cultivation of programming practice skill, and faces numerous majors and students with different knowledge foundation and learning ability, the course is hard to teach and learn all along. It is necessary to explore new teaching mode and method for the course, and carry out curriculum teaching reform to improve the teaching quality and teaching effect continuously.

2. Analysis on the teaching practice of Computer Science and Programming

"Computer Science and Programming" is a difficult, wide range of applications, and strong practical course. Although, referring to many advanced teaching modes and the characteristics of Computer Education for Undergraduates, the course has undertaken a series of exploration and reform, there are still some prominent problems in the teaching practice at present.

First of all, the teaching-oriented teaching method is still generally used in university computer education courses. Most of the time in classroom teaching is mainly lectured by teachers, and teachers try to deliver knowledge as clear as possible to each student in limited time. However, the responses of students are ignored, and the students' enthusiasm for learning cannot be effectively stimulated, which makes the students passively accept knowledges. Self-study ability, practical programming ability and innovation ability cannot be promoted, which restricts the cultivation of top-notch innovative talents [1].

Secondly, the learning ability and computer science foundation of students are uneven. For example, found through online questionnaire survey, among the 578 freshmen in Xu Teli School,

Beijing Institute of Technology, 18 students have participated in the National Olympiad in Informatics, and some of them even achieved outstanding results in national or provincial competitions. On the contrary, most of the students do not learn any high-level computer programming language during their secondary school years. If simply put students with different knowledge foundation and learning ability in the same classroom, the instructor has to compromise to adopt unified teaching objectives and teaching methods. As a result, students with poor foundation cannot accept all the knowledge, while the students with better foundation feel hungry for more knowledge. Students' learning enthusiasm becomes lower and lower, which leads to poor teaching effect.

Thirdly, unified textbook and teaching materials cannot meet the demands of students at different levels and in different majors. In most cases at present, all students who take part in "Computer Science and Programming" use the same textbook and related materials regardless of the major and foundation distinction. The contents, examples and exercises in the textbooks do not take into account the differences of students' majors and learning abilities, which leads to the disconnection between the teaching materials and the actual learning requirements of students.

Based on the analysis of the above teaching practice problems, this paper adopts the Classification and Grading teaching method in "Computer science and programming". It deeply studies the construction of classification and grading teaching system for the course. Students with similar levels and professional development requirements are arranged to study in the same class, and the teaching contents and teaching methods are carefully chosen based on the actual demands of students. At the same time, give full use of university network resource platform to assist the Classification and Grading teaching, providing students with an open and autonomous learning space. The teaching practice shows that the Classification and Grading teaching system plays an important role in improving the teaching quality of computer programming series courses.

3. "Computer Science and Programming" Classification and Grading Teaching System design

3.1. Classification and Grading Teaching System architecture

The Classification and Grading Teaching System of "Computer Science and Programming" scientifically divides students into teaching groups with similar levels according to the differences of students' basic computer knowledge level, potential tendency and major direction, and teaches students according to their aptitude. In the Classification and Grading teaching system, scientific classifying and grading is the key. On the one hand, it is necessary to comprehensively investigate students' knowledge background, learning ability and potential tendency. And on the other hand, it is necessary to scientifically classify teaching levels and modules. So that students can enter the most suitable level module for learning.

Based on the thoughts of classification and grading, and aiming at the talent cultivation, the Classification and Grading Teaching System of "Computer Science and Programming" covers two major courses and three levels of teaching objectives. The diversified learning requirements and computer science foundation of students are fully considered. According to the overall direction of classified training and graded teaching, the classification and grading teaching system is as follows:

Category 1, Computer Science and Programming (C++)

Category 2, Computer Science and Programming (C language)

And furthermore, Computer Science and Programming (C language) are divided into two levels:

Level A is for the students who have basic computer science knowledge and computer operation ability, but have not studied advanced computer programming languages in depth. This level course teaches C programming knowledge directly, focusing on the advanced level of C programming ability.

Level B is for the students with weak computer knowledge and skills. Before learning C language programming, the basic knowledge of Information Technology should be learned first for 16 hours, and then learn the knowledge of C language to solve general problems by using C language programming.

The overall framework of the Classification and Grading Teaching System of "Computer Science and Programming" is shown in Figure 1.
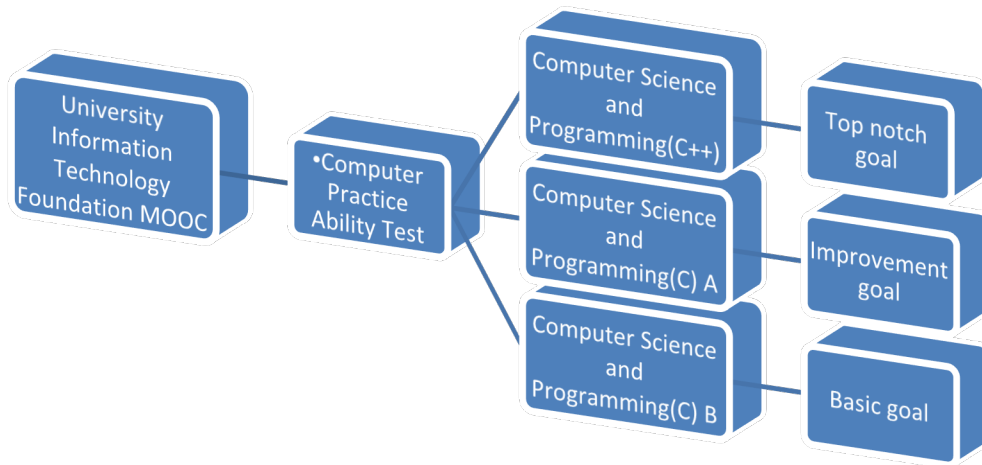

Figure 1 Overall Framework of Classification and Grading Teaching System.

Computer Science and Programming (C++) course strives to achieve the goal of "Top-notch" in depth of Object-oriented programming knowledge, and highlights top-notch innovation. The course objectives integrate knowledge, ability and quality organically, and the teaching contents emphasize breadth and depth to cultivate students' comprehensive ability to solve complex practical problems, computational thinking and innovative thinking. With comprehensive project development as the starting point of teaching, students are guided to deeply analyze, boldly question, diligently explore and bravely innovate[2].

Computer Science and Programming (C language) A-class strives to achieve the goal of "Improvement" by clearly teaching structured programming knowledge combined with frontiers of computer science and technology. The teaching contents timely introduce academic research and cutting-edge achievements in scientific and technological development into the curriculum. Meanwhile with the help of online learning platform, the curriculum vigorously promotes the deep integration of modern Information Technology and teaching, and actively guides students to conduct inquiry learning and personalized learning.

Computer Science and Programming (C language) B-class focuses on the goal of "Basic" by explaining profound theories in simple language and consolidating basic knowledge and basic programming ability. The contents of the course lays emphasis on strengthening both the solid foundation and the applied skill. At the same time, the course increases the amount of homework or test in class or after class in order to encourage students to increase their involvement in learning. In addition, strict assessments and examinations can promote students to master basic computer knowledge and basic computer programming ability firmly through hard working.

The "Computer Science and Programming" courses with two classes and three levels of teaching system is truly student-oriented, which teaches students in accordance of their aptitude and builds a multi-level top-notch innovative talent training teaching mode.

3.2. Classification and Grading Teaching System construction objectives

3.2.1. Implementation of teaching students according to their aptitude

In Classification and Grading Teaching System, scientific classification and grading is the primary basis. Freshmen receive "Freshman Orientation Study Guide" from the student administration during the summer vacation before they are officially enrolled. According to the guidance, students must study "University Information Technology Foundation MOOC" on Lexue network learning platform of Beijing Institute of Technology, and complete the corresponding exercises and examinations. After the freshman's enrolment, the online "Computer and Programming Test" was held on line. The test covers a basic computer knowledge test (20

one-choice questions) and a basic C programming ability test (three C programming questions). Based on fully informing students the teaching contents, teaching objectives of courses at all levels, and combined with the students' personal will, the students of C++ language teaching classes are selected according to scores. The requirements for students to take the "Computer Science and Programming (C++)" are "a good grasp of the basic knowledge of computer science, and having the preliminary programming ability of C language". That means the students can correctly complete most of the basic computer knowledge questions and implement at least one C programming problem completely correctly (pass all the test cases) in the test. A total of 34 students with a good computer science and C language programming foundation were selected to form the "Computer Science and Programming (C++)" class after the test for the 2021 freshmen in Xuteli School, Beijing Institute of Technology. In line with the principle of "student-oriented and fully respecting the will of students", if students are not comfortable with the teaching environment of C++, they can apply for adjustment to the "Computer Science and Programming (C Language) A-level" class after one week's trial. In the end, a total of 32 students studied in the "Computer Science and Programming (C++)" course.

According to the final scores of "Computer and Programming Test", the rest students are divided into two-level classes: Computer Science and Programming (C language) A-Class and B-Class. The students who have already mastered the basic knowledge of computer science but do not have the preliminary programming ability of C language attend the "Computer Science and Programming (C language) A-Class". Whilst students who fail to master basic computer science knowledge are put into "B-Class" courses to study.

At the same time, in order to implement the goal of Classification and Grading teaching mode, the number of the two level classes is dynamically adjusted according to the number of students, so as to meet the actual learning needs of students.

3.2.2. Accurately Design Classification and Grading Teaching Objectives

Teaching objectives provide guidance in the teaching process, and the teaching objectives is an important part in the Classification and Grading Teaching System. The teaching objectives should be based on curriculum standards, teaching contents, students' requirements and social needs to guarantee the scientificity, feasibility and hierarchy of teaching objectives, and ensure that the Classification and Grading Teaching System is carried out in an orderly manner and the teaching objectives can be realized eventually. The classification and grading teaching system of "Computer Science and Programming" should accurately design the teaching objectives according to different requirements of different levels. According to the teaching characteristics of "Computer Science and Programming", based on the general teaching objectives of "basic, improve, top-notch", and considering the students' computer knowledge level, combined with the different needs of disciplines and majors, feasible teaching plans are designed for different levels and different requirements.

Table 1 "Computer Science and Programming" Classification and Grading Teaching System.

Course Name	Credit/ Hours	Target Student	Teaching Objectives	Teaching Mode	Assessment Standard
Computer Science and Programming (C++)	4/64	students who grasp the basic knowledge of computer well, and have the preliminary programming ability of C language	By learning C++, students will master the basic methods and skills of programming and debugging, grasp object-oriented programming thoughts and basic methods, learn to use object-oriented methods to solve practical problems, to lay a solid foundation for further study of other relevant courses.	Classroom Teaching + SPOC + Project-driven Teaching	Usual Performance 20% + Project Results 30% + Online Exam Scores 50%
Computer Science and Programming	3/48	students who have already mastered the	To cultivate students' logical thinking ability and computational thinking ability, as well as higher computer	Classroom Teaching + MOOC	MOOC scores 10% +

(C) A-level		basic knowledge of computer but do not have the preliminary programming ability of C language	programming ability. Enable students to skillfully use structured programming methods to design and debug programs. Cultivate students' ability to analyze and solve practical problems, and lay a solid foundation for further study of other relevant courses.		Usual Performance 40% + Online Exam Scores 50%
Computer Science and Programming (C) B-level	3/48	students who fail to master basic computer knowledge	Strengthen the basic knowledge of computer, and cultivate students' logical thinking ability and computational thinking ability, as well as the general C language programming ability. Students learn to master the basic method of structured programming and the basic steps of solving practical problems with computers. To lay a solid foundation for further study of other relevant courses.	Classroom Teaching + MOOC	computer basis score 20% + Usual Performance 20% + Online Exam Scores 60%

3.2.3. Full combination of teaching and learning under the network assisted teaching mode

The Classification and Grading Teaching System of Computer Science and Programming adopts online and offline hybrid teaching method, That is "Classroom teaching + Network learning + Project development". Relying on Lexue network learning platform which integrates abundant online learning resources and good interactivity, the course breaks through the constraints of time, space and human factors, makes up the deficiencies of traditional classroom education, and leads students to study independently. Depending on the network assisted learning platform, the course alters the traditional single classroom teaching model and makes full use of network platform resources to implement the full combination of teaching and learning, as well as the full interaction between teachers and students[3]. It mainly means two aspects, one is classroom teaching with "teaching" as the core, and the other is network assisted learning with "learning" as the key. The combination of teaching and learning in the network assisted teaching mode can fully reflect the leading role of teachers and the dominant position of students, so that students' active learning and teacher-student interaction can be truly unified.

3.2.4. Project-driven teaching method for cultivating top-notch innovative talents

Aiming at cultivating top innovative talents and combining with the practical requirements of computer programming ability, project-driven teaching method is adopted. Project-driven teaching method is an inquiry teaching method based on constructivism teaching theory. Project-driven teaching method is different from traditional teaching methods. It runs through the whole teaching process with a complete development project[4]. With the guidance of teachers, students participate in the whole process of project development in a way of discussion, exploration and openness, and take the project as the centre to learn each knowledge point. Project-driven teaching method can stimulate students' learning desire, help students to internalize classroom knowledge into personal ability, guide students to apply the knowledge to actual project development, and meet students' needs for innovative learning and independent learning. The project-driven teaching method lays emphasis on the training of innovation ability and teamwork ability, which can not only cultivate students' programming ability, but also promote their ability to solve practical problems effectively by using the knowledge they have learned[5].

3.2.5. Construction of scientific curriculum assessment and evaluation system

Scientific assessment method is an important guarantee for the implementation of the Classification and Grading Teaching System. The assessment method should reflect the requirements of comprehensive evaluation of teaching quality and cultivation of top-notch innovative talents. "Computer Science and Programming" is a course with strong application and

operation. The assessment method of the course should be application-oriented, focus on the comprehensive evaluation of students' learning ability, and construct a diversified, comprehensive and scientific assessment and evaluation way to encourage students to pay more attention to the cultivation of practical application programming skills.

The Classification and Grading teaching evaluation system carries out the classifying and grading on assessment. It emphasizes on "four combinations": process evaluation combines with summative evaluation, online evaluation combines with offline evaluation, in-class evaluation combines with out-of-class evaluation, and internal evaluation combines with external evaluation[6]. The four combinations strive to build the diversity and rationality of evaluation methods. At the same time, in order to solve the fairness of assessment, we have developed a reasonable results conversion standards, and managed to reflect the real knowledge and ability of students, as far as ensure the fairness of all kinds of evaluation activities.

4. Summary

Aiming at cultivating top-notch innovative talents, the Classification and Grading Teaching System of "Computer Science and Programming" covers two categories of courses and three levels of teaching objectives. Classification and Grading Teaching System has changed the teaching mode of "unified teaching syllabus, unified course materials and unified assessment method" in the previous teaching process, which leads to the teaching dilemma of students' low learning interest and students' achievement deep polarization. For promoting students' motivation and enthusiasm in learning, improving teaching efficiency, enhancing students' comprehensive quality and ability, stabilizing and improving the teaching quality, "Computer Science and Programming" Classification and Grading Teaching System has positive significance and important practical value.

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