Research on Teaching Reform and Innovation of "Data Structure and Algorithms" in the Context of New Engineering

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Abstract. By analyzing the characteristics of data structure and algorithm courses, this paper elaborates on the innovative teaching reform ideas of data structure and algorithm courses in the context of new engineering,discusses the methods of course reform,and reconstructs course knowledge,with a focus on strengthening the cultivation of students' practical and innovative abilities.

Keywords: Data structure and algorithms;course competition integration;online and offline;

1 Introduction

Data Structure and Algorithm is one of the eight core courses of computer specialty. It is an applied course that pays equal attention to theory and practice. It is also a core course of new engineering majors such as artificial intelligence and Big data, which plays a very important role in the training of new engineering talents. This course covers C language programming[1], including computer operating systems, databases, embedded system design,Java language programming, web applications, Android basics, artificial intelligence,and more. The course mainly introduces how to organize, store, and process data reasonably[1], as well as how to design algorithms correctly and analyze and evaluate algorithm performance. The relevant theoretical knowledge of this course is still an important basis for many cutting-edge research fields. At the same time, these theoretical knowledge are also facing many new problems and challenges raised in the Big data era[1]. To meet the employment needs of society, teachers need to balance basic knowledge and cutting-edge disciplines, as well as theory and practice in their teaching work.

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2 Problems in the course

2.1 Inadequate learning of pilot courses

The algorithms in the course of Data Structure and Algorithms are mostly described in C language, and the course of C programming is generally offered as a precursor course for this course. But students have just started to learn programming languages and are not proficient enough in using them. Especially the knowledge of multiple loops, pointers, and structures commonly used in this course is a challenge for C language. The lack of solid learning in the pilot course has buried hidden dangers in the teaching of this course.

2.2 Students lack the ability to practice independently

Data Structure and Algorithms is a course that emphasizes both theory and practice, requiring students to be able to use their knowledge to analyze and solve problems. Our school's Data Structure and Algorithms course has a total of 48 class hours, divided into Theory (40 class hours) and Practice (8 class hours). Due to limited time in class, some practical tasks require students to complete after class. However, some students with weak foundations and poor self-control find it difficult to complete them on their own, which leads to the algorithm in theoretical courses becoming a "paper talk". If students cannot achieve the unity of knowledge and action, they will gradually lose interest in the course[1].

2.3 Traditional teaching methods urgently need to be transformed

The teaching centered approach weakens students' subjectivity and affects their initiative and enthusiasm in learning. In terms of teaching methods, obscure and difficult to understand abstract data types are generally used to explain principles, which are difficult for students to understand and even more difficult to relate to specific applications. In terms of content, the basic data structure and algorithm knowledge in the textbook are not combined with cutting-edge technologies, and the knowledge taught is disconnected from the actual needs of society.

In response to the current problems in this course, the design of teaching cases is guided by case driven approach, combined with a mixed online and offline teaching mode. The knowledge system is expanded and extended through subject competitions, and application practice is strengthened. The assessment method led by process evaluation is adopted to construct a "four in one" teaching mode that integrates "case driven, online and offline, course competition combination, and process evaluation".

3 Teaching reform content

3.1 Teaching content

The traditional "Data Structure and Algorithms" course is divided into two parts: data structure and algorithms, which can be refined into 10 sub modules: linear tables (including sequential tables, linked lists, stacks, queues, strings, generalized tables, etc.), nonlinear tables (trees, graphs), search, sorting, etc. The application of data structure and commonly used greedy, divide and conquer, Dynamic programming, backtracking and other algorithms is less.

This project redesigns the teaching content. In addition to introducing the concept, algorithms, and basic implementations of data structures, it also introduces corresponding classic competition cases[2]. Starting from problem solving, the course knowledge system is organized at three levels: basic theory, abstraction, and design. Data structures and algorithms are organized from the perspectives of logic, storage, and computation, cultivating students to independently implement abstract data types of commonly used basic data structures, Emphasizing the cultivation of practical and engineering abilities lays a solid foundation for future learning, development, and research in the field of computer science, or for using computers for problem-solving in other disciplines, which is beneficial for students' future development.

According to the educational positioning and philosophy of local application-oriented undergraduate colleges, the course "Data Structure and Algorithms" is positioned as the core core core professional basic course of information science that emphasizes both theory and practice, and is also an important basic course for many non information science and engineering students.

The teaching objectives of the course can be summarized into the following three aspects:

(1) Emphasizing the training of basic data structures and algorithms[3], from the perspective of problem solving, cultivate students' ability to analyze and solve problems using the basic theories of data structures and algorithms.

(2) Combining modern cutting-edge research topics in computer science and technology, design and research heuristic teaching cases, expand students' knowledge system, and cultivate active learning, research, and innovation awareness.

(3) Emphasis is placed on cultivating practical and engineering abilities, enabling students to comply with the standardization of software development, and establishing a knowledge system for data structure and algorithm design and problem solving.

For example, when discussing recursion, introduce the Blue Bridge Cup real question, step 39.

Xiao Ming has just finished watching the movie "The 39th Step".

When he left the cinema, he counted the steps in front of the auditorium, which happened to be 39 steps!

Standing in front of the steps, he suddenly thought of another question:

If I could only step up one or two steps at a time.

Take the left foot first, then alternate left and right, and the last step is to take the right foot, which means taking an even number of steps.

So, after climbing 39 steps, how many different climbing methods are there?

Please use the advantages of computers to help Xiaoming find answers.

From the perspective of problem solving, introduce recursive algorithms. Explain relevant knowledge points.

3.2 Online and offline blended teaching

Establish supporting teaching resources on the Superstar platform, including learning materials such as teaching videos, question banks, classic application case banks, and teaching materials such as lesson plans and PowerPoint presentations[4].

Based on the teaching resources built on the superstar platform, the traditional teacher centered and single offline teaching mode has been changed to a student centered and blended online and offline teaching mode[5].

Online, students use the Superstar platform for online learning. Before class, students watch video learning on the platform based on the learning tasks assigned by the teacher. In class, complete classroom tests, and further learn and deepen understanding based on learning outcomes, difficult issues, and key points. After class, review and expand, further consolidate through homework, and conduct reinforcement training, such as practical application training on the OJ platform (Likuo, Blue Bridge Cup practice system) to improve students' practical application abilities.

Offline, teachers focus on problem-driven (case based) teaching, starting with problem-solving as the starting point to guide students to group and discuss solutions. The knowledge points involved are integrated into the entire case solving process, allowing students to understand and master relevant knowledge during the problem-solving process, combining theory with practice, and achieving the goal of improving students' practical application ability. During the teaching process, teachers can use methods such as answering questions, selecting students, and group discussions to interact with students. After class, you can answer questions online and conduct a questionnaire survey on teaching methods and learning outcomes, continuously improving the teaching mode based on student suggestions.

3.3 Combining courses with competitions

Combine courses with competitions, strengthen course practice and training, stimulate students' enthusiasm and enthusiasm for continuous and in-depth learning, and achieve the goal of "promoting learning through competitions and learning through competitions"[6].

(1) Construction of Competition Guidance Team

The setting of subject competition questions is different from general exams, involving a wide range of knowledge, and it is difficult to do a good job of competition guidance solely relying on the strength of a teacher. Therefore, we will incorporate teachers with rich teaching experience, solid professional foundation, hardworking and dedicated spirit into the guidance teacher team, forming a professional guidance teacher team with excellent skills. In terms of teaching, group members first discuss the outline of relevant courses based on the needs of various competition tutoring, and

then work together to prepare course related materials according to their areas of expertise. Then, they collectively discuss the teaching methods and content of the course. In competition coaching, group members develop relevant training objectives and plans based on the characteristics of various programming competitions, effectively classify knowledge points, distinguish priorities and key and difficult points, develop targeted teaching plans, and integrate competition coaching into the regular teaching process. After class, use the programming competition platform to organize students for training, requiring them to write down their problem-solving ideas and explain them to other group members. After the explanation, the teacher will sort out and analyze the knowledge points involved, and enrich them into the teaching resource library.

(2) Training of student competition teams

Subject competitions, after all, are different from regular exams and have high requirements for students' various qualities. To establish and cultivate a competition team, it is necessary to:①pay attention to observation during the teaching process, select good candidates, and establish a program design interest group based on students who have achieved excellent results or won awards in the competition[7]; ②By promoting competitions, we aim to attract students who are interested in programming, encourage them to participate in college competitions, and select students to join the team through college competitions. For students who enter the team, the "old leads new" approach is adopted, requiring old team members to share their participation experience and competition resources, and helping new team members familiarize themselves with the competition platform through guidance on the computer. This method not only accelerates the integration speed of new team members, but also exercises the communication and coordination skills of old team members ; ③ Cultivate students' interest in competition through diversified incentive mechanisms. For students who achieve excellent results in competition activities, not only corresponding certificates and bonuses will be issued, but also corresponding innovation credit rewards will be given, which are linked to the school's evaluation and prioritization. In addition, for students who have achieved excellent results, publicity should be carried out through various channels to form a role model[8].

The main innovative measures include:

(1) Transform the two process assessments of this course from traditional offline written test answering to online machine test answering, and hold a programming challenge competition in the form of algorithm programming competition, displaying the competition ranking in real-time, and using the competition results as the course's usual grades. Through the form of competitions, the learning effect is tested, while stimulating students' desire to win or lose and seek knowledge, creating a positive internal environment, promoting competition through learning, and thereby enhancing students' enthusiasm for continuous learning and enthusiasm for participating in competitions.

(2) Using the existing mature programming training platform, such as leetcode, there are a large number of algorithm programming questions for each knowledge point involved in Data Structure and Algorithms and there are also various forms of challenge arena competitions, such as weekly competitions, thematic competitions,

etc.. After learning each knowledge point, competition tasks are assigned for enhanced practice, and students can carry out a large number of programming practices outside the classroom. At the same time, students can participate in various provincial and national software programming competitions, such as the Blue Bridge Cup and the Sky Ladder Competition. Students who have won the first prize in the provincial software programming competition are exempt from the course and directly recognized as excellent. Through the model of promoting learning through competition, providing appropriate competition and pressure, stimulating students' potential, enabling them to actively invest more energy in course learning and application practice, and continuously improving their professional skills.

3.4 Reform of evaluation methods

The traditional assessment method is mainly based on static and quantitative closed book assessment[9], and the evaluation indicators are not detailed enough, ignoring the process evaluation of students, affecting the objectivity and accuracy of the evaluation results, which is not conducive to the comprehensive development of students. At present, the "learning centered" assessment method has not received sufficient attention[10]. However, domestic universities have already conducted a series of research and exploration on how to evaluate the learning and development situation of college students, as well as the quality of talent cultivation in universities. Reasonably design evaluation activities for each stage based on the combination of online and offline teaching methods, and achieve a comprehensive evaluation organization. The assessment should include all teaching processes in which students participate, and establish quantitative evaluation standards for pre class, during class, and after class. Based on the needs of different stages of the course, a "learning centered" assessment method should be implemented to ensure fairness and objectivity of the assessment. The student-centered and student-centered assessment method can give diligent students a sense of achievement, further stimulate their learning motivation, and also serve as a kind of supervision for students who have a fishing in troubled waters attitude. It can transform their passive and assessed learning into active and willing learning, which is conducive to improving the subjective consciousness of teachers and students in participating in teaching.

4 Effectiveness of curriculum reform

In recent years' teaching practice, the author has continuously explored the construction and reform of the "Data Structure and Algorithms" course from the aspects of teaching team building, teaching material optimization, teaching process design, and teaching achievement promotion. The course has been practiced and verified in computer related majors, and good reform results have been achieved, specifically reflected in the following two aspects.

(1) The teaching effect is good and has a promoting effect on students' later development. The course 'Data Structure and Algorithms' is a prerequisite course for multi-

ple computer related majors, laying a professional foundation for students to learn subsequent courses well. The systematic and targeted teaching process of the course has played a positive role in promoting students' subsequent postgraduate entrance exams and graduation employment, and previous graduates have received praise from employers.

(2) The effectiveness of teaching reform has been significant, and subject competitions have shown great skills. Organizing students to participate in subject competitions is an effective means of verifying the results of data structure practical teaching. There are many subject competitions related to practical teaching of data structures, such as the "Blue Bridge Cup" competition that tests students' individual abilities, the Team Programming Sky Ladder Race programming competition that tests students' teamwork problem-solving ability, and the group programming ladder competition that tests the overall level of school programming teaching. Teachers can recommend students to participate in different competitions based on their level of proficiency and programming abilities. Over the years, the author has organized students to participate in various levels of discipline competitions, constantly improving their Computational thinking ability, algorithm design level and software development ability, and stimulating their learning initiative. Students have achieved good results in various national and provincial discipline competitions.

5 Conclusion

This article focuses on the problems that arise in the course of data structure and algorithms, adheres to the educational concept of "learning as the center", combines the necessary links of traditional classroom teaching and the advantages of online teaching content, and makes a bold attempt to integrate online and offline teaching mode. In the online segment, emphasis is placed on a problem-oriented and student-based approach to self-directed learning. Offline, through in-depth exploration and interaction at multiple levels, students can gain a deeper understanding of knowledge and stimulate their awareness of self-directed learning. In the practice teaching of data structure guided by subject competitions, the study of theoretical knowledge is organically combined with subject competitions, emphasizing the cultivation of students' analytical, problem-solving, and programming abilities, as well as the training of complex programming abilities. Building an extracurricular practice system based on stepped micro projects can not only effectively compensate for the shortage of practical teaching hours, but also cultivate students' teamwork spirit and innovative practical ability, It has stimulated students' interest in self-directed learning and effectively promoted the improvement of students' comprehensive quality and practical teaching quality. At the same time, conduct assessment and evaluation covering the entire process based on each teaching link. Relying on subject competitions, the online and offline teaching mode is adopted to evaluate and assess the entire learning process of students through process evaluation. Emphasis is placed on cultivating students' analytical, problem-solving, and programming abilities, and competition, discussion, and team cooperation mechanisms are introduced to stimulate students' interest in auton-

omous learning and research-based learning. Practice has shown that the curriculum reform has achieved significant results. Students who have participated in competitions have performed more outstandingly in the process of taking postgraduate entrance exams or finding jobs, and are more favored by mentors or employers.

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