Exploration on the Teaching Reform of Data Structure Course under the Background of "Si Xin" and Engineering Education Certification

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Abstract: *Under the background of "Si Xin" and engineering education certification, taking the major of computing science and technology of the College of Information Science and Technology of Hebei Agricultural University as an example, in view of the problems existing in the teaching of data structure courses in the past, a result-oriented data structure course teaching system was built from four aspects: revising the syllabus, reforming teaching methods, improving the assessment and evaluation system, and establishing a continuous improvement mechanism, and scientifically quantified the teaching effect of data structure courses, so as to improve the teaching quality.*

Keywords: *"Si Xin"; engineering certification; data structure; teaching reform*

1. Introduction

In April 2019, the Ministry of Education held the "Six Excellences and One Top-notch" Program 2.0 Conference at Tianjin University, officially launching the construction of new engineering, new medical, new agricultural, and new liberal arts. In the same year, the Ministry of Education issued the "Opinions on Deepening the Reform of Undergraduate Education and Teaching and Comprehensively Improving the Quality of Talent Training", which requires "leading the construction of new engineering, new medical, new agricultural, and new liberal arts to drive the adjustment and optimization of the professional structure and the improvement of the connotation of colleges and universities." Si Xin" construction is a strategic move, a key move, and an innovative move to build a "Quality China" of higher education, a "Chinese plan" for higher education talent training, and a strategic layout for the high-quality development of higher education. In recent years, with the rapid development of the Internet and information technology, the importance of computer science has become increasingly prominent. In order to meet the needs of the industry, the engineering education certification system has been gradually established and improved, which puts forward higher requirements for computer professional education. The core concept of engineering education professional certification is "student-centered, results-oriented, continuous improvement". Therefore, the educational curriculum of computer majors also needs to be continuously reformed and improved to adapt to the development trend of the industry. The data structure course is an important part of computer professional education, and it is a basic course for mastering the basic theories and methods of computer science. Under the background of "Si Xin" and engineering education certification, how to reform and improve the data structure course to improve students' comprehensive quality and ability is an important topic of computer professional education [1]. This paper takes the computer science and technology major of the School of Information Science and Technology of Hebei Agricultural University as an example. The four aspects of the improvement mechanism discuss the reform practice of the data structure course.

2. Revised syllabus

The original syllabus was based on knowledge and did not implement the concept of OBE. Our school revised it from the following two aspects. First, combine the graduation requirement indicators to clarify the course objectives. The original syllabus cannot reflect the corresponding relationship to the graduation requirement support matrix, while the OBE education concept requires setting course objectives and arranging course teaching content from the perspective of students' ultimate ability

training [2]. Therefore, the revised teaching syllabus of our school is based on the ability training of students in each chapter of the data structure, reorganizes the course objectives, and matches the course objectives with the graduation requirement indicators one by one. Secondly, understand BLOOM, recognize classification levels, and express course objectives. Concrete description of capacity building for different knowledge units. The original teaching syllabus only uses verbs such as "know", "understand" and "master" for the degree of mastery of course objectives and teaching requirements. According to the professional certification requirements of engineering education, knowledge points are connected with students' abilities. Different knowledge points have different abilities to cultivate. BLOOM cognitive classification is adopted to divide cognition into six levels of memory, understanding, application, and analysis, which are accurate. Express the teaching requirements of curriculum objectives and knowledge units [3]. The data structure course in our college is divided into two sub-courses, lecture and experiment. According to the graduation requirements, the teaching objectives have been revised. Through the study of the data structure course, the goals that students should achieve are shown in Table 1 and Table 2. The teaching objectives of the course and Table 3 and Table 4 show the corresponding relationship between the graduation requirements of the data structure course.

Table 1: Teaching objectives of data structure course

The Objective of Data Structures Lecture Course
Objective 1: To be able to comprehensively use the basic concepts of data structure, the representation and characteristics of computer internal data objects and other relevant knowledge, to compare and analyze the logical structure, physical structure and their differences of basic data structures such as linear tables, trees, and graphs, Build the foundation for solving complex engineering problems in computing. Objective 2: Be able to choose an appropriate data structure, model practical engineering problems and design an algorithm with a clear structure, correct and easy to read, and better complexity, and be able to program and implement algorithms based on different storage structures such as sequence and chain. Objective 3: Able to select appropriate sorting and searching algorithms according to the scale and storage structure of the data; use the basic knowledge of the main branches of mathematics closely related to algorithm analysis to analyze the complexity of the algorithm.

Table 2: Teaching objectives of data structure experiment course

The Objectives of Data Structures Lab Course
Objective 1: Be able to comprehensively use the knowledge of data structures learned to analyze complex engineering problems, select appropriate data structures to model them, and program to solve problems. Objective 2: Be able to use the principles and comparison methods of algorithms such as search and sorting to design better algorithms for solving complex engineering problems.

Table 3: Corresponding relationship between the teaching objectives of the data structure course and the graduation requirement index points

Graduation Requirements	Index Point	Course Teaching Objectives	Support
1. Engineering knowledge Possess the mathematics, natural science, engineering foundation and professional knowledge required by computer science and technology majors, and be able to comprehensively apply them to solve complex engineering problems in the computer field.	1.2 Master the basic knowledge of computer science, and be able to model and solve complex engineering problems in the computer field.	Course Objective 1 Course Objective 2	H
2. Problem analysis Able to comprehensively use the basic principles and methods of mathematics, natural science and engineering science, through literature research, correctly identify, express and analyze complex engineering problems in the computer field, and conclude and obtain effective conclusions.	2.2 Be able to comprehensively use the basic principles and methods of computer science to analyze complex engineering problems in the computer field.	Course Objective 3	H

Table 4: Corresponding relationship between the teaching objectives of the data structure course experimental course and the graduation requirement index points

Graduation Requirements	Index Point	Course Teaching Objectives	Support
4. Research Able to conduct research on complex engineering problems in the computer field based on scientific principles and using scientific methods, including abstract problems, designing models and algorithms, designing experimental schemes, analyzing and interpreting data, and obtaining effective conclusions through information synthesis.	4.2 Be able to use scientific methods to design experimental schemes, complete experimental operations according to the experimental schemes, and solve problems arising in the experiments.	Course Objective 1 Course Objective 2	M

3. Reform teaching methods

Table 5: Diagram Teaching Cases

Teaching Content	Traditional Teaching Methods	Exploration on the Teaching Reform of data structure course under the background of "Si Xin"
picture	Basic concept of graph How the graph is stored graph traversal minimum spanning tree shortest path topological sort Critical Path Disadvantages: more abstract, difficult to understand	Taking the campus floor plan of Hebei Agricultural University as the main line, store the basic information of teaching buildings and dormitory buildings, and learn to use the depth-first traversal, breadth-first traversal, shortest path, shortest spanning tree, topological sorting, and critical path algorithms of graphs to apply to practical problems.

Traditional teaching methods are mostly based on explanations, supplemented by experimental operations. Due to the single teaching method, the quality of higher education talents cannot be comprehensively improved through courses. It is still "teacher-centered", but ignores students' subjective initiative and characteristics of the traditional training model. In the context of the current deep integration of information technology and education and teaching, teaching resources are no longer limited to textbooks. Establishing an "online and offline hybrid" teaching model and reforming teaching methods can realize the transition from knowledge training to ability training. Learning outcomes and competency levels serve as nurturing objectives. First of all, redesign the teaching cases with the goal of "solving complex problems" and establish a teaching case library. Under the background of "four new" and engineering education certification, the teaching content of the data structure course should closely follow the development trend of the industry. Specific problems in the background will make students feel more involved, enhance students' interest in learning, and cultivate students' ability to analyze problems and solve "complex problems" [4,5,6]. Table 5 uses pictures as an example to compare the traditional teaching content and the improved teaching case with the goal of "solving complex problems". Second, design the teaching process. The classroom adopts the teaching mode of offline teaching. By introducing cases, it can better arouse students' interest in the course, guide students to think independently and actively, and improve students' enthusiasm and classroom activity. After class, the learning mode of online homework is adopted. Students submit their homework on the PTA experimental teaching platform. Knowledge base to choose from. Encourage students to improve the data structure or algorithm step by step, cultivate students' innovative ability,

let students make full use of spare time for independent learning, and fully reflect the "student-centered" educational concept. Table 6 is a sample of graph traversal instructional design.

Table 6: An example of instructional design for graph traversal

Step	Mode	Content
knowledge review	lecture	Review how graphs are stored
	question and answer	Given the floor plan of Hebei Agricultural University, ask students if they can give the floor plan of Hebei Agricultural University based on different storage structures such as adjacency matrix and adjacency list.
import	lecture	Use practical examples to teach, and the specific questions are as follows: Your classmate Xiao Ming is coming on Sunday, and you need to show Xiao Ming a tour of the entire campus. Xiao Ming has limited time, how do you design the route? Entering from the main entrance of the school, how to traverse every teaching building and scenic spot?
	discuss	Have a class discussion on the topic of "What are the problems you may encounter during the traversal? What are your coping strategies?"
problem analysis	lecture	Summarize the group discussions and speeches just now, and analyze the main problems encountered during the graph traversal process.
algorithm design	lecture	Referring to the preorder traversal and level traversal of the binary tree, the solution to the problem is given.
	video	Demonstration of micro-lesson video.
programming	question and answer	What data structures need to be established?
	lecture	Code explanation.
Summarize	lecture	Summarize the algorithm ideas of depth-first and breadth-first traversal and the algorithm implementation methods based on adjacency matrix and adjacency list.

4. Improve the assessment and evaluation system

The traditional evaluation methods are mostly based on examinations, which is difficult to comprehensively evaluate the comprehensive quality of students. Under the background of "Si Xin" and engineering education certification, we should pay more attention to process assessment and improve students' practical ability. Our hospital has improved the assessment and evaluation system from two aspects: assessment method and assessment content.

4.1. Assessment method

The traditional teaching assessment adopts the combination of daily homework and test papers, does not pay attention to the process assessment, the disconnection between the teaching assessment and the teaching process is serious, and the assessment method is single. The new assessment and evaluation system, combined with "Rain Classroom" for class interaction, "XueXiTong" for after-class review, and "PTA" for programming practice, has greatly improved the diversity of assessment methods. The platform conducts process assessment, grades the results, and quantifies the assessment content, which is conducive to improving the assessment effect. At the same time, adding procedural assessment can not only assess students' learning outcomes more scientifically and reasonably, but also help teachers improve the shortcomings in the teaching process in a timely manner.

4.2. Examination content

The traditional teaching assessment only asks questions for knowledge points, which is not enough to test students' comprehensive ability and practical application ability. The new assessment and evaluation system will arrange design problem-driven assignments at the later stage of the course. This type of problem-driven design aims at complex engineering application problems and can cultivate students' comprehensive ability and advanced thinking to solve complex problems. The basic principle

of developing students' learning ability is the center, reflecting the "advanced nature" of the course. Students must analyze and model the problem, select a certain data structure or synthesize multiple data structures to design corresponding algorithms, implement programming, and design appropriate test cases to complete the task. The setting of assignments is student-oriented, with continuous improvement and adjustment of difficulty in order to more accurately assess students' learning outcomes.

5. Establish a continuous improvement mechanism

Before engineering education accreditation, no clear continuous improvement mechanism was established. Each improvement was based on the previous students' grades and classroom conditions, and the teaching methods, progress, and tests were adjusted. Now, combined with the usual quizzes, after-school assignments, major assignments, final exams submitted by students, and the results of questionnaire surveys on students after the course is over, continuous improvement reports can be written, teaching cases and teaching methods can be adjusted in a timely manner, and targeted Carry on continuous improvement in order to achieve better teaching effect.

6. Reform results

Compared with the teaching process of the second semester of the 2021-2022 and the second semester of the 2020-2021, the final computer-based examination method will continue to be used last time, but the number of programming questions in the final examination paper will be increased to two, and the number of difficult questions will increase. "High order". The large homework used in the usual assessment increases the difficulty of the project, and increases the writing of experimental reports, the PowerPoint of lectures and defenses, and strengthens the process assessment. According to the questionnaire survey conducted on the students at the end of the term, 38.2% of the students think that their study status is good, 47.7% of them think that their studies are slightly difficult, and 14.1% of them think that the courses are difficult. For most of the students, although the courses are challenging, they can still be completed well, and the overall feedback from the students is good. At the same time, it organizes students to participate in various programming competitions such as "Blue Bridge Cup" and "Ladder Competition", and has won many national awards. Through the competition, the knowledge learned has been consolidated, the students' innovative consciousness has been strengthened, the students' computer programming ability has been improved, the teamwork spirit has been cultivated, and the overall quality of college students has been improved.

7. Conclusion

To sum up, the data structure curriculum reform under the background of "Si Xin" and engineering education certification is of great significance. It not only improves the teaching quality of data structure courses, but more importantly, it can better adapt to the needs of engineering education, enable students to better grasp the basic principles and methods of data structures, and improve students' practical ability and comprehensive quality. In the future, the reform of the data structure course will be a topic worthy of continuous attention. It is necessary to continuously introduce new teaching concepts and methods, improve the teaching environment and evaluation methods, and improve the teaching quality of the data structure course.

Acknowledgement

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