

Research on Data Structure Course Teaching System Based on Open Teaching Model

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Keywords: Data Structure, Open Teaching, Creative Thinking, Team Cooperation, Multi-level Practice

Abstract: Data Structure is an important basic course for computer science and other information related majors. It carries a tremendous responsibility for cultivating students' computer program design capabilities and computational thinking skills. This article mainly discusses how to develop students' learning initiative, thinking innovation and independent thinking ability in the process of data structure teaching which may be useful to the other instructors in the universities.

1. Introduction

Data Structure is an important basic course for computer science and other information related majors. It carries a tremendous responsibility for cultivating students' computer program design capabilities and computational thinking skills. Data Structure is the core course in the computer science curriculum system, and corresponds to the theories, abstractions, and design methodology of problem solving in the discipline. The content structure of the course is divided into three levels: conceptual representation, data model construction, and algorithm design. It highlights the data organization methods and implementation technologies, develops student's algorithm design ability and creative thinking, and develops the abilities of abstraction and solving problems. The abilities to deal with complex problems is a fundamental skill in the research, development, and management of computer system architecture, system software, and application software. Therefore, an important feature of the Data Structure course is to highlight the cultivation of student data abstraction ability, algorithm design ability, and creative thinking ability.

However, in many years of "data structure" teaching practice, students generally have such problems: "We can understand in class but do not know how to start when they solve problems independently out the class" "The teachers in the class speak vividly. Listening can also be heard clearly, but it is confusing when it is actually used". Why is this happening? The main reason is that students do not really participate in the learning process, resulting from passive learning. Therefore, in the data structure classroom teaching, how to cultivate students' self-learning ability, inspire students to think positively, enable students to embrace life in the learning process, learn to observe and think, take the initiative to explore, carry out in-depth, comprehensive, unique thinking, this is what we have always had to face and have to think about.

The data structure teaching team of Central South University adopted the "modernization of teaching ideology (syllabus), modernization of teaching content (standardization), modernization of teaching process (open teaching model), assessment modernization (separation of test and teaching and multiple assessment systems), and the networking of experimental process (online learning and assistant) to focus on the reform of the "data structure" teaching, focusing on improving the teaching methods, experimental methods, teaching counseling methods, to achieve a diversified curriculum teaching (multimedia classroom, personality classroom), curriculum counseling network (campus teaching network and the related communication software) and integrated curriculum training methods (laddered project, complexity and team projects), to improve teaching quality, and

also achieved good results. This article mainly discusses how to develop students' learning initiative, thinking innovation and independent thinking ability in the process of data structure teaching.

The essence of "open classroom teaching" is to regard the classroom as a teacher-student interactive teaching system and make further extensions in time and space. It focuses on students' autonomy, research, discovery, and cooperative learning and pursues the optimization of the classroom teaching process, the benefit and scientific process of the classroom teaching management, and the rationalization of the classroom teaching assistant system.

Cultivating students' creative thinking is the main task of implementing innovative education in classroom teaching. Traditional classroom teaching places too much emphasis on knowledge transferring and students' passive acceptance. The more clearly the instructors taught, the more restrictions on students' thinking. With time goes on, students forget to think, lazy to think, or even not be capable of thinking. They need to mobilize all kinds of perceptual organs of the body to participate in "the class", especially the active learning process that requires positive thinking. Therefore, it is imperative to reform the classroom teaching model to realize the interaction between teaching and learning and inspire students' innovative thinking. In recent years, our teaching team has been trying new teaching models, transforming teaching methods from one-way teaching into heuristic, interactive, experiential and other forms, and stimulating students' thinking. Students' learning initiative will be brought into play to promote the formation of students' innovative thinking.

2. Revision of the "Data Structure" Syllabus

The course group explores the engineering practice ability, research learning and innovation ability training from the education and teaching system, mode, and means, and establishes the curriculum concept of "tightening the foundation, strengthening practice, putting people first, and highlighting the ability" to revise the curriculum plan. The teaching team invited experts to carry out pre-revision and post-revision audits. Under the guidance of the experts' inspections and audit opinions, we conducted in-depth discussions and repeated revisions to finalize the new version of the data structure curriculum syllabus. The teaching objectives are subdivided into knowledge goals, ability goals, and literacy goals, so that students can achieve in their knowledge goals: understanding of the structure and classification of data, the close relationship between data structures and algorithms, familiarity with various basic data structures and their operations, and learning to select the data structure according to the actual problem requirements, master the steps of the algorithm design and algorithm analysis methods. In the ability goals, it is focused on analyzing problems and solving problems for complex engineering problems, selecting appropriate data structures and designing effective and competitive algorithms for application problems. In the literacy goal, it is emphasized that through participation in the group project, exercise leadership and teamwork spirit, cultivate innovative awareness and innovation ability, and cultivate psychological awareness of stress.

3. Arrangement of the Teaching Contents

In response to the experts' opinions "curriculum over-emphasis on theoretical knowledge, inadequate training of students' practical abilities", "the knowledge points are aging, it should promptly track the development trend of computer science and industry", We teaching team should track the teaching content arrangement of the data structure courses of well-known domestic and foreign universities, modify and improve the two parts theory teaching and practical teaching of the data structure, focus on and train students to have the ability to solve problems, especially complex engineering problems, and we have published the national 12th Five planning textbook "data structure and algorithm."

4. Basic Teaching Principles and Methods

In order to achieve the teaching objectives of this course, the teaching team strengthened the open course teaching, vacation course discussion, extracurricular development exercises, extracurricular literature reading, team exploration project, online test system exercises and other teaching methods including traditional classroom teaching and in-class comprehensive experiments in the teaching process. A flexible and diverse teaching method is adopted for different teaching contents. Heuristic, interactive and experiential teaching theory is used to organically integrate teaching content, reflecting the latest teaching and scientific research achievements, cultivating students' interest in learning, and increasing the practice teaching. During teaching process, the course group adheres to the following basic principles and methods:

4.1. Adhere to the Student-centered Approach and Pay Attention to the Students' Enthusiasm and Initiative

Based on the "Data Structure" course group, the new approach to teaching methods and teaching reforms was explored, and the "teacher-oriented and student-centered" teaching model was defined, namely "instructional teaching and discussion as a guide, independent learning and practice as an improvement".

Following the concept of "student-oriented and highlighting capabilities" to improve the efficiency and quality of teaching and learning, this course has already built and implemented an "interactive teaching process". First, the "face to face" interaction is the direct communication between "classroom-b/t classroom-after class". Second, the online interaction is the "online-offline" remote communication through the Internet. This "anytime, anywhere" interactive platform provides great convenience for teachers and students, while ensuring and promoting the improvement of teaching quality and level. At the same time, the computer room is actually completely open to students to provide students a good learning environment with a good combination of theoretical learning and innovative sense. It is required that students learn to conduct extra-curricular research, writing course research reports or course research papers, and conducting course presentations.

4.2. Focus on the Combination of Theoretical Learning and Engineering Cognition, Implement a Complete set of Diversified Teaching Solutions

In the teaching, students are guided to "apply the basic theory, the basic concepts," and "pay attention to the engineering application background", to understand how to apply them flexibly, and what are their inherent laws and characteristics. Data structure is to solve the "how to do well" problem from an engineering perspective. Students are inspired to challenge textbooks and improve algorithms. In order to enable students to understand the basic concepts, definitions, algorithms and other teaching content more vividly and vividly, this course group achieves a "diversified teaching plan, uses modern teaching methods in addition to teaching PPT presentations in class but also rich and complete animation demonstration, including stacks and queues, trees and binary trees, graphs, searching and sorting techniques and so on. We also provide multimedia CAI courseware, extra-curricular development training, course video, online training and testing and Q&A. At the same time, students are encouraged to form an interest group to discuss and analyze the key issues and achieve the purpose of learning from each other and improving together.

After the class, students can communicate with the instructor individually via email, QQ, MicroMsg, telephone, text messages, etc., and they can also communicate and discuss with each other in the group. It is also able to promptly give feedback on the highlights and deficiencies of teaching and learning and make progress together.

4.3. Using Heuristic Teaching to Cultivate Students' Creative Thinking

"Take students as the center of teaching, so that they can keep active in the whole process of learning, actively raise questions, actively think about problems, and actively discover and actively explore. The core of heuristic education is to train students to think independently and innovative thinking." This is Premier Wen Jiabao's speech at the Fifth National Conference on Teaching Achievement for Higher Education. Popper, a famous contemporary scientific methodology scholar, also pointed out

that "it is the question that inspires us to learn, to develop knowledge, to practice, to observe." Therefore, we should teach students how to find problems, ask questions, analyze problems and solve problems.

Problem is the starting point of innovation and it is the ideal carrier for students' interest and motivation. The key to implement heuristic teaching is high-quality, innovative, heuristic problem design. Data Structure teaching, especially in the algorithm design process can verify this. After introducing algorithms such as dictionary sequential search, binary search, block search, etc., students can be guided to analyze the common features of these search methods: the search can be achieved through the "comparison" between the searched element x and the key and search efficiency can be improved by reducing the number of comparisons. In this regard, whether it is possible that if there is a function H and the function value $H(x)$ of the element x is the location of the element x ? if so, it is a very good search method, the average search length may reach a constant level. Then the hash table technique was introduced. In this method, we continuously create problem scenarios, transform the knowledge and skill points on the teaching materials into questions, trigger students' interest in innovation, and increase students' drive for thinking. If you think about it, you will gain something. When you think about it, you will gain something.

Considering the current situation, student autonomy is a weakness, and the reasons are closely related to the student's educational experience and background. Many university courses still use indoctrination methods in middle school. In the reform of data structure courses, teachers should adhere to three directions: First, to compress basic course time, and students should be self-study prior to teaching. The second is to learn while practicing. It is not necessary to wait until the student's basic knowledge is known to be reliable before arranging experiments and projects. It is necessary to increase the intensity of the project in a planned manner so that the students can explore and solve problems by themselves during the project and discuss it within the team. In terms of basic knowledge and practical ability, the latter should be appropriately tilted. The third is to strengthen the process of guidance and examination. In order to prevent students from having slacking due to more problems, teachers should develop a comprehensive and thorough guidance and examination plan, check the progress of the project at any time, and see if students are using their brains to solve problems and try to solve them.

The art of teaching depends to a large extent on the skill of the teacher and the ability to create problem situations. In preparing lessons, teachers should not only digest the content of the textbooks, but also deeply explore the mysteries of knowledge. They should also carefully design the classroom scenarios and prepare the "problems". Classroom teaching should not only explain the knowledge vividly and thoroughly, but also try to stimulate students' thinking; the teaching process not only do students are required to listen carefully, but they also need to guide students to think positively and gradually develop their ability to discover, analyze, and solve problems.

4.4. Training Abstract Thinking Ability with Experiential Teaching

Experience is a kind of psychological activity that people experience knowledge and feel emotion in practice. The so-called experiential teaching refers to a teaching method in which students learn their own life experiences and rely on their own emotions, intuitions, savvy and other intuitive feelings, scent, and comprehension to re-recognize, rediscover, and re-create knowledge.

The data structure itself is an abstract representation of some common problems in the real world. This determines that the content of this course is derived from reality. The abstract method is expressed as an algorithm that the computer can accept, which itself is a complex abstract thinking process. For students to complete and realize this transformation, they need strong abstract thinking ability. This is also the reason why beginners of the "data structure" can "listen clearly in class and can not do questions after class" and they do not know how to start facing problems. The formation of abstract thinking ability must have a "quantity accumulation". Only when "quantity accumulation" is the training of abstract thinking to a certain extent can we achieve "a qualitative leap?" In class teaching, it is very important for students to experience the process of "facing problems, analyzing

problems, and solving problems”. For example, when teaching each basic data structure, the author will generally come up with some examples while let the students cite some similar examples, and then let them sum up and summarize what common characteristics these examples have. For example, when introducing the chapter “Trees and Binary Trees”, we will first give examples such as “school administration organization” and “family genealogy”. Students will also give examples such as “content of a book”, “File system structure and other familiar examples, students will sum up the common characteristics of "hierarchical structure". In this way, students are allowed to understand the logical characteristics of the "tree", and to realize the storage organization, insertion, deletion, and query operations that those data objects with hierarchical structures in the real world, and then to abstract a data structure "tree" to discuss and research. Another example is, when introducing sorting algorithms, the “sorting of test papers after students' exams” is often used as an example to guide students to think about the process of insertion or selection sorting, so that students can abstract the basic operations of each sorting and form a solution to the sorting problem, the idea of the algorithm, and then let the students describe each operation in a programming language. In this way, we guide students step by step, to let them feel the process of algorithm formation, and train their abstract thinking skills. After class, the extra-school thinking and exploring questions will be arranged according to the contents of the classroom.

4.5. Multi-angle All-round Training of Student's Thinking Openness

Classroom teaching should place students in the position of inquiry, create an atmosphere that allows students to let off associative thinking, change from a closed state to an open state, think from different angles, break old habits of thinking, and use different methods to solve different problems. Train students' abilities to use knowledge flexibly to develop divergent thinking and innovative thinking. For example, after teaching “direct insertion sorting algorithm”, students will be guided to analyze the number of comparisons and movement times of the algorithm, indicating that the time complexity is $O(n^2)$, and the time complexity on this order is general and must be discussed to improve algorithm. The "improved algorithm" can be used to reduce the number of comparisons, leading to binary insertion sorting; from the perspective of reducing the number of moves, eliciting table insertion sorting; when the time is less and n is not too large, the difference between n and n^2 is also small, leading to SHELL sorting; if you do not need to compare, do not move, how to achieve sorting? Get "cardinal sort" idea from the "playing card sort" idea, with the allocation and collection to achieve sorting. From multiple angles, all directions guide students to think about problems and exercise their openness in thinking.

In the teaching process, it is supplemented with a large number of exercises, on-board experiments, and comprehensive design. At the same time, it also pays attention to the supporting role of data structure to other software series courses, that is, to focus on cultivating students' ability to adopt data structure knowledge to solve computer problems. Through strengthening the establishment of mathematical modeling awareness in teaching, the writing of experimental reports and the writing of curriculum design reports, to train students form a good behavioral literacy.

The “problem-driven” teaching model implements the project-driven teaching method. The teacher plays a leading role. The teacher prepares one or more problems or projects in advance according to the teaching content, and uses the research and development process of the project to guide and organize students to carry out discussion activities. The demonstration was combined with the successful project. The teaching content was triggered by the project task. The development process of the entire project was drilled from the point to the surface and the students were guided to participate in an example, complete an example, strengthen the tour guide to practice the project teaching method, so as to promote classroom teaching. For example: store charging simulation and analysis project, campus map information inquiring project, book information inquiring project and other projects. The teacher should extract the main knowledge points of the course and integrate it into each specific project. The project comes from real life, close to their daily learning and life experience, which is conducive to stimulating students' interest and mobilizing their enthusiasm for

learning.

4.6. Establish a Positive and Harmonious Classroom Atmosphere and Use Conversational Teaching to Build an Innovative Thinking Environment

A lot of students like a course, but in fact started from the teacher who instructed the course. People's emotions are contagious to each other, especially teachers' influence on students' emotions is even more pronounced. Only teachers are active, responsible, and passionate, classrooms will be vibrant and students' thinking will be active and actively explored. Therefore, the teacher's emotions will directly affect the atmosphere of the classroom. The establishment of an atmosphere of equality, mutual assistance, and positive classroom atmosphere will lead to more effective lessons.

There is such a passage in the book "The Idea of First-Class University in the United States": "The essence of a university is to bring together a group of excellent young people and let their creativity motivate each other to generate wisdom that will benefit them for life. Therefore, professors Where is the Ph.D., how many monographs have been produced is still secondary. What is important is how the teaching of the university creates a more effective environment for young people to inspire wisdom and creativity." How to break through the traditional classroom teaching mode? The "deciding everything by only teacher's say" and "spoon-feeding method" classrooms have been transformed into forums for "allow everybody to air his view" to allow young people to freely collide their ideas, critically absorb other people's views, and exercise openness and creativity in thinking, thereby enhancing their innovative capabilities. This is a challenge for students and a challenge for teachers. The key lies in the fact that teachers instruct students to participate in discussions by designing teaching problems and inspire students to explore and form their own opinions. Make students become the main body of learning, develop discussion and questioning into students' learning behavior habits, and they can cultivate their own innovative consciousness, develop thinking skills, and consciously study and argue in the collision of different opinions in positive thinking.

4.7. Designing Multi-level Practice Links, Effectively Improving Students' Ability to Analyze Problems and Solve Problems

According to the characteristics of this course, we designed a series of teaching practice content, including: basic training of data structure, team exploration project (larger homework), extracurricular online program testing (ACM/ICPC testing), curriculum theory and applied research, etc. This multilevel practice sections enable students to "learn from the teacher-leadership to student autonomy" in a "sequential, progressive, and step-by-step" manner, thereby cultivating students' ability to comprehensively analyze problems, solve problems, and create awareness. And then to encourage students to ask questions, solve problems, and explore different solutions to the same problems.

In view of the lack of experimental time and inaccurate assessment results, we will apply online judgments system to data structure practice courses, draw lessons from the ACM/ICPC competition model, adhere to the "student-centered" teaching philosophy, design the content of practical teaching in different levels; open the time and space of the experiment, change the target assessment into a process assessment, strengthen the communication between teachers and students, and between students; The programming competition is based on individualized training and aims to cultivate innovative spirit and practical ability. It fully mobilizes the enthusiasm of students to participate in practice, combines learning with competition, teaches students in accordance with their aptitude, and improves the practical teaching effect of data structure courses.

4.8. Originate from Life and Stimulate Students' Interest in Learning

From the perspective of the development of the data structure, it emerges in response to the needs of the problem, and serves to solve the problem. Specifically, specific data structures are selected for specific problems and algorithms; data structures are improved in order to improve algorithms; and new data structures are created for new problems and algorithms. For example, why the tree has four traversal methods: preorder, in-order, post-order, and layer order, which are needed for different

applications. To determine whether the two book directories are equal, as long as the headline (root node of a subtree) is different, then it does not wait, apparently this time to use the preorder traverse; and if to remove the book directory from the computer, you must first delete the subtitle (left and right subtree) before you can delete the headline (the root node), and then use the post-order traversal. Through examples in life, students can recognize that the data structure exists in our lives, waiting for us to explore and organize. Each holiday we will arrange for students to find problems in life, and then discuss the problems in the team after the holidays to determine the team project topics in the team. The topics such as "tourism planning and management," "Bank service call alert system," "monitoring and managing the sharing vehicles." etc., are topics that students themselves feel and determine in their lives.

The cultivation of interest in learning plays an effective role in the students' learning process. In the classroom teaching, teachers should constantly strengthen their interest in studies. In the process of strengthening interest, teachers should pay attention to let students understand the specific application of the knowledge they have learned in real life. When they see that the knowledge they learn can become a practical software product and they can serve the community, they will be greatly stimulated and students have a strong interest in learning.

4.9. Carry out Reforms of Course Assessment Methods to Develop Students' Ability to Find Problems and Solve Problems

The reform of assessment methods is mainly reflected in the traditional assessment. It also increases the assessment methods and proportions of the usual assessment results. The proportion of the scores usually reaches 40%. The project involves daily performance, in-class work, extended work, in-class experiments, and online test assessment, curriculum research (external thinking questions and course papers) and other items.

The purpose of individual assignments is to consolidate the knowledge learned in the classroom, develop learning abilities and self-learning skills, and exercise the ability to independently analyze problems and solve problems. The purpose of the teamwork is to cultivate teamwork spirit, exercise organizational and coordination ability, innovation ability, software cooperation and development ability. In response to team project operations, a procedural planning arrangement was formulated. Correspondingly, the job scoring consists of three parts: class work, extracurricular work, and extracurricular practice, table 1 is an example.

Table 1 Example of evaluation result of operation total score

Student ID	Team Class Name	In-class 1	Extra-curriculum Extension 1	Personal Assignment 1	Personal Assignment 2	In-class 2	Extra-curriculum Extension 2	Team Score	Total score after conversion
	CSUWolf	6	9	7.5	6	7.5	8		12.5	86
	Academic slag team	7	7.5	8	7	10	9		11.5	95
	CSUWolf	6.5	9.5	8.5	6	7.5	8		11.5	88
	Fishing gues	8	9.5	9.5	6	7.5	8		11.5	88
	CSUWolf	7	10	8	7	10	7		11.5	88
	Fishing gues	6	6.5	6.5	7	10	8		11.5	84
	Academic slag team	7	7.5	8	7	10	6		11	87

The reform of data structure course assessment method is mainly based on the traditional assessment. According to the engineering point of view, the process supervision and assessment are strengthened, and online test assessment and curriculum research (extracurricular thinking and

course paper presentation) and other items are added. Three dimensions of experiments, practical work in practice (individuals, teams), and online submitting system exercises are used to strengthen the training of engineering practice and guarantee the achievement of graduation requirements.

5. Implementation effect

5.1. Realized the Integration of "Teaching, Learning and Doing"

By guiding students to change their learning methods, students can actively participate in the conversion process from theory to practice, and the ability of students to analyze problems and solve problems is continuously improved according to the skills requirements of professional positions. The comprehensive development of knowledge, ability and quality has laid a solid foundation for the design and development of the software industry after graduation.

5.2. Improve the Overall Quality of Students' "Learning, Practice and Innovation"

The practical teaching mode developed through the project enables students to apply knowledge to specific actual project development. Focus on students' knowledge, application and ability training, and strengthen students' comprehensive analysis, innovative thinking, and practical hands-on capabilities.

5.3. Develops Students' Ability to be "Honest, Trustworthy, Hard-working, and Team-friendly"

The project has established specific application cases for students and students can practice in the process of learning. Through the implementation of this method, students have good moral qualities, teamwork and interpersonal coordination; they have the ability to make scientific innovations, decisions, and execution; and as new technologies and new knowledge develop, they acquire information learning capabilities through various channels.

6. Conclusion

This paper takes the data structure as an example to illustrate the application of open teaching in the data structure curriculum teaching system, from the curriculum syllabus, teaching content arrangement, teaching process principles and methods, coursework settings, course assessment mechanism and other teaching process. Starting from the requirements of bringing students' subjective initiative into cultivating students' innovative awareness and ability to innovate, we will grasp the main problems of students' ability to solve complex problems, and do a good job of continuously improving the quality of course teaching and the mastery of students' ability, and promote the achievement of graduation requirements. , which in turn supports the realization of training goals. Through the reform of the data structure course teaching model, significant results have been achieved, teaching quality and teaching levels have been improved, and the teaching reform has been demonstrated as a model, and students' ability in innovation and entrepreneurship has been improved and local economic development has been served.

Acknowledgements

This work was supported by the China Association of Higher Education under Grant 2018GCJZD11.

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