

Exploration of Teaching Design for Data Structure Course Based on OBE Concept and BOPPPS Teaching Model

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Abstract

In the traditional teaching mode, the course of data structure neglects the cultivation of students' logical thinking and practical ability. This essay will explore how to design the teaching of the data structure course based on the OBE concept and the BOPPPS teaching model. Firstly, applying the OBE theory, the course system and teaching methods are designed in reverse, taking the final learning outcomes that students should achieve as the orientation, and clarifying the teaching goals that students should reach. Secondly, the teaching process is reconstructed and a diversified evaluation system is established based on the BOPPPS teaching model, aiming to enhance students' data abstraction thinking, algorithm design ability and innovative thinking, and solve the problems in the traditional teaching mode such as students' passive acceptance of knowledge and the disconnection between theory and practice.

Keywords

OBE concept; BOPPPS teaching model; Data structure.

1. Introduction

In 2017, in response to the new economic situation and to promote development through innovation, the Department of Higher Education of the Ministry of Education put forward new requirements for engineering and technology talents and decided to carry out research and practice on new engineering disciplines. As the construction of new engineering disciplines deepens, the traditional teaching mode of engineering courses is difficult to cultivate talents that can adapt to the development trend of the industry, and teaching reform is extremely urgent. Data structure, as a core course of computer science and technology, has the characteristics of abstract teaching content and complex algorithms. Therefore, students need to have certain logical thinking and programming abilities before learning this course. However, the traditional teaching mode often focuses on theoretical explanation and neglects the cultivation of students' practical ability and innovative thinking, resulting in students' difficulty in effectively applying the knowledge they have learned to solve practical problems. Therefore, exploring a teaching mode that can effectively improve students' comprehensive quality is particularly important.

2. Theoretical Basis

2.1. The OBE Concept

In recent years, the OBE concept has been widely applied in higher education at home and abroad, effectively enhancing teaching quality and students' learning outcomes. The OBE (Outcome-Based Education) concept, or outcome-oriented education, is based on students' final learning outcomes and designs the curriculum system and teaching methods in reverse. The traditional teaching approach focuses on the explanation of knowledge, while this approach is more student-centered and pays more attention to the improvement of students' abilities and learning outcomes. This requires teachers to clearly define the knowledge, ability

and quality goals that students should achieve, and to select appropriate teaching content and strategies around these goals to ensure that students gradually achieve these goals in the learning process. Therefore, when training computer professionals, teachers should combine the training objectives and impart knowledge to students in order to improve the quality of talent cultivation.

2.2. BOPPPS Teaching Model

BOPPPS teaching models include Bridge-in, Objective, Pre-assessment, and Participatory learning Six stages: Learning, Post-assessment, and Summary. Compared with the traditional teaching model, the BOPPPS teaching model is more likely to stimulate students' learning initiative and innovation ability. By forming a complete, operable and evaluable teaching chain, teaching strategies can be adjusted in a timely manner according to students' learning situations to ensure the achievement of teaching objectives. Therefore, when conducting teaching activities, teachers should dynamically regulate teaching and guide students to constantly correct cognitive misunderstandings to improve the teaching effectiveness of data structure instruction.

3. Analysis of the Current Teaching Situation of the Data Structure Course

At present, there are many prominent challenges in the teaching of data structures, which affect the quality of teaching and the improvement of students' comprehensive abilities, and are difficult to meet the requirements for cultivating high-quality applied talents in the construction of new engineering disciplines.

(1) The theoretical knowledge is abstract and difficult to understand

The data structures course contains many abstract knowledge concepts, such as linked lists, stacks, queues, trees, graphs, and algorithmic ideas like sorting and searching. Most teachers explain these contents out of specific application scenarios, making it difficult for students to understand the essential logic and design principles. They can only memorize the concepts and codes by rote and have difficulty applying them to real life.

(2) Students have a weak foundation in programming

Learning data structures requires a solid foundation in programming, and some students have not mastered the grammar rules, logical thinking, and debugging methods of programming languages proficiently in the early programming courses. When faced with the task of writing code for complex algorithm implementations in data structures, they often don't know where to start. Not only do they have difficulty completing after-class exercises and experimental tasks, but they also gradually lose interest and confidence in learning. This leads to a vicious cycle of "the harder you learn, the less you learn".

(3) Disconnection between theory and practice

Data structure courses under the traditional teaching model fail to meet the talent demands for professional foundation and comprehensive practical ability. This is mainly manifested in the following two aspects. In terms of theory, teachers tend to focus on explaining theoretical knowledge, spending too much time in the classroom explaining concepts and deriving algorithms, and the way of outputting knowledge is mostly one-way, neglecting the cultivation of students' practical ability and innovative thinking. In terms of practice, experimental teaching is mainly verification experiments, lacking comprehensive, design-oriented and innovative tasks. Students only need to complete the operations according to the textbook or the steps given by the teacher, and cannot truly appreciate the application value of data structures in real scenarios, resulting in students' difficulty in transforming the theoretical knowledge they have learned into the ability to solve practical problems.

In order to address the numerous challenges that have emerged at present, it is necessary to reform the existing teaching mode of data structures. Therefore, this essay is student-centered, deeply integrating the OBE concept with the BOPPPS teaching model, optimizing teaching content, innovating teaching methods, strengthening practical teaching, solving various problems in teaching, and laying a solid foundation for cultivating high-quality talents to meet the needs of new engineering construction.

4. Curriculum Reform Design Based on the OBE Concept and BOPPPS Teaching Model

The core of the Outcome-based education (OBE) concept is "student-centered, outcome-based, and continuously improvement-driven", emphasizing that the design and implementation of teaching activities should revolve around the learning outcomes that students should ultimately achieve, focusing on the overall improvement of students' knowledge, abilities, and qualities. The BOPPPS teaching model is a closed-loop teaching model centered on students' active learning, dividing the teaching process into six links, each closely connected and progressive, which can effectively stimulate students' learning initiative and improve the efficiency of classroom teaching.

The deep integration of the OBE concept with the BOPPPS teaching model and its application in the design of the data structure curriculum reform can effectively combine goal-oriented and process optimization. The OBE concept clarifies the outcomes that students are expected to achieve in terms of knowledge, ability, and quality. Based on this, the BOPPPS model is used to refine the teaching process, ensuring that each teaching process is centered around the learning objectives and that each teaching activity provides support for the achievement of students' learning outcomes. Through this integrated reform design, students' mastery of professional knowledge, practical application ability and innovative thinking quality can be effectively enhanced, truly transforming students from passive acceptance of knowledge to active exploration of learning.

4.1. Establish a Three-Dimensional Teaching Objective System

Based on the OBE concept and in light of the characteristics of the data structure curriculum, establish teaching objectives in three dimensions: knowledge, ability, and literacy. The knowledge objective, as the most fundamental teaching objective, is to help students master the core concepts, basic principles and key algorithms of data structures and build their own learning framework. That is to say, students should not only understand the common abstract data types such as linked lists, stacks, and queues, but also know how they are defined, what kind of organizational logic they have, and how they are actually stored. In addition, students should be informed of the specific application of data structures in computer software and the field of artificial intelligence to help students establish the connection between data structures and practical application services. Considering that many students have a weak foundation in programming, the knowledge objectives are divided into the basic level and the advanced level. The content of the basic level includes all the core knowledge points and is aimed at all students. The advanced level is aimed at students who have spare capacity for learning, so that students with poor foundations can be taken care of as well as those who are good at learning.

The focus of the ability goals is to develop students' ability to abstract data, design algorithms, and solve practical problems. Data abstraction ability means that students can find the appropriate data model based on the actual problem they encounter, and then select the corresponding data structure to describe the problem clearly. The ability to design and implement algorithms means that when faced with specific problems, students can not only design efficient algorithms but also write them in programming languages. The ability to solve

practical problems is the ability to apply the knowledge of data structures and algorithms learned to specific scenarios in life, such as how data is stored, how queries are optimized, and how paths are planned.

The main objective of literacy is to help students enhance their abilities in innovative thinking, teamwork, and professional ethics. One is innovative thinking, encouraging students to try to optimize the performance of existing data structures and algorithms, or come up with new solutions, to cultivate their innovative consciousness and ability. Second, teamwork skills. Through group discussions and projects, students are encouraged to divide tasks reasonably, cooperate with each other, and communicate more within the team. This way, both teamwork skills and communication and expression skills can be enhanced. Third, professional ethics, based on actual cases in the industry, guide students to develop a rigorous programming attitude, attach importance to the readability and maintainability of code, and cultivate professional habits of honesty, integrity, and striving for excellence.

Combining the OBE concept and the characteristics of the data structure course, a three-in-one teaching objective system of knowledge, ability and quality was established, breaking the traditional model that only valued knowledge objectives. This objective system together constitutes the core content of students' learning outcomes and also provides a basis for the subsequent design of the teaching process and the establishment of the evaluation system.

4.2. Reconstruct the Design of the Teaching Process

4.2.1. Engaging Introduction Sessions

The introduction is the beginning of teaching, and its core purpose is to arouse students' interest in learning, enable them to quickly get into the learning state, and lay a solid foundation for the subsequent learning. Since the theory of the data structure course is too abstract, students are prone to fear. The introduction should combine scenario simulation, case analysis and problem guidance, and in combination with students' professional interests and the actual situation in the industry, design some introduction content that is close to real life and meets professional needs to stimulate their learning interest and thirst for knowledge. For example, when explaining the knowledge related to linked lists, you can design such an introduction scenario: First ask the students why the contacts in their mobile phone contacts can be found and sorted quickly, and use these life-related questions to guide them to think. Then show the actual operation screen of the phone contact list, along with simple animation demonstrations, to show how the linked list works in these scenarios, allowing students to intuitively see the flexible insertion and deletion of the linked list. Finally, in combination with the recruitment needs of Internet companies, emphasize that proficiency in data structures such as linked lists and trees is one of the core requirements for computer-related positions. Through these methods, let students understand the necessity and urgency of learning data structures and ignite their motivation to learn.

4.2.2. Clearly Define Specific Learning Goals

At the beginning of the class, clearly define the three-dimensional learning objectives of the class, that is, break down the teaching objectives into specific, measurable, achievable knowledge points, ability improvement points, and quality development points, so that students have a clear understanding of "what to learn, what to learn, and what to improve in this class", avoid learning blindness, and provide a clear direction for subsequent learning and self-assessment. For example, when presenting the learning objectives, they will be presented in layers and accompanied by corresponding examples. For instance, when explaining the basic operations of linked lists, theoretically, students should understand the definition, structure and storage method of linked lists, as well as master the basic usage of double linked lists and circular linked lists, and know the differences between linked lists and arrays. In terms of skill improvement, be able to write key code for creating, inserting, and deleting singly linked lists

in Python, and be able to debug simple linked list program problems. In terms of literacy, develop a meticulous programming mindset and improve the ability to analyze problems.

4.2.3. Precise and Effective Pre-Testing Sessions

The pre-test is a crucial step in BOPPPS teaching. Its core is to understand students' knowledge reserves, learning abilities and learning needs, laying the foundation for the precise implementation of subsequent classroom learning and avoiding a one-size-fits-all teaching model. When designing the pre-test, pay attention to bridging the previous teaching content and targeting the students' weak points. On the one hand, it can check whether the students have mastered the previous learning content; on the other hand, it can also show whether the students have previewed the course in advance. The pre-test is mainly conducted through a combination of online and offline methods. Before class, teachers assign preview tasks and pre-test questions to students through the online teaching platform. The preview tasks mainly include a brief review of the core knowledge points taught, reading of relevant cases, and a review of basic programming knowledge. The pre-test exercises are mainly objective questions and simple subjective questions. The content covers the key points of the previous class and the preview content of the current class. During the class, conduct a brief analysis based on the results of the pre-test, focusing on identifying common problems and weak points of knowledge among students. At the same time, further understand students' learning needs by asking questions in class, for example, asking students, "What difficulties did you encounter while previewing linked lists?" Adjust the pace and methods of the class based on the students' responses to ensure the pertinence and effectiveness of the teaching. The results of the pre-test will also serve as part of the post-process evaluation, providing a reference for the assessment of students' learning.

4.2.4. Interactive Participation in Classroom Learning

Classroom learning with group discussions and project-based exercises enables students to gain a thorough understanding of knowledge through active participation and practice. Group discussion is a very common form of interaction in the classroom, mainly to train students' teamwork, problem-solving and expression of ideas. When designing discussion topics, they should be closely related to the objectives and key and difficult points of the course, and give topics of appropriate difficulty that can arouse students' interest, such as when talking about the traversal algorithm of trees, Let students discuss how to implement preorder, inorder, and postorder traversals for a given binary tree, the differences among these three methods, and how to write the inorder traversal in code. When grouping, divide students with different programming foundations and learning abilities into one group to ensure that there are both students with a good foundation and those with a weak foundation in each group to achieve "complementary strengths and mutual assistance", and also clarify the responsibilities of each member in the group to ensure that everyone can truly participate. During the discussion, the teacher should patrol each group's discussion, provide timely guidance, help students solve problems in the discussion process, and guide students to think deeply about the discussion topic. After the discussion, each group sends a representative to present their ideas and code, other groups comment, and finally the teacher summarizes as a whole.

4.2.5. Post-test Session for Comprehensive Assessment

The post-test session is used to examine students' mastery of the content of this class, determine whether the teaching objectives have been achieved, identify possible problems in teaching, and adjust teaching strategies. In accordance with the OBE outcome-oriented requirements, the test will be conducted in various ways, including multiple-choice questions, programming questions, and case analysis, to assess students' mastery of knowledge, understand their programming ability and literacy improvement, and adjust teaching methods in a timely manner based on the results of the post-test. The post-test will be divided into two

parts: in-class offline tests and after-class practical tasks. The in-class tests will mainly assess students' basic knowledge and programming skills. The after-class practical tasks are comprehensive programming tasks, such as using a linked list to make a student contact list, using a graph to represent the relationship between classmates and friends and implementing traversal, to test your practical application ability and thinking ability.

Students are required to complete the task independently or in groups and submit code files and task reports, which include task analysis, implementation ideas, code interpretation and problem summary, with a focus on the ability to solve practical problems and innovative ideas. Establish hierarchical evaluation criteria to ensure fairness and reasonableness. For example, for basic programming questions, students with a weak foundation only need to complete the code writing of core functions to get a basic score, while students with a better foundation need to complete code optimization, function expansion, etc. to get a high score. The results of the post-test will be promptly fed back to students to help them understand their learning situation, identify their shortcomings, and clarify their future learning direction. Teachers, based on the post-test results, analyze the problems in the teaching process, conduct targeted review and reinforcement in subsequent courses, and adjust teaching methods.

4.2.6. Systematic Summary and Feedback

The summary and feedback session is a crucial part for teachers to improve their teaching. The core is to help students consolidate knowledge and clarify the knowledge framework. In addition, collect students' feedback, evaluate teaching effectiveness, and constantly adjust and optimize the teaching process and methods. According to the OBE concept, the summary and feedback session is divided into three parts: knowledge summary, extended learning, and feedback collection, as follows.

The knowledge summary is not just a simple repetition of knowledge points, but a systematic review of knowledge to help students build a complete knowledge framework and deepen their memory and understanding of knowledge points. For example, after explaining the basic operations of linked lists, you can make up mnemonic rhymes to help students quickly remember the core operations, then show mind maps to clarify the relationships between the knowledge points, and at the same time emphasize the key and difficult points and error-prone areas of this lesson, and provide targeted explanations and consolidation based on the problems found in the post-test to help students fill in the gaps. The extended learning part is mainly to guide students to learn actively and broaden their knowledge, and to assign extended tasks based on the content of this lesson, such as learning the application of graphs and understanding how graphs are applied in the field of artificial intelligence.

The feedback collection section involves understanding students' feelings about the class, the difficulties they encounter, and their needs for teaching, which will be used to optimize the teaching later. It is collected through online questionnaires and random questions in the classroom. The online questionnaire will be posted on the teaching platform, allowing students to evaluate the content, methods and pace of the teaching, and to raise difficulties encountered in learning and corresponding suggestions. For example, ask students if they are adapting to the teaching method, what they find the most difficult knowledge points, and what kind of interaction they hope to add later. After collecting the feedback, organize and analyze it in a timely manner, summarize the strengths and weaknesses of the class, and adjust the teaching later based on the students' suggestions. For example, if the practical time is insufficient, increase it later. Improve the quality of teaching and ensure the smooth achievement of the three-dimensional teaching objectives.

4.2.7. Establish a Multi-Evaluation System

Build a multi-evaluation system of process-outcome, theory-practice, professional-ideological and political. Process evaluation focuses on students' classroom engagement, group

collaboration ability, and project practice performance. Outcome-based evaluation, on the other hand, assesses students' learning outcomes through forms such as final exams and project reports. At the same time, incorporate ideological and political elements into professional teaching and cultivate students' professional ethics and sense of social responsibility through case analysis, role-playing, etc.

5. Summary

Based on the OBE concept and the BOPPPS teaching model, this essay conducts a preliminary exploration of the instructional design of the data structure course. By clarifying the three-dimensional teaching objectives, reconfiguring the teaching process design, and establishing a multi-evaluation system, students' learning interest and hands-on practical ability have been effectively enhanced. The practice shows that the reform plan significantly improves the teaching quality of the data structure course and provides a useful reference for the teaching reform of the course in the context of new engineering. In the future, we will continue to deepen the teaching reform and explore more teaching models and methods that meet the needs of new engineering construction. At the same time, we will strengthen exchanges and cooperation with other universities and enterprises to jointly promote teaching innovation and development of the data structure course, and contribute to the cultivation of more high-quality talents with innovative spirit and practical ability. To provide a basis for the reform of teaching in other courses.

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