Reform and Exploration of BOPPPS Teaching Model based on Problem-Based Learning in the course of Data Structure and Algorithm

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Abstract. With the continuous development of computer science and technology, data structure and algorithm have become one of the core courses of computer major. However, traditional teaching methods are often difficult to stimulate students' learning interest and initiative, resulting in students' difficulty in flexibly applying the knowledge in practical application. Therefore, this paper proposes a BOPPPS teaching model based on problem-based learning (PBL). Through the introduction of practical problems, attract students' attention, use BOPPPS mode to guide students to actively participate in classroom activities, improve students' subjective initiative, and combine intelligent teaching platform and curriculum ideological and political elements to help students learn professional knowledge while cultivating correct outlook on life, values and world outlook.

1. Introduction

With the continuous development of computer technology, "Data structure and Algorithm" has become a basic course in the field of computer science, and is the core of program design. Master the data structure, can efficiently organize and process data; Algorithms give life and function to data structures. Learning "Data Structure and Algorithm" not only helps us to understand various upper abstractions of data, but also can think and solve from a macro perspective when facing complex problems. However, traditional teaching methods are often difficult to stimulate students' interest in learning, resulting in students' insufficient understanding and application of data structures and algorithms. Therefore, most universities insist on student-centered teaching activities, and stimulate students' learning interest and subjective initiative through the combination of online teaching platforms and offline classes [1]. However, the online-to-offline teaching mode has certain requirements on students' online learning time, the stability of learning equipment, teaching resources and other aspects. Moreover, the survey report on the daily time allocation of contemporary college students shows that although college students are aware of the importance of time management, they have certain difficulties in time management. Online learning can be perfunctory.

Therefore, this study has no mandatory requirements for online learning before class, and students can choose according to their own situation. Make full use of classroom teaching time, adopt BOPPPS teaching model combined with PBL teaching method, and use the teaching platform of Superstar Learning to reform and explore the teaching of data structure and algorithm courses, realize student-centered, increase the participation of students and the interaction between teachers and students in the teaching process. Effectively improve the quality of classroom teaching and the enthusiasm of students for independent learning [2].

2. Problem-Based Learning teaching method

Problem-Based Learning (PBL), a problem-oriented teaching method, originated from medical education in the 1950s and is a student-centered teaching method based on the real world [3]. Under the guidance of teachers, the teaching method is "student-centered and problem-based". Through the form of group discussion, students independently collect information around problems, find and solve problems, and cultivate students' independent learning ability and innovation ability. Compared with traditional teaching, PBL emphasizes students' active learning, which not only cultivates students' independent learning ability and innovative thinking, but also helps students to master knowledge more deeply [4-5]. According to the course content, the key and difficult contents of each course of "Data Structure and Algorithm" are designed to publish problems of actual projects, guide students to analyze the problems, deepen their analysis and understanding of the problems through group discussions and other activities, and provide solutions, guide students to solve the problems actively, and improve their ability of independent learning and innovative thinking.
3. Problem-Based Learning teaching method

BOPPPS teaching model is a new teaching model that is oriented by educational goals and centered on students. It can effectively stimulate students' learning interest and participation, and improve the teaching effect and quality. BOPPPS teaching mode includes Bridge-in, Objective, Pre-assessment and Participatory learning. There are six stages: learning, Post-assessment and Summary [6]. The introduction of the course in the way of questions can arouse students' attention and interest; To clarify the learning objectives, key points and requirements of the course can highlight the educational function of the activity; Pre-assessment can understand students' pre-preparation knowledge and training ability in advance, so as to adjust the depth and progress of the subsequent teaching content; Participatory learning is to guide students to actively participate in the learning process through various interactions on the learning platform, deepen their understanding and mastery of what they have learned, and cultivate students' various qualities and skills. The purpose of post-evaluation is to test whether students have achieved the expected learning effect, evaluate and give feedback on the teaching effect through various means, and conduct teaching reflection and improvement according to the evaluation results. Finally, by summarizing the knowledge points of this lesson and clarifying the knowledge context, students can further deepen their impression and memory.

4. Design of BOPPPS teaching mode based on PBL

With the help of the Superstar learning platform and the combination of PBL teaching method and BOPPPS teaching mode, the course "Data Structure and Algorithm" introduces the topic of data structure and algorithm through practical problems in the course introduction stage, then defines the learning content and objectives of this course in the learning objective stage, and then understands the learning basis and needs of students in the pre-assessment stage. Then, in the participatory learning stage, students are guided to solve problems through group discussion, research and practice, and finally, students' learning effects are evaluated and fed back in the post-assessment, assessment and summary stage [7]. At the same time, classroom ideology and politics are integrated into the whole process of classroom teaching, guiding values into knowledge imparting and ability training, and helping students to shape a correct world outlook, outlook on life and values [8]. The specific teaching mode is shown in Fig.1.

![Figure 1: Design of BOPPPS teaching mode based on PBL](image)

(1) **Bridge-in**: In this stage, teachers need to stimulate students' interest and guide students to think about the importance and application of the course content. Topics can be introduced by asking a question or telling a practical case that is relevant to the course content. For example, in the Data Structures and Algorithms course, "How to store and manage data efficiently in a computer?" How can we use the data structure to model real-world problems like student medical check-up queues?" In the form of questions to capture students' attention and interest.

(2) **Objective**: Clarify the learning objectives of the course, including knowledge, skills and qualities. Taking the course of Data Structures and Algorithms as an example, the knowledge objectives of the course include: understanding the basic concepts and classification of data structures; Master the realization and application of basic data structures such as linear tables, trees and graphs; The ability goal is to train students' ability to analyze and solve problems; Through the study of the course, to establish students' ability of scientific and technological innovation, determined to work hard for the construction of the country.

(3) **Pre-assessment**: Review the relevant knowledge points that students have learned, prepare for the new content or conduct a simple test on the previous knowledge, so as to understand and master the basic skills of learning new knowledge points, and adjust the progress and depth of the teaching content according to the foundation of students. For example, before this lesson, we have learned the basic concepts of computers,
algorithms and programming methods, and how to use existing knowledge to solve new problems.

(4) Participatory Learning: Through explanations, examples and animations, students are shown the basic concepts, principles and implementation methods of the course content. It can be combined with practical problems, so that students can better understand the role of important knowledge points in the course content. In this process, teachers should pay attention to heuristic teaching, guide students to think and discuss, and stimulate students' interest in learning. It can be combined with the teaching platform of Super Star Learning to carry out various activities and guide students to actively participate in the class. Similarly, taking the Data Structures and Algorithms course as an example, "A linear table is a simple data structure that can efficiently store and manage data." How to implement linear lists with arrays, linked lists, etc." Through the release task of Super Star Learning Pass, students discuss in groups, and publish the results of the discussion to the learning pass, use the word cloud map to display the content submitted by students, highlight the key content of the answer, on this basis, combined with the course content to explain and demonstrate the content.

(5) Post-assessment: Design some practical problems or cases related to the course content and let students apply the knowledge to solve them. PBL teaching method can be adopted, allowing students to discuss and cooperate in a group around a practical problem, complete the task together, and display the task results in a group. In addition, teachers can also use the online programming platform to let students practice programming and improve students' hands-on ability.

(6) Summary: This stage summarizes the content of this lesson, emphasizes the key points and difficulties, and helps students consolidate what they have learned. Students' autonomous learning ability can be improved by asking them to share their experiences and experiences in the practice process. For example: "In this lesson, we have learned the basic concepts of data structures and how to implement them. In real problems, we need to choose the right data structure according to the characteristics of the problem to solve the problem." Etc., it is more convenient to guide students to think about and share situations in which they can use a chain storage structure to store data.

In a word, the BOPPPS teaching mode based on PBL teaching method can improve students' learning interest and initiative, cultivate students' innovation ability and teamwork ability, and help improve the teaching effect.

5. Application of BOPPPS teaching mode based on PBL in Data Structure and Algorithm

The shortest path solution of graph is a basic problem in graph theory. Its core goal is to find the shortest path between two nodes in graph. This problem has a wide range of uses and importance in practical applications. For example, it can be used for network routing, traffic planning, social network analysis, and more. Taking the shortest path solution of the graph in "Data Structure and Algorithm" as an example, with the help of Superstar Learning, based on the teaching concept of "learning-centered, teaching-led", PBL teaching method and BOPPPS teaching mode are adopted to organically structure the ideological and political elements of the course and the course teaching content, and redesign the teaching process.

5.1. Problem introduction

Take the "The Belt and Road Economic tour" as an example, draw a road map from Xi’an to Almaty, Xinjiang, there are many routes to choose, then which route is the shortest distance between Xi’an and various cities along the way?

5.2. Learning objective

Knowledge objective: the shortest path solution method and algorithm design.

Ability objective: Without relying on the premise of data, be able to master and use the shortest path algorithm to solve the shortest path from a certain vertex to other vertices in the graph.

Quality goal: Through the understanding of the "The Belt and Road Initiative" resources, guide students to pay attention to the current cooperation projects, progress and challenges, at the same time, promote Chinese culture, enhance cultural confidence, promote cultural exchanges and mutual learning; Through the Dijkstra algorithm solving process, you can appreciate the charm of teamwork, and with the support of team members, you can gradually achieve the goal.

Key point: "Find friends, adjust the route" in the shortest path solution.

Difficulty: How to find the shortest path in Dijkstra algorithm.

5.3. Pre-assessment

In Fig.2, the relationship and weight between the six vertices are shown. Students are required to find the shortest path from vertex 0 to vertex 5 within 2min, and the results are displayed in the form of word cloud map.

![Pre-assessment graphics](image)
5.4. Participatory learning

Watch the "The Belt and Road Economic tour" micro-lesson video, simply understand the background, purpose and significance of the Belt and Road Initiative, through high-quality co-construction of the "Belt and Road", hand in hand to promote the construction of human destiny community, at the same time, carry forward the Chinese culture, enhance cultural confidence, promote cultural exchanges and mutual learning.

According to the video content, the students discussed in groups, brainstormed and summarized the solution steps of Dijkstra algorithm. The results of student group discussion are posted to the learning channel, and the teacher displays them in the form of word cloud map.

The teacher commented on the students' discussion results, and summarized the solution process of Dijkstra algorithm as follows: initialization, finding friends, and updating the path. In real life, we also need to cooperate with others to better solve the problems we face, achieve personal and social development, and emphasize the power of team.

5.5. Post-assessment

Post the problem in Fig.2 again through the Super Star Learning Guide. Please use the Dijkstra algorithm just summarized to solve it and test the learning effect of this course content.

5.6. Summary

Summarize the content and issue homework and tasks to clarify the knowledge context of this course content, and implement Dijkstra algorithm with programming language to consolidate students' foundation.

Dijkstra algorithm seeks the shortest path through continuous exploration of various paths. In the process of "finding friends", it constantly expands its circle of friends and finds the shortest path through the medium of "friends". This course assignment and program design task will be issued through Super Star Learning Pass. (1) Use Dijkstra algorithm to solve the shortest path from vertex a to other vertices, as shown in Figure 3; (2) Design and complete the implementation of Dijkstra algorithm with C language.

![Figure 3](image)

**Figure 3.** Find the shortest path from vertex a to the remaining vertices

6. Conclusion

Research on the application of BOPPPS teaching mode based on PBL in the course "Data Structure and Algorithm", based on PBL teaching method, modularization of course content, introduction of course content in the form of questions, attract students' attention and interest, and deepen students' understanding and application of data structure and algorithm in practice; Adopting the BOPPPS teaching model, which is oriented by educational goals and centered on students, can effectively improve students' learning effect, enhance students' learning interest and class participation. In the course of teaching implementation, the ideological and political elements of the course are integrated into the course teaching links to help students cultivate correct outlook on life, values and world outlook while learning professional knowledge. At the same time, smart teaching tools are combined with electronic devices and classroom teaching to provide students with a richer and more flexible way of learning. Although the use of BOPPPS teaching mode based on PBL still has some shortcomings in both teaching and learning, it can constantly summarize, reflect, improve and innovate in teaching practice, so as to give full play to its due advantages [9].

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References


