

Practical Research on PBL Blended Learning in Data Structures and Algorithms Fundamentals Course

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ABSTRACT

The basic content of data structures and algorithms is complex, the theory is abstract, and the traditional static learning environment and teacher led classroom design are monotonous, which cannot meet the needs of students, therefore, in the context of "Internet + Education", this paper explores the blended learning of data structures and algorithms courses based on the PBL (Project-Based Learning) model, integrates various learning resources with the help of Chaoxing Learning Platform Online Platform, encourages students to carry out project collaboration inside and outside the classroom, and improves teaching effectiveness.

KEYWORDS

Data Structures and Algorithms; PBL; Blended Learning; Chaoxing Learning Platform

1 Research Status of Teaching Reform Based on Blended Learning

In recent years, the emerging research on the reform of blended learning models has mainly focused on the application of digital technology, online and offline collaborative education and vocational college education ^[1-3]. With the tool named Xuantibao, a situational analysis was performed based on the keyword "blended learning reform" to obtain clustering analysis results of relevant literature, policies, laws and regulations, news reports, etc. related to blended learning reform over the years, as shown in Figure 1. It can be seen that blended learning has obvious clustering in education and teaching, and it is a research hotspot in education and teaching reform.

Blended Learning, as an emerging teaching model, is widely applied and promoted in the field of education worldwide. It combines traditional face-to-face teaching method with modern online learning methods, aiming to improve teaching quality while also meeting the learning needs of various students. The mainstream teaching methods include Outcome Based Education (OBE), Small Private Online Course (SPOC), Back Design for One Shot Instruction (BOPPPS), flipped classroom, etc. ^[4-6]. In the process of practice, blended learning, in combination with the above innovative teaching mode, fully considers students' individual and team learning, which has effectively improved the teaching quality, students' learning efficiency and comprehensive ability of vocational education in the context of "Internet plus" ^[7].

2 Introduction to Data Structures and Algorithms Fundamentals Course

The "14th Five-Year Plan" period is an important stage for China to achieve education modernization and promote high-quality education development. As one of the core components of computer science, data structures course is a compulsory foundational course for students

majoring in computer science^[8]. The course content mainly revolves around basic data structures (arrays, linked lists, stacks, and queues), advanced data structures (trees, graphs), algorithm design and analysis (sorting, searching, recursion), algorithm optimization and complexity analysis (time complexity, space complexity), aiming to help students understand how to efficiently organize and process data, master algorithmic thinking for problem-solving, and cultivate students' abilities in analyzing and solving problems, programming, etc.

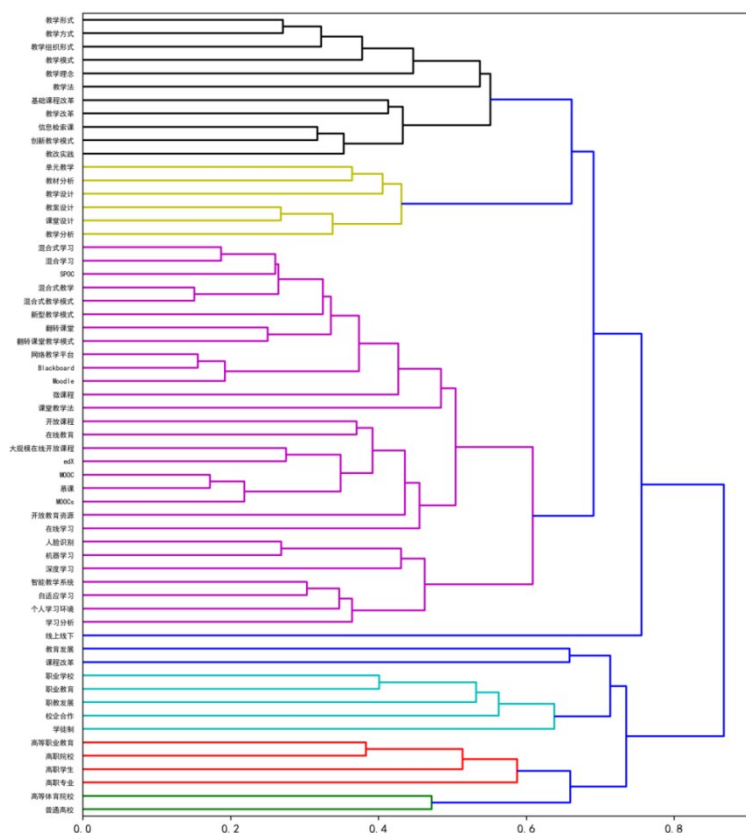


Figure 1 Hierarchical Clustering Diagram

3 Analysis of Difficulties in Course

(1) The classroom teaching content that requires advanced cognition often exceeds the cognitive load of some students, resulting in a gap between theoretical understanding and application ability, which in turn affects students' mastery and digestion of knowledge.

(2) Students may face the dilemma of resource scarcity or lack of effective tutoring during the learning process, which may affect their learning outcomes and goal achievement.

(3) Although students have clear learning goals, insufficient external motivation, lack of personal interest, or excessive learning pressure often result in failure of their learning motivation to be converted into sustained learning motivation, which may affect the achievement of learning outcomes.

In response to the new trend of teaching reform, this paper will study the application of data structures and algorithm foundations in PBL based blended learning, in order to create a rich and flexible learning experience environment, improve students' learning participation and

effectiveness.

4 Blended Learning Reform Based on PBL

Project-based learning (PBL) ^[9] is based on curriculum standards, using driving tasks as traction, project outcomes as guidance, and learning frameworks as support. It involves a new reconstruction of textbook content, guiding students to explore practical problems independently and collaboratively, and cultivating their creative thinking.

4.1 Course architecture

This paper selects the national planning textbook for vocational education in the 14th Five Year Plan as a reference, reconstructs the teaching content into six projects, and carries out teaching with typical work projects. Following the principle of "student centeredness, project priority", the course content is organized, and the project design is decomposed into the implementation of a single task, implementing task-based teaching, as shown in Figure 2. The knowledge points involved in each project are both independent and interrelated, forming a hierarchical and progressive curriculum from single to comprehensive.

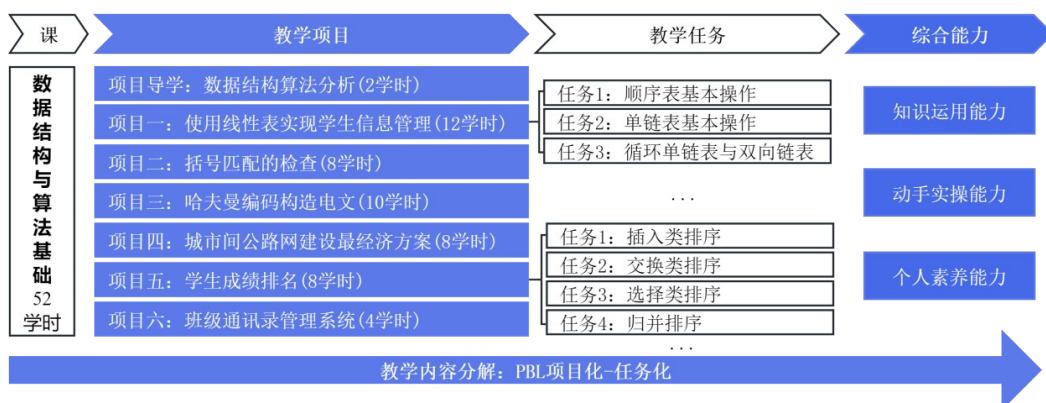


Figure 2 Teaching Content

4.2 Project driven and theoretical integration

Break the divide between theory and practice, and instantiate theoretical learning. The PBL model, through a project driven approach, can enable students to learn theory while solving practical problems. Students can independently choose, optimize, and implement algorithms during the process of completing practical projects. For example, when completing a complex data processing project, students not only need to master various data structures, but also need to improve the efficiency of the project through algorithm selection and optimization. The efficiency of the same project may vary depending on the design of different data structures and algorithms. By studying the theory of instantiation, we aim to cultivate students' initiative in thinking and help them gain a deeper understanding of the application of data structures and algorithms.

4.3 Application of PBL-based blended learning mode

Based on the teaching mode described in this paper, the actual teaching process is implemented

through the Chaoxing Learning Platform. On the platform, corresponding teaching resources such as documents, videos, animations, and teaching activities such as Q&A, discussions, quizzes, assignments, and exams have been set up for each chapter's knowledge points, as shown in Figure 3. In the chapter, it can be seen that ideological and political elements are "genetically" integrated into the entire process of curriculum teaching, with the aim of combining "knowledge imparting with value guidance" to stimulate students' sense of identification with socialist core values. Theoretical knowledge courseware is matched with instructional videos, combining dynamic and static elements to complement each other, allowing students to understand and master knowledge more efficiently in the process of self-directed learning. Simultaneously, the chapter tests can help students identify learning blind spots and weak areas and promote deep learning among students.

教学资源

课程章节资源

课程章节	文件类型	修改时间	大小	备注
1.1 【思政小课堂】学习的“时间复杂度”	视频	2024-08-20	13.54MB	
1.2 数据结构的基本概念	文档	2024-08-19	382.17KB	
1.3 算法	文档	2024-08-19	2.35MB	
1.4 【视频】时间复杂度分析1	视频	2024-08-19	11.26MB	
1.5 【视频】时间复杂度分析2	视频	2024-08-19	19.44MB	
1.6 【视频】时间复杂度分析3	视频	2024-08-19	16.28MB	
1.7 【视频】空间复杂度分析	视频	2024-08-19	22.78MB	
1.8 【习题】章节测验	作业	2024-08-26	--	
2.1 【思政小课堂】人生就是“单链表”	视频	2024-08-19	38.72MB	
2.2 线性表概述	文档	2024-08-19	267.72KB	

更多

Figure 3 Curriculum Construction Resources

In blended learning mode, if online, students can learn independently and complete related tasks through the platform. If offline, teachers can use face-to-face teaching methods to explain, answer questions, and engage in interactive discussions, helping students understand complex knowledge points. With the support of online platforms, the teaching process is designed as three stages and six stages, as shown in Figure 4.

(1) Pre class exploration

Teachers can release learning tasks through Chaoxing Learning Platform, and students can



Figure 4 Teaching Design

receive tasks and use information resources for self-study, to build a preliminary knowledge framework and cultivate students' learning habits of independent exploration. Teachers can adjust the focus and teaching strategies of their classes in a timely manner based on feedback from student task completion on the learning platform, helping students overcome key and difficult points in class.

(2) In class deep learning

The students' learning interest can be stimulated and classroom participation can be enhanced through situational teaching, case analysis, group discussions, and other methods. Teachers can use methods such as explanation, demonstration, and platform operation to analyze key knowledge points, introduce case operations, and help students overcome difficult knowledge points. Combining teaching and practice, guided by project tasks, rich project practices are conducted to enhance students' skills, techniques, and practical abilities.

(3) Expand learning after class

By establishing a question bank through the teaching platform, as shown in Figure 5, rich learning resources can be provided to adapt to students' different needs and continue to expand their learning. The students' learning situation can be tracked and recorded during the entire process and precise guidance can be provided for individual students.



Figure 5 Online Question Bank

During the three-stage specific implementation of each project, a six link guided teaching process of "clarifying tasks scenario creation knowledge exploration combination of teaching and practice evaluation results expansion training" is adopted, which stimulates students' active learning and Self-motivated ability, deepens students' understanding of knowledge points.

5 Curriculum Reform Effects

According to the backend statistics of Chaoxing Learning Platform, the online traffic (PV value) of this course has reached over 100,000 times. Compared with the majors offered by our college in the past, this course has received more attention or visits, and the online participation of students has significantly increased, as shown in Table 1.

Table 1 Statistics of Online Visits

Major	Course Creation Date	PV Value
Software Technology	2024-2-18	107,122
Network Engineering	2022-7-11	12,912

On the SUPWISDOM educational administration management system platform of our school, a quantitative analysis was performed on the grades of the Data Structures and Algorithms Fundamentals courses for two classes majoring in Software Technology in the 22nd grade. The results are shown in Table 2 and Table 3. It can be observed that under the teaching mode of this paper, the performance of students' grades in terms of average, standard deviation, skewness, and kurtosis is basically within the reference normal range. The overall distribution of class grades is statistically reasonable and meets general standards.

Table 2 Quantitative Analysis of Software Class 221 Scores

Item	Value	Normal Reference Range
Average	74.37	70 - 80
Standard Deviation	6.06	5 - 12
Skewness	-0.68	-0.47 - 0.47
Kurtosis	-0.22	-1.05 - 0.95

Table 3 Quantitative Analysis of Software Class 222 Scores

Item	Value	Normal Reference Range
Average	72.26	70 - 80
Standard Deviation	7.06	5 - 12
Skewness	0.25	-0.47 - 0.47
Kurtosis	-0.34	-1.05 - 0.95

6 Conclusion

As the cornerstone of computer science, data structures and algorithms rely on efficient data storage and processing methods for almost all advanced computer applications and technologies, such as operating systems, databases, network communication, artificial intelligence, machine learning, etc. For students in this major, it can not only help them develop programming skills and form a problem-solving thinking framework, but also lay a solid foundation for their subsequent course learning and career. In the context of "Internet + Education", the PBL-based blended learning mode combines learning content with practical problems to solve the problems of high-level cognitive requirements, insufficient learning resources and insufficient learning motivation of students in data structures and algorithms courses at a certain level, thus forming a set of teaching reform programs for reference.

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