Education Reform and Development, 2026, Volume 8, Issue 6
https://ojs.bbwpublisher.com/index.php/ERD
Online ISSN: 2652-5372
Print ISSN: 2652-5364

Construction and Practice of Personalized BOPPPS Teaching Model for *Data Structures* Empowered by AIGC

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Abstract: Aiming at the problems of homogenization and disconnection between learning and application in the traditional teaching of *Data Structures* in higher vocational colleges, this paper proposes to deeply embed AIGC technology into the six links of the BOPPPS teaching model, so as to construct a personalized teaching model adapted to the learning situation and post needs of higher vocational students and realize personalized adaptation of the whole teaching process. Through the practice and analysis of the BOPPPS+AIGC teaching model in the *Data Structures* course, it is shown that this teaching model significantly improves students' course completion rate, practical operation completion rate and post-skills compliance rate, and effectively stimulates learning interest, which can provide practical reference for the teaching reform of computer courses in higher vocational colleges.

Keywords: AIGC; BOPPPS teaching model; Data Structures; higher vocational colleges; personalized teaching

Online publication: July 20, 2026

1. Introduction

Data Structures is a core basic course for computer majors in higher vocational colleges, which is highly abstract, logical and practical. Its core goal is to cultivate students' engineering practice ability of using relevant knowledge to solve practical post problems [1, 2]. The teaching content and mode of the traditional *Data Structures* course have been difficult to adapt to the development requirements of the artificial intelligence era [3, 4]. Against this background, AIGC technology, with its advantages of personalized and intelligent empowerment, provides a new path for the reform of *Data Structures* in higher vocational colleges. The closed-loop design of the BOPPPS teaching model is highly consistent with the higher vocational concept of "teaching according to posts and teaching students in accordance with their aptitude", which is an important direction to promote the teaching reform of this course and improve the quality of talent training.

This paper takes the higher vocational course *Data Structures* as the research object, and deeply integrates AIGC technology into the whole process of the BOPPPS teaching model to promote the implementation of personalized teaching reform of the course. At the theoretical level, this study enriches the connotation and application paradigm of the BOPPPS model and further highlights the educational concept of "teaching students in accordance with their aptitude"; at the practical level, it can accurately connect the teaching difficulties and industry post needs, weaken abstract theoretical derivation and strengthen practical skill training. Through technical empowerment, it effectively solves the pain points such as insufficient personalization and disconnection between learning and application in traditional teaching, effectively improves teaching quality, helps students consolidate professional foundation, and enhances their programming practice ability and problem-solving ability, adapting to post requirements.

2. Related concepts and theoretical basis

2.1. Educational empowerment of AIGC

As an important branch of artificial intelligence technology, Generative Artificial Intelligence (AIGC) has become an important technical support for empowering the teaching reform of *Data Structures* in higher vocational colleges by virtue of its core capabilities such as intelligent generation, personalized adaptation, real-time interactive feedback and knowledge visualization [5, 6]. Its core empowerment values are reflected in: generating visualized demonstrations of abstract knowledge points, post-oriented practical case analysis and other concrete teaching resources to adapt to the cognitive characteristics of higher vocational students; accurately pushing learning resources and conducting real-time Q&A combined with students' knowledge foundation and post development needs to realize teaching students in accordance with their aptitude; transforming abstract contents such as binary trees and search algorithms into dynamic demonstrations to reduce learning difficulty; instantly correcting programming practical tasks, locating errors and guiding ideas to strengthen the effect of practical training. The above characteristics of AIGC are highly consistent with the teaching positioning of "emphasizing practice and strengthening posts" of *Data Structures* in higher vocational colleges, which can effectively solve the prominent problems of students' weak abstract thinking and disconnection between theory and practice, and lay a solid foundation for its integration with the BOPPPS teaching model.

2.2. BOPPPS teaching model

The BOPPPS teaching model is a student-centered structured teaching framework focusing on interactive feedback and goal achievement. It consists of six closed-loop linked teaching links: Bridge-in (B), Objective (O), Pre-assessment (P), Participatory Learning (P), Post-assessment (P) and Summary (S), providing clear logical support for the implementation of personalized teaching [7]. Bridge-in focuses on situation creation and problem guidance to quickly attract students' attention and connect old and new knowledge; Objective combines teaching objects, course content and post needs to clarify measurable knowledge, skills and literacy goals; Pre-assessment accurately grasps students' knowledge and skills foundation to provide a basis for adjusting teaching priorities; Participatory Learning, as the core link, takes students as the main body and teachers as the guide to strengthen classroom participation and knowledge and skills transformation through diverse forms; Post-assessment tests learning effects and provides a reference for teaching optimization; Summary sorts out the knowledge system and connects follow-up courses to form a complete teaching closed loop. Its characteristics of "student-centered, closed-loop feedback and focusing on practice" provide a framework support for reconstructing the personalized teaching model of *Data Structures* in higher vocational colleges [8].

3. Construction of personalized BOPPPS teaching model for *Data Structures* empowered by AIGC

The construction of the personalized BOPPPS teaching model for *Data Structures* in higher vocational colleges empowered by AIGC follows four principles: personalization, practicality, empowerment and closed-loop [9]. That is, adapting to the knowledge foundation, learning habits and post tendencies of higher vocational students, fitting the core knowledge points of the course and industry needs, giving full play to the advantages of AIGC technology to avoid formal application, and improving the connection of the six BOPPPS links to form a teaching closed loop. The specific construction focuses on the personalized design of the six links. Relying on AIGC technology, personalized push of situational cases, generation of hierarchical teaching objectives, accurate identification of knowledge weaknesses, construction of personalized practical scenarios and real-time Q&A, generation of personalized tests and feedback, and personalized summary and review resource push are realized in each link respectively, realizing personalized empowerment and closed-loop linkage of the six links, adapting to the teaching needs of integration of theory and practice in higher vocational colleges.

Figure 1. Comparison between traditional mode and AIGC-empowered personalized transformation of BOPPPS teaching links

BOPPPS Teaching Link	Traditional Teaching Mode	AIGC-Empowered Personalized Transformation
Bridge-in (B)	Adopt unified cases or problem introductions, lack of post pertinence, difficult to take into account students' interest differences.	Generate situational cases fitting the actual posts of higher vocational education, push personalized according to students' post development tendencies, adapt to concrete learning characteristics
Objective (O)	Set unified teaching objectives, without considering students' knowledge foundation and skill differences, insufficient adaptability	Generate hierarchical personalized objectives combined with pre-assessment results, clarify knowledge and skill requirements at each level, fit students' cognitive level
Pre-assessment (P)	Adopt a unified diagnostic test, lagging feedback makes it difficult to identify students' knowledge weaknesses accurately.	Design a personalized diagnostic test, with real-time correction and analysis, accurately locating knowledge shortcomings and providing a basis for teaching adjustment
Participatory Learning (P)	Unified practical practice and discussion tasks, lack of pertinence, uneven student participation	Build personalized practical scenarios, push tasks adapting to skill levels, real-time Q&A, strengthen practical participation and skill training
Post-assessment (P)	Unified test and homework, delayed correction feedback, insufficient targeted improvement suggestions	Generate personalized test and practical tasks, automatically correct and provide feedback on error causes, provide personalized improvement suggestions
Summary (S)	Teachers sort out knowledge points uniformly, students passively accept, difficult to form personalized knowledge system	Generate personalized summary and mind map combined with students' learning data, push targeted review resources, strengthen knowledge connection

4. Teaching model practice and effect analysis

4.1. Practice objects and scenarios

The practice objects are sophomore students majoring in software technology in a higher vocational college. This group has mastered pre-knowledge points such as linear lists and binary trees, has basic programming practical ability, and adapts to the teaching requirements of the "Graph" chapter. The practice scenario focuses on the "Graph" chapter of *Data Structures*. Relying on AIGC tools and the integrated teaching platform of theory and practice in higher vocational colleges, AIGC is deeply integrated into the six BOPPPS links to carry out a two-week teaching practice. Closely following the higher vocational concept of "post-course integration", the practice content is designed in combination with the application requirements of graph structure in posts such as software development and data processing.

4.2. BOPPPS + AIGC teaching practice process based on the "graph" chapter

Combined with the characteristics of abstract knowledge points and strong post applicability of the "Graph" chapter, AIGC is integrated into the six links of "Bridge-in, Objective, Pre-assessment, Participatory Learning, Post-assessment and Summary" to implement personalized teaching practice.

4.2.1. First link: Bridge-in

AIGC combines the actual software development posts to generate a practical case of logistics warehouse cargo distribution path planning (Figure 2), quickly connecting the pre-knowledge point of binary trees and stimulating students' learning interest. AIGC generates a dynamic demonstration animation: the first step shows the complete structure of the graph, with vertices labeled with names and edges labeled with distances, simulating the scenario of "Warehouse A needs to deliver goods to all distribution points"; the second step demonstrates "finding the shortest total distance distribution path covering all distribution points starting from A"; the third step connects the pre-knowledge point of binary trees: guiding students to think that "the traversal of binary trees (pre-order, in-order) visits nodes in a fixed order, while the traversal of graphs (depth-first, breadth-first) can choose different orders according to needs, for example, in distribution path planning, nodes with the shortest distance can be prioritized to visit", realizing the natural connection of knowledge points.

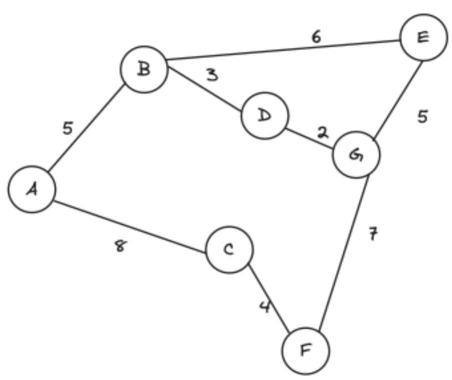

Figure 2. Logistics warehouse cargo distribution path planning graph.

4.2.2. Second link: Objective

Combined with the pre-assessment results and the practical case of logistics warehouse cargo distribution path planning, AIGC generates hierarchical personalized teaching objectives for the "Graph" chapter, fitting the knowledge foundation and post needs of different students. Basic-level objective: combined with logistics distribution cases, master the definition of graphs, adjacency matrix/adjacency list storage structure and basic application of traversal algorithms. Improvement-level objective: combined with logistics distribution scenarios, complete programming practice of graph traversal algorithms, realize basic traversal and simple optimization. Expansion-level objective: combined with post needs, relying on logistics distribution cases, complete the development of simple graph structure application programs or the construction of data statistics modules.

4.2.3. Third link: Pre-assessment

AIGC designs a personalized diagnostic test, focusing on detecting students' mastery of pre-knowledge points and preview degree of graph structure, accurately identifying students' weaknesses in "graph storage structure" and "algorithm logic". Combined with students' knowledge foundation and post tendencies, it provides a scientific basis for adjusting classroom teaching priorities and implementing hierarchical teaching to ensure more targeted teaching.

4.2.4. Fourth link: Participatory learning

AIGC builds personalized practical scenarios, fitting the knowledge foundation and post tendencies of different students, strengthening the sense of practical participation, deepening knowledge understanding, and connecting post needs through group discussions.

(1) Personalized practical scenario construction: students with a weak foundation can complete basic practices such as adjacency matrix/adjacency list construction and warehouse A traversal distribution points with the help of logistics distribution graph visualization demonstration and simple programming templates; students with spare capacity can complete post simulation tasks: software development-oriented optimize distribution path algorithm, data processing-oriented statistics distribution-related data.

(2) Real-time guidance and error correction: AIGC responds to students' practical questions in real time, and gives accurate prompts for programming and algorithm logic errors combined with logistics cases (such as A-B, A-C distribution data) to correct errors and help students master core practical skills.

(3) Group discussion and deepening: take the group as a unit, discuss the post-application of graph structure combined with logistics distribution cases: the software development group discusses path algorithm optimization, the data processing group discusses distribution plan suggestions, shares experiences, learns from each other, and strengthens knowledge understanding.

4.2.5. Fifth link: Post-assessment

AIGC generates personalized test questions and practical tasks, combined with the logistics warehouse cargo distribution path planning case, fitting hierarchical objectives: basic-level focuses on the basic test of graph storage structure and traversal algorithm; improvement-level and expansion-level focus on programming practice and post-application tasks. After the test, automatic correction is carried out, error causes are fed back, and personalized improvement suggestions are generated for each student, focusing on providing targeted guidance for error-prone points such as graph traversal algorithms and programming syntax to help students check for deficiencies and consolidate improvement.

4.2.6. Sixth link: Summary

Combined with students' whole-process learning data, AIGC generates a personalized knowledge point summary, combined with the logistics warehouse cargo distribution path planning case, focusing on sorting out the core points of graph storage structure, traversal algorithm and post-application precautions; push targeted review resources, connect follow-up chapter knowledge points, help students build a complete graph structure knowledge system and consolidate learning results.

4.3. Teaching effect analysis

According to student questionnaires and teacher interviews, 85.7% of students recognize this teaching model, believing that personalized cases and practical tasks pushed by AIGC fit post needs and effectively reduce the learning difficulty of graph structure; 78.6% of students said that their learning interest and autonomous learning ability have been improved, and they can take the initiative to use AIGC tools to solve practical problems. Comparing students' learning effects of the "Graph" chapter before and after practice: the practical task completion rate was 71.4%, and the post skill compliance rate was 69.0% before practice; after practice, the class average score increased to 79.5, the practical task completion rate reached 92.9%, and the post skill compliance rate reached 88.1%. The data show that this teaching model can effectively improve students' knowledge mastery and practical skill level, especially in programming practice and post application. The results show that students' ability to solve practical post problems using graph structure has been significantly improved, and their ability to adapt to post needs has been enhanced. Overall, the practical application effect of the BOPPPS teaching model empowered by AIGC in the "Graph" chapter is good, which can effectively solve the pain points of traditional teaching and fit the talent training goals of higher vocational colleges.

5. Conclusion

Data Structures is a core course for computer-related majors, connecting computer foundation and professional core courses, and plays a key role in the computer discipline knowledge system [10]. Teaching practice has proved that the personalized BOPPPS teaching model empowered by AIGC can effectively solve the pain points such as homogenization and disconnection between learning and application in the traditional teaching of *Data Structures* in higher vocational colleges, significantly improve teaching effect and students' post adaptability, and effectively fit the talent training goal of "post-course integration and skill-oriented" in higher vocational colleges. In the follow-up related courses of vocational undergraduate education, this teaching model can be further promoted, and its adaptive optimization path can be continuously explored to accumulate practical experience for improving the teaching system and teaching quality of computer majors in vocational undergraduate education.

Disclosure statement

The authors declare no conflict of interest.

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