DOI: 10.23977/aetp.2024.080120
ISSN 2371-9400 Vol. 8 Num. 1

Innovation and Data Visualization Analysis of the Course "Introduction to Computational Thinking" in Architecture Universities Based on "One Flat and Three Ends"

Cheng Lv

Department of Computer Science, School of Electrical and Information Engineering, Beijing University of Civil Engineering and Architecture, Beijing, 100044, China
lvcheng@bucea.edu.cn

Keywords: One flat and three ends; One question and three actions; four stage cycles; Characteristic thinking training library; Knowledge graph; Student Portrait

Abstract: Introduction to Computational Thinking is a computer basic course offered by our school for various majors. In response to the practical situation of reducing both theoretical and experimental class hours, the course team has established a teaching mode of "one question and three actions, and four stage cycles" through modular restructuring of the course content. Through visual analysis of mixed online and offline teaching data, we explore talent cultivation paths with significant architectural characteristics.

1. Introduction

With the development of information technology, blended online and offline teaching has gradually become popular in universities, and the "one flat and three ends" system [1,2] is also widely used. "One flat" refers to online teaching platforms, and "three ends" refers to the classroom end, mobile end, and management end. Among them, the classroom end refers to the smart classroom, mainly used for offline classroom teaching, the mobile end refers to the mobile end, mainly used for online self-directed learning, and the management end refers to the smart academic affairs, mainly used for teaching management.

Our university's "Introduction to Computational Thinking" course is a computer basic course aimed at first-year students from 54 natural classes in 37 majors. It has 24 hours of theoretical study and 24 hours of experimental study. For many years, the teaching team has fully implemented blended online and offline teaching with the support of the "one flat and three ends" system, and has innovated teaching to address the pain points and problems in actual teaching, achieving good results.

2. The main problems in the teaching of the course "Introduction to Computational Thinking"

1) I don't want to learn, nor do I love learning

The course is aimed at 37 majors across the university and is offered in the first year of college. As students have just entered university and do not understand the role of computers in their majors, their thinking and consciousness are still stuck in high school. They are only interested in software operation courses, such as AutoCAD, Dreamweaver, or Photoshop, and have no interest in programming courses, thinking that the courses are "useless", The question of "why do non computer major students need to learn programming? Learn algorithm design?" is raised, and the phenomenon presented is "not wanting to learn, nor love to learn." This is due to insufficient connection between teaching content and majors, and the inability to apply what is learned. Therefore, it is imperative to build a thinking training library with "architectural" characteristics that is in line with industry background and professional cognition.

2) I want to learn, but I don't know how to learn

The course is an introductory course, which inevitably involves a wide range of knowledge points and makes it difficult for students to master. Students are not good at abstracting difficult algorithms and models, and the phenomenon presented is "wanting to learn, but not learning". This is because students' lack large-scale engineering training, cannot connect the knowledge they have learned, and cannot form a cohesive force. Therefore, it is imperative to connect knowledge points and dynamically adjust the content and difficulty of knowledge points according to actual situations, in order to build a collaborative learning circle between teachers and students.

3) I want to learn, but I can't learn

Once students enter the deep waters of learning, they often experience the phenomenon of wanting to learn but not being able to. This is because students themselves have differences, and thinking training is a one size fits all approach, without distinction between majors or levels. The 37 majors in the school adopt the same set of plans, and the same level of difficulty inevitably leads to students who are good at learning not being able to eat enough, while students with learning difficulties cannot eat enough, resulting in insufficient thinking training, low challenge level, and high difficulty. Therefore, it is imperative to construct student group portraits and personal portraits.

3. Innovative ideas and measures

In response to the prominent problems, the teaching team proposed the teaching concept of "strengthening the foundation, adhering to integrity and innovation", which is to strengthen the foundation of "computer skills and information literacy", consolidate the foundation of "thinking training", adhere to the principle of "cultivating morality and talent", and create a new "architectural characteristic". The innovative approach is to (1) rebuild course resources and construct a "architectural" characteristic thinking training library through "thematic design"; (2) Based on the "one flat and three ends" teaching platform of Chaoxing, the teaching team optimize teaching content, draw a knowledge graph to dynamically connect knowledge points, design a comprehensive case for each chapter, form a "series of large blocks", and build a collaborative learning circle for teachers and students through the "Five Micro Linkages"; (3) The teaching team innovatively propose the teaching model of "one question and three actions, and four stage cycles", striving to achieve personalized teaching according to individual needs by constructing student group and individual portraits, as shown in Figure 1.

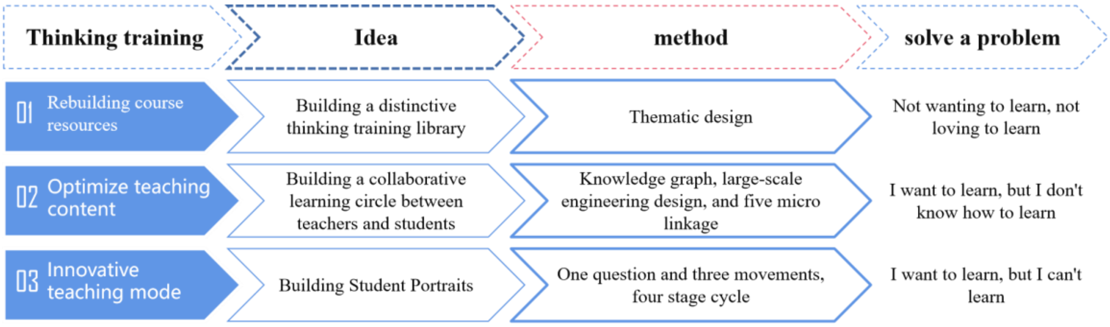

Figure 1: Schematic diagram of course innovation ideas

1) Regarding problem 1, reshape course resources, focus on "thematic design" and "large-scale engineering design", and build a thinking training library with architectural characteristics

The core content of computational thinking is problem solving, system design, and enabling computers to understand human behavior. The characteristics of computational thinking are abstraction and automation. Abstraction means cultivating students' mathematical and logical thinking, while automation means cultivating students' engineering and AI thinking, thereby forming professional thinking. So, the course of computational thinking is a bridge from the understanding of knowledge to the construction of thinking consciousness, and it is a course that combines theory and practice. To this end, the teaching team closely focused on teaching objectives, designed special topics, highlighted architectural characteristics, and constructed five special series of topics: mathematical thinking, logical thinking, engineering thinking, AI thinking, and professional thinking, as shown in Figure 2.

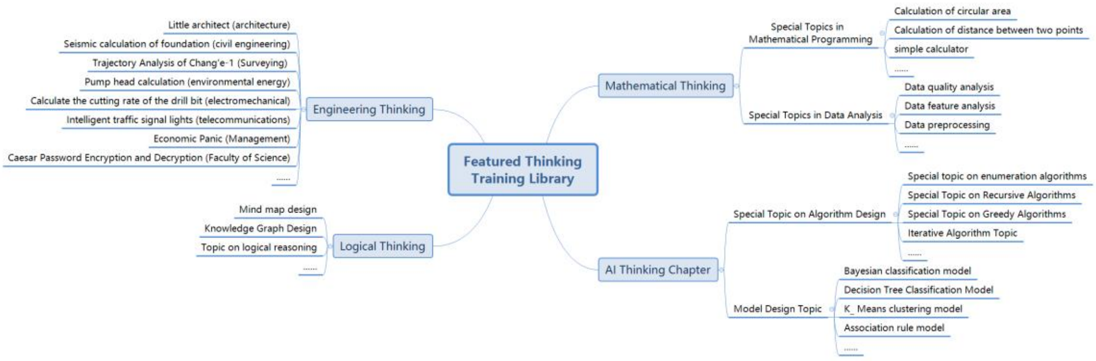

Figure 2: Schematic diagram of a thinking training library with "architectural" characteristics

[Example 1]Calculation of Water Pump Head (School of Environmental Energy)

Title description: The data designed for a certain project is: flow rate of 200 meters ^{3}/h. The loss per 100 meters is 2.1 meters, and the total length of the pipeline is x meters. The vertical height is unknown, and the slope is 30 degrees. We plan to use DN200mm seamless steel pipes, with a required outlet pressure of y kg and a loss of 10 meters per kg. So, what is the head of the water pump? Please use Raptor software to draw a flowchart and run the results.

Input: x and y, separated by a space in the middle

Output: Water pump head

Example input: 1100 10

Sample output: 573.1 meters

[Example 2]Calculating the cutting speed of drill bits (School of Mechanical and Electrical Engineering)

Title description: Using a drill bit with a diameter of D to drill small holes, at the speed of the drilling machine n, try to find the cutting speed of the drill bit? Known cutting speed ν、 The relationship between the drilling diameter d and the drilling machine speed n is: $v = \pi D \cdot n$. Please write code in C language to implement it.

Input: diameter D (mm) and rotational speed n (r/min)

Output: Cutting speed v

Example input: 3 2500

Example output: 23.550

2) Regarding question 2, draw a knowledge graph, design a large-scale project, and build a collaborative learning circle for teachers and students based on the "one flat and three ends" teaching platform

(a) Draw a knowledge graph

Knowledge graph was proposed by Google in 2012, which is a structured semantic knowledge base used to describe concepts and their interrelationships in the physical world in symbolic form. Its basic unit of composition is the "entity relationship entity" triplet, as well as entities and their related attribute value pairs. Entities are interconnected through relationships, forming a network of knowledge structures. Knowledge graph, as an important representation of thinking visualization in the information age, showcases the process and structural relationship of knowledge development. It is an effective way to go beyond shallow knowledge transmission, develop higher-order thinking abilities, and achieve deep learning[3]. The teaching team has drawn a knowledge graph for this course based on the Chaoxing "one flat and three ends" teaching platform. Through the knowledge graph, the mastery of each knowledge point, as well as the mastery of pre-knowledge points, post-knowledge points, and related knowledge points, can be clearly grasped. The content and difficulty of knowledge points can be dynamically adjusted in real-time according to the teaching situation, as shown in Figure 3.

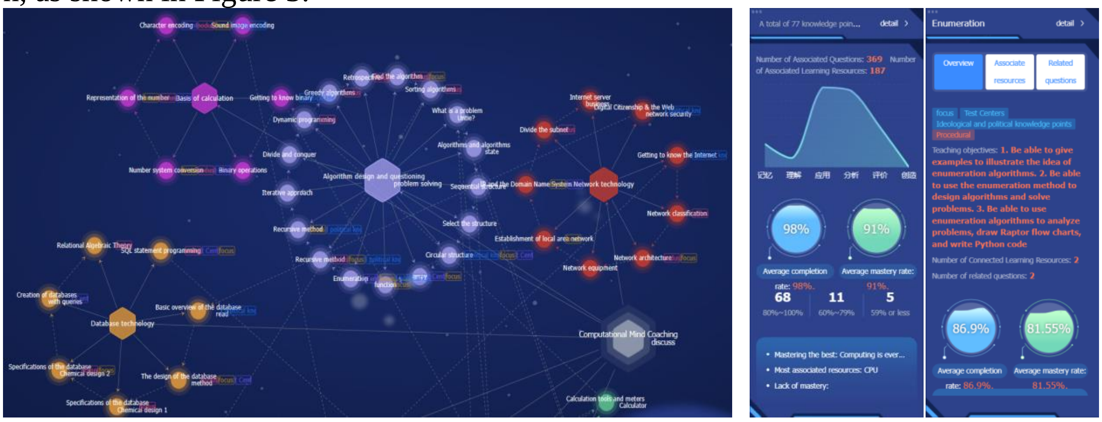

Figure 3: Knowledge Graph (Part) and Schematic Diagram of Achievement of Knowledge Point Objectives

(b) Large scale engineering design

The concept of "big engineering" is an important higher education concept proposed by the country[4]. It is based on the background of big engineering and integrates "big ideological and political" education[5]. Through classic big engineering cases as the main line, it effectively connects knowledge points and guides students to flexibly use the knowledge they have learned, forming a "series of large blocks" that run through the entire teaching process. To this end, the teaching team optimizes the teaching content, dividing knowledge into three modules: basic knowledge, engineering design, and thinking training. Each module focuses on different thinking training and integrates ideological and political content into the curriculum, as shown in Figure 4.

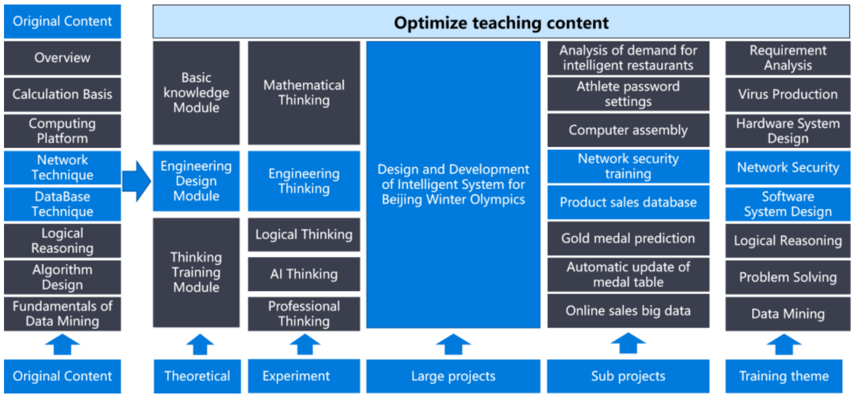

Figure 4: Schematic diagram of engineering thinking training

(c) Building a collaborative learning circle between teachers and students

After threading knowledge into a string, in the actual teaching process, teachers need to constantly grasp the mastery of knowledge points, and at the same time, communicate effectively with students in a timely manner, and adjust the content and difficulty of knowledge points in a timely manner. The teaching team uses the "one flat and three ends" teaching platform of Chaoxing to interact with students in real-time through the "Five Micro Linkages" (Micro book, Micro lesson, WeChat, Micro project, and Micro Forum), answer questions and clarify doubts, jointly build a collaborative learning circle for teachers and students.

3) Regarding question 3, innovatively propose a teaching model of "one question and three actions, and four stage cycles" and construct student portraits

In the teaching process, teachers closely focus on the main theme of the curriculum, "one question and three actions", that is, problem oriented, digging "pits" and burying "thunder" at teaching hot spots, key points, difficulties, and doubts. Students are responsible for stepping on "pits" and eliminating "thunder". These "thunder" are preset questions, and through interactive communication such as answering questions and bullet comments, students are guided to strengthen their foundation, adhere to integrity, and innovate.

Before class, the teacher creates a scenario, uses the Chaoxing teaching platform to push cases and assign tasks, provides student mobile phone information, guides students in selecting topics, tracks the learning situation of each group, and students explore the topic. If there are any questions, the teacher answers them. In class, the teacher creates a scenario, and after the students enter the scenario, the teacher explains the hot topics, key and difficult issues respectively, and interacts with the students using the learning tool. If the students have a translation, they continue to interact at the suspicious points. After class, the teacher assigns experimental tasks, and students receive "four stage cycles" thinking training. The teacher guides the project and evaluates it together with the students, as shown in Figure 5.

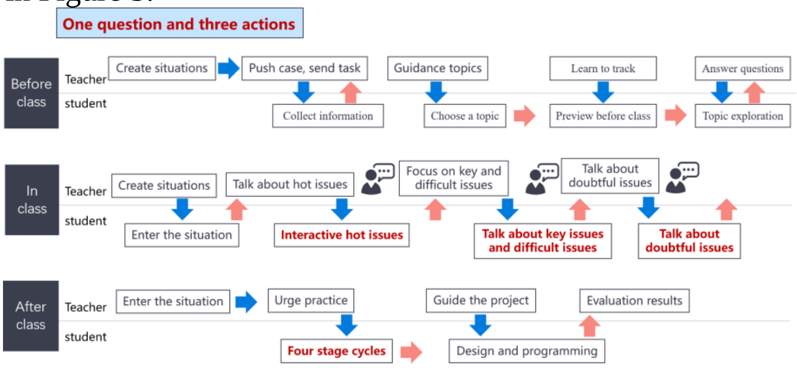

Figure 5: "One Question and Three Actions" Teaching Mode (Theory)

The teaching team will divide the teaching stages into layers, and select ideological training topics (such as password programming topics, logical reasoning topics, algorithm design topics, data mining topics, etc.) based on each stage. The teaching team select appropriate topics according to the difficulty level of knowledge, and guide students in selecting topics; The teaching team divide each chapter's ideological training into four types: basic training, improvement training, challenge training, and characteristic training, with a four stage cycles that progresses layer by layer, repeating the cycle according to the chapter, and spiraling upwards. As shown in Figure 6.

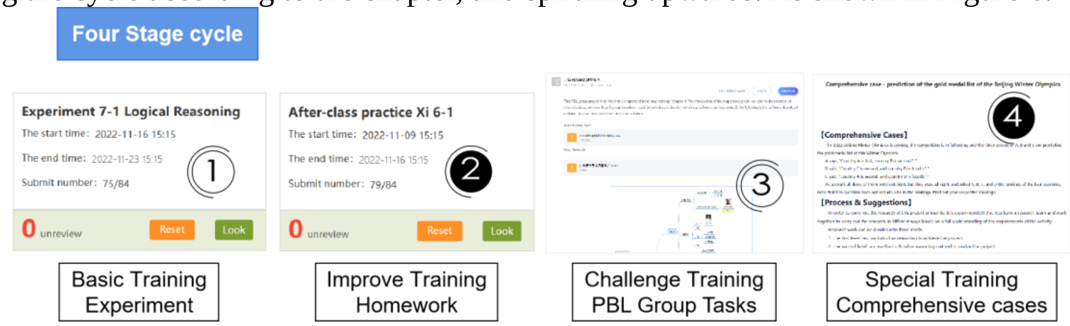

Figure 6: "Four stage cycles" teaching mode (experiment)

Each chapter or module has a "four stage cycles", and after training at four levels and different levels of difficulty, students gradually improve their various thinking abilities. At the same time, the teaching team utilizes platform data to construct student profiles, establish learning warning mechanisms, and achieve personalized teaching according to individual needs.

4. Innovation Effect and Visualization Analysis

Taking Class 221-2 of Shui as an example for statistical analysis, part of the data comes from the direct download of student academic performance data from Chaoxing Learning Pass, and the other part comes from website data statistics. We use Python web crawlers to crawl web data, preprocess the data using the Pandas package, and visualize the data using the Matplotlib package.

1) Analysis of mastery of knowledge points

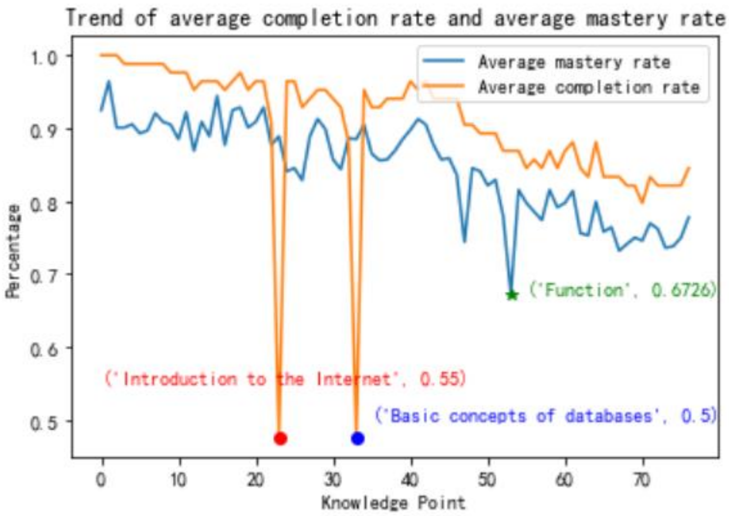

Figure 7: Line chart of average completion rate and average mastery rate of knowledge points

Analysis:

From Figure 7, it can be seen that the course has a total of 77 knowledge points. From the line chart, it can be seen that as the course progresses, both the average completion rate and the average mastery rate gradually decrease. For the average completion rate, there are two knowledge points with a completion rate below 50%, namely "Initial Knowledge Network" and "Basic Database Concepts". Deep level analysis shows that the initial network is self-learning knowledge points with a low completion rate, while "Basic Database Concepts" are abstract concepts, making it difficult to construct an E-R model and the completion rate of E-R graph drawing is not high. For the average mastery rate, only the knowledge point of "function" is lower than 70%, indicating that this knowledge point is difficult, and students need to further improve their recursive programming ability.

(a) Analysis of the average mastery rate and completion rate of student knowledge

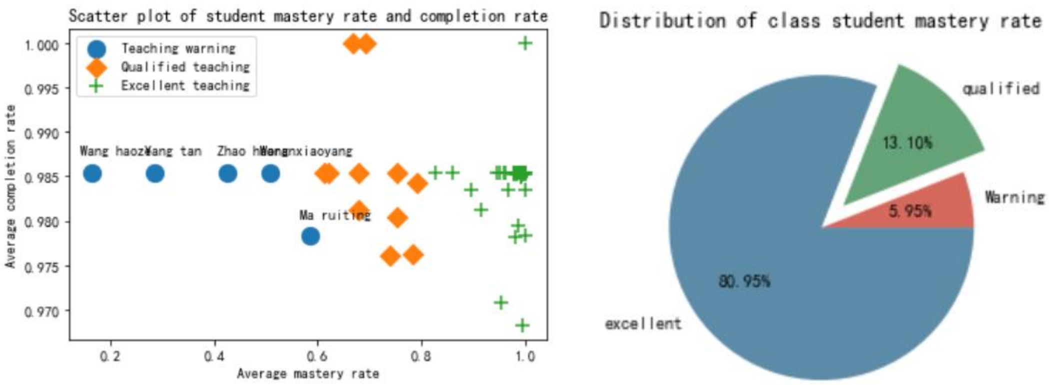

Figure 8: Visual analysis of average completion rate and average mastery rate of students

Analysis:

From Figure 8, it can be seen that there are 84 students in the class, of which 5 students have an average mastery rate below 60%, accounting for 5.95%. It is necessary to send teaching warnings to these 5 students and timely monitor their subsequent learning progress. There are 11 students with an average mastery rate between 60% and 80%, accounting for 13.10%. The vast majority of students have an average mastery rate of over 80%, accounting for 80.95%.

2) Student Portrait

Student portraits abstract labeled student models based on their learning behavior data, aiming to achieve the goal of seeing data like seeing people[6]. Student portraits include group portraits and individual portraits of students. The teaching team determined six types of personal profile labels for students based on data from the Chaoxing platform: classroom interaction points, learning type, classroom attendance, task completion rate, learning scores, and platform learning frequency, as shown in Figure 9.

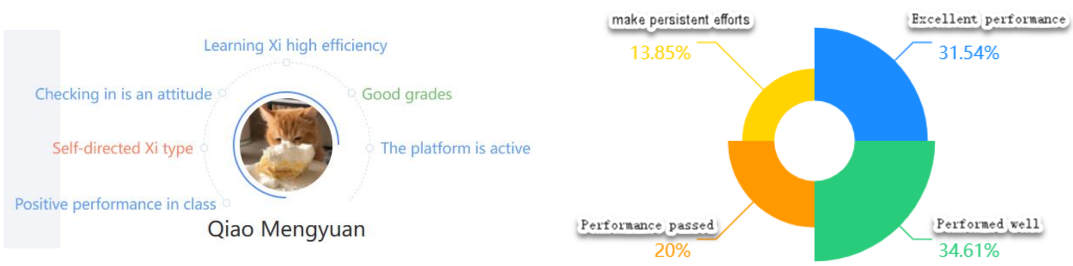

Figure 9: Personal and group portraits of students

Analysis:

From Figure 9, it can be seen that in student profiles, classroom interaction scores exceeding 80% indicate positive classroom performance, 60% -79% indicate average classroom performance, and scores below 60% indicate negative classroom performance; The types of learning are divided into self-directed learning and passive learning. Those who participate in discussions, experiments, PBL group activities, and complete task points within the specified time are considered self-directed learning, while those who do not meet the standards are considered passive learning; Those who meet the standards for attendance in class are considered qualified, while those who do not meet the standards are considered unqualified; Those who complete the task points within the specified time and meet the standards are considered to have high learning efficiency, while those who meet the standards are considered to have low learning efficiency; The grades are rated at five levels: excellent, good, average, passing, and failing; If the learning login system meets the specified time, the platform is active, and vice versa. In student group portraits, use a circle chart to represent the percentage of excellent, good, average, and passing students.

5. Conclusion

The course team has built a thinking training library with significant architectural characteristics; A collaborative learning circle between teachers and students has been constructed through drawing knowledge graphs, large-scale engineering design, and "five micro linkage"; And integrate reforms in the teaching process, achieving good results in practice. Innovatively proposed the teaching model of "one question and three actions, and four stage cycles", and used the big data of the Chaoxing platform to draw student group portraits and individual portraits. Good teaching results were achieved during the teaching process.

Acknowledgement

Fund projects: 2023 Beijing Digital Education Research Project (No. BDEC2023619041), 2023 Beijing Education Science 14th Five Year Plan Project (No. CDDB23218), 2023 China Construction Education Association Education Teaching and Research Project (No. 2023087), and Beijing University of Civil Engineering and Architecture Campus Teaching and Research Project (No. BJ202002).

References

[1] Qin Ying; Song Yinqiu. Curriculum Construction of Blended Learning Xi Based on the "one flat and three ends" Smart Teaching System: A Case Study of "Advanced English".[J]. Journal of Wuzhou University. 2022(10):58-64.

[2] Xue Ying. The application of "one flat and three ends" in the course of mechanical measurement technology[J]. Ship vocational education. 2022(03):22-24, 28.

[3] Zhang Yuan; Liang Yin. Research on the Construction of Knowledge Graph of Secondary Vocational Courses from the Perspective of Deep Learning Xi: A Case Study of "Information Technology" Course[J]. The computer age. 2023(08):89-97

[4] Liu Jiangli; Zhang Haiguang; Liu Li. Construction of general course of quality engineering and precision measurement in the context of large-scale engineering [J]. China's educational technology equipment. 2022(12):58-64.

[5] Xiong Chunhong; Zhang Jiayan; Liu Junping etc. Exploration and Practice of Teaching Reform of Food Major under the Integration of the Concept of "Great Ideology and Politics" and "Big Project": A Case Study of Nanchang University [J]. Contemporary agricultural machinery. 2021(12):73:74

[6] Liu Renjia. Accurate ideological and political exploration based on the analysis of college students' portraits [J]. Journal of Shanghai Second Polytechnic University. 2023(12):1-8