Construction and Application of Intelligent Adaptation System for Higher Vocational Training Courses Based on AI Large Model

Li Yin[1], Congjun Li[1], Aidi Xie[2]
[1]School of Bio-Engineering, Hubei Vocational College of Bio-Technology, Wuhan 430070, Hubei, China
[2]Department of Biochemical Engineering, Hubei University of Technology Engineering and Technology College, Wuhan 430068, Hubei, China
Corresponding author: Aidi Xie (e-mail: xad0952@163.com).

ABSTRACT Aiming at the prominent problems of solidified training content, single teaching mode, inconsistent individual learning levels of students, and disconnection between training teaching and industrial post demands in higher vocational practical training teaching, this paper constructs an intelligent adaptation system for higher vocational training courses based on AI large model. Combined with the characteristics of vocational education skill training, the system builds a four-layer overall architecture including data perception layer, large model algorithm layer, intelligent adaptation service layer and teaching application layer, and designs a closed-loop adaptation mechanism of "student portrait modeling - post demand matching - course resource dynamic adjustment - teaching effect feedback optimization". Based on fine-tuning the industry vertical large model, the paper realizes personalized learning path planning, intelligent matching of training resources, real-time error diagnosis in training operation and dynamic iteration of course content. Through the teaching application experiment of multiple vocational majors, the results show that the system can effectively solve the problem of heterogeneous learning adaptation in vocational training, significantly improve students' practical operation ability and independent learning efficiency, and realize the precise docking of training courses and industrial post competency requirements. The system provides a new technical scheme and teaching reform path for the digital and intelligent upgrading of higher vocational training teaching, and has good popularization and application value.

INDEX TERMS AI Large Model; Higher Vocational Education; Training Course; Intelligent Adaptation; Student Portrait; Precision Teaching

I. INTRODUCTION

A. RESEARCH BACKGROUND

With the in-depth advancement of educational digitalization strategy and the rapid iteration of industrial intelligent transformation, higher vocational education, as the main position for cultivating high-quality technical and skilled talents, puts forward higher requirements for the precision and intelligence of practical training teaching. Traditional higher vocational training courses adopt unified teaching content and fixed training progress, which cannot adapt to the differences in students' basic knowledge, practical operation ability and learning acceptance speed. At the same time, the update speed of traditional training curriculum resources lags behind the iteration speed of industrial post skills, resulting in the disconnection between training teaching and enterprise actual employment demands, and the low efficiency of talent training.

In recent years, AI large model technology has made breakthrough progress in natural language processing, data mining, intelligent decision-making and other fields, and has been gradually applied to the field of education and teaching. The generative ability and intelligent perception ability of large models provide technical support for breaking through the bottleneck of personalized adaptation of vocational training courses. How to use AI large model to mine students' learning characteristics and industrial post competency demands, realize the intelligent matching and dynamic adaptation of training course content, resources and teaching progress, and build a closed-loop intelligent training teaching system has become a key research hotspot in the digital teaching reform of modern higher vocational education.

B. RESEARCH STATUS

At present, domestic and foreign scholars have carried out a series of researches on intelligent adaptive teaching in vocational education. In terms of personalized teaching, some researchers build student learning portraits based on learning behavior data, realizing the preliminary classification of students' learning levels. In terms of curriculum optimization, scholars use big data technology to analyze industrial post demands and complete the modular design of training courses. However, most of the existing researches rely on traditional machine learning algorithms, which have problems such as insufficient mining depth of learning data, low accuracy of student portrait modeling, and poor dynamic adaptation ability of curriculum resources.

In the field of large model empowered vocational teaching, the existing researches mostly focus on classroom auxiliary teaching and intelligent resource generation, while systematic research on full-process intelligent adaptation for skill-oriented vocational training courses remains insufficient. There is a lack of closed-loop system architecture integrating student evaluation, curriculum adjustment, teaching implementation and effect optimization, which cannot meet the personalized and industrialized development needs of higher vocational training teaching. Therefore, it is urgent to construct a full-scene intelligent adaptation system of training courses based on AI large model to make up for the deficiencies of existing teaching modes.

C. RESEARCH SIGNIFICANCE AND INNOVATION

Theoretical significance: This paper constructs a theoretical model of intelligent adaptation of higher vocational training courses driven by AI large model, clarifies the logical relationship between student individual differences, industrial post demands and curriculum resource adaptation, enriches the theoretical system of digital vocational education, and provides theoretical reference for the intelligent reform of vocational practical training teaching.

Practical significance: The system realizes the whole-process intelligent management of training teaching, solves the pain points of unified teaching and inaccurate talent training in traditional training courses, improves the pertinence and effectiveness of vocational skill training, and helps higher vocational colleges cultivate high-skilled talents matching industrial intelligent development.

Research innovation:

(1) A four-layer intelligent adaptation system architecture integrating data perception, algorithm processing, service application and teaching practice is proposed to realize full-coverage intelligent empowerment of training teaching links;

(2) A vertical fine-tuning strategy of industry large model oriented to vocational training scenarios is designed to improve the accuracy of student portrait modeling and curriculum demand matching;

(3) A closed-loop dynamic adaptation mechanism of "evaluation-matching-adjustment-optimization" is constructed to realize the sustainable iteration of training courses.

II. KEY TECHNOLOGIES AND THEORETICAL BASIS

A. AI LARGE MODEL FINE-TUNING TECHNOLOGY

This system adopts the domestic open-source industrial large model as the basic model, and carries out scenario-based fine-tuning combined with higher vocational training teaching data and enterprise post competency data. Through supervised fine-tuning (SFT) and reinforcement learning human feedback (RLHF) technology, the model's understanding ability of vocational training scenarios, skill operation standards and post demand characteristics is optimized. The fine-tuned large model can accurately identify students' operation errors, mine learning weakness, and intelligently match personalized training resources and learning paths.

B. STUDENT PORTRAIT MODELING TECHNOLOGY

Based on multi-source learning data such as students' pre-class assessment results, in-class operation behavior, training error records and after-class learning feedback, the system constructs a multi-dimensional student portrait system including basic learning ability, practical operation level, knowledge mastery degree and learning preference. Through the large model data mining and feature extraction function, it realizes quantitative evaluation of students' individual learning differences, and provides data support for personalized curriculum adaptation.

C. INTELLIGENT CURRICULUM ADAPTATION THEORY

Taking constructivist learning theory and competency-based education theory as the core, combined with the vocational education principle of "post-course docking", the system takes student individual differences and industrial post competency standards as the dual adaptation basis, realizes the dynamic matching of training course content, training difficulty, teaching progress and resource type with students' learning level and post skill demands, and achieves the core teaching objectives of individualized instruction and precise vocational talent cultivation.

III. SYSTEM OVERALL ARCHITECTURE DESIGN

Combined with the business process and teaching characteristics of higher vocational practical training, this paper builds a full-scene intelligent adaptation system for training courses based on AI large model, which is divided into four core layers from bottom to top: data perception layer, large model algorithm layer, intelligent adaptation service layer and teaching application layer. The overall system architecture is shown in Figure 1.

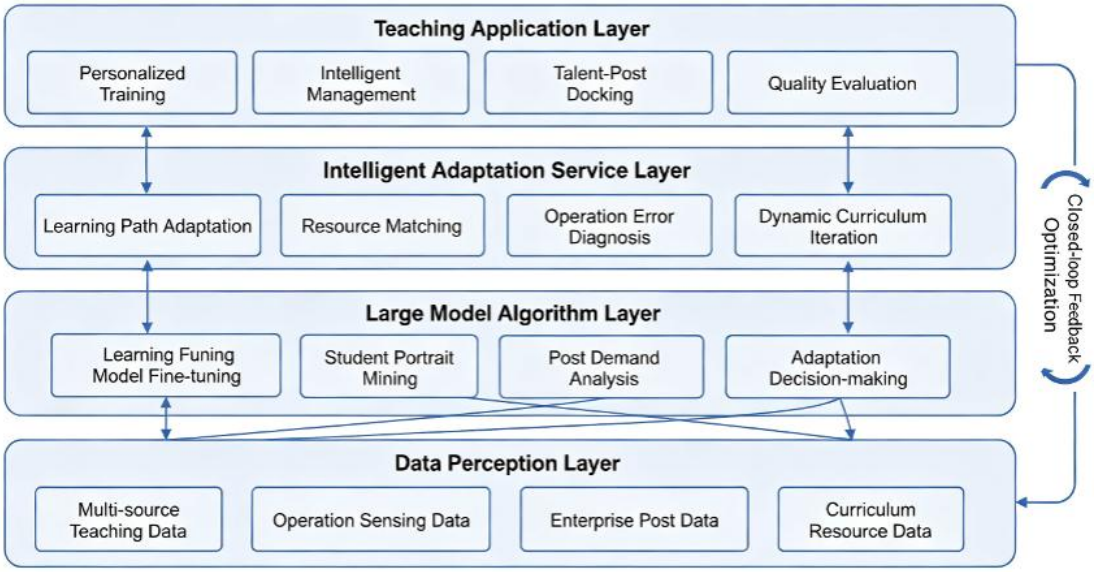

FIGURE 1. Overall layered architecture of the proposed intelligent adaptation system for higher vocational training courses

(1) Data Perception Layer

It undertakes the collection of multi-dimensional data for practical training and teaching, including student learning behavior data, teacher teaching data, training operation data, enterprise post competency data and curriculum resource data. Via sensors on training equipment, terminals of teaching platforms and enterprise data interfaces, this layer realizes real-time collection and standardized storage of structured and unstructured data, providing raw data support for model training and intelligent adaptation.

(2) Large Model Algorithm Layer

As the core computing layer of the system, it performs industry scenario fine-tuning, feature extraction for student portraits, mining of post demands, curriculum adaptation decision-making and learning effect evaluation based on the foundational large model. It enables intelligent analysis of multi-source data and automatic generation of adaptation schemes, and supports all intelligent service functions of the upper layer.

(3) Intelligent Adaptation Service Layer

It encapsulates core service modules, including personalized learning path adaptation, intelligent matching of training resources, intelligent diagnosis of operational errors, dynamic iteration of curriculum content, and real-time feedback on teaching effects. It achieves intelligent connection between algorithm outputs and teaching businesses, and delivers customized service support for teachers and students.

(4) Teaching Application Layer

It refers to the terminal application scenarios of the system, covering personalized practical training for students, intelligent teaching management for teachers, teaching quality evaluation of schools, and talent matching for enterprise posts. It facilitates the practical implementation of intelligent adaptation functions in real practical training and teaching.

IV. SYSTEM CORE FUNCTION MODULE DESIGN

A. MULTI-DIMENSIONAL STUDENT PORTRAIT CONSTRUCTION MODULE

The system builds a student portrait label system covering four dimensions and 12 secondary indicators, including basic learning quality, practical operation ability, learning state characteristics and skill development potential. The AI large model automatically mines student learning data, generates quantitative portrait scores and visual learning thermal maps, and accurately locates students' knowledge blind spots and operation weaknesses. According to the portrait results, students are divided into basic level, improvement level and excellent level, which provides classification basis for personalized curriculum adaptation. The student portrait indicator system is shown in Table 1.

TABLE 1.

Primary Dimension	Secondary Indicators	Evaluation Standard
Basic Learning Quality	Professional basic knowledge mastery, pre-training assessment score, theoretical learning efficiency	Quantitative scoring based on platform test data
Practical Operation Ability	Operation standardization, error rate, task completion efficiency, equipment operation proficiency	Intelligent recognition and scoring by large model combined with operation video
Learning State Characteristics	Learning initiative, problem-solving ability, learning persistence, interactive participation	Data mining and feature analysis of learning behavior track
Skill Development Potential	Skill innovation ability, knowledge migration ability, post adaptation potential	Comprehensive evaluation based on learning growth trend

B. DUAL-DRIVEN CURRICULUM INTELLIGENT ADAPTATION MODULE

Different from the traditional single student-oriented adaptive mode, this system adopts a dual-driven adaptation strategy of student individual difference + industrial post demand. On the one hand, according to the student portrait level, the system adaptively adjusts the training difficulty, task quantity and teaching progress, and pushes personalized training tasks and auxiliary resources; on the other hand, through the large model mining enterprise post competency standards and industry skill iteration trends, it dynamically updates the training curriculum content, eliminates outdated skill knowledge points, and supplements cutting-edge industrial technologies and standardized post operation specifications.

The module realizes three core adaptation functions: first, hierarchical adaptation of training tasks, matching basic, improvement and innovative training tasks for students of different levels; second, intelligent adaptation of teaching resources, pushing videos, drawings, operation guidelines and case resources matching students' learning weaknesses; third, dynamic adaptation of curriculum system, realizing real-time iteration of training content based on industrial post demand changes.

C. WHOLE-PROCESS INTELLIGENT TEACHING DIAGNOSIS AND FEEDBACK MODULE

Relying on the real-time perception ability of AI large model, the system realizes whole-process intelligent diagnosis of training teaching. In the pre-training stage, it completes student ability pre-evaluation and generates personalized training plans; in the training process, it real-time recognizes students' non-standard operation behaviors, automatically marks abnormal error points, and pushes targeted corrective guidance; after the training, it comprehensively evaluates the training effect, generates learning analysis reports, and forms a closed-loop feedback mechanism of "pre-evaluation - in-process guidance - post-optimization". The teaching diagnosis process is shown in Figure 2.

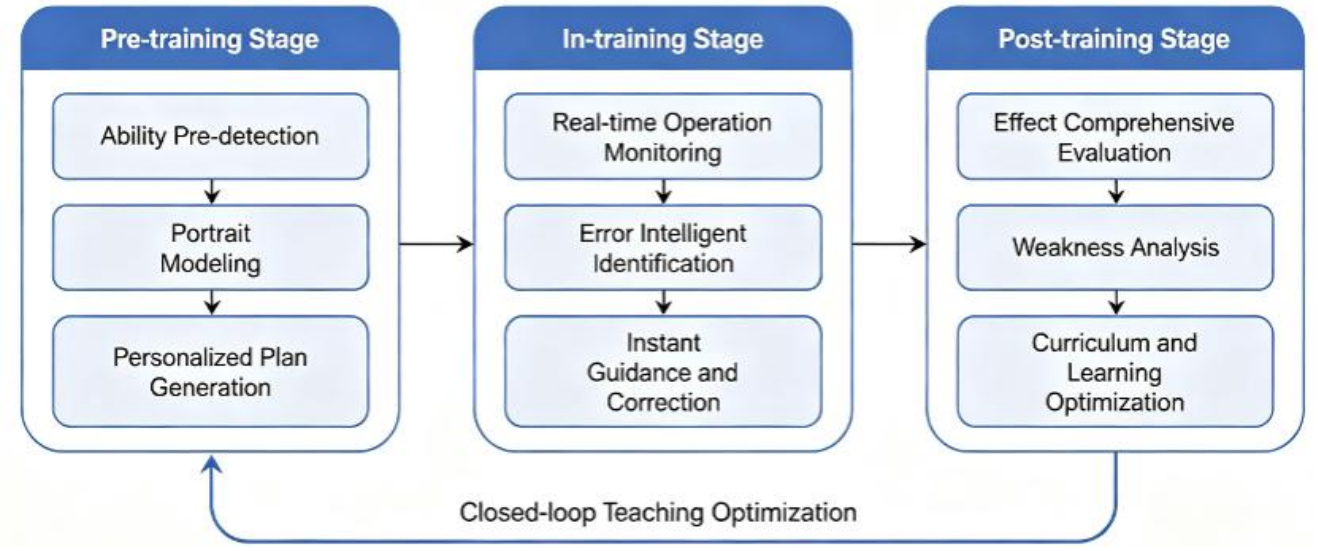

FIGURE 2. Full-process closed-loop intelligent diagnosis and feedback flowchart of vocational training teaching

D. TEACHING QUALITY INTELLIGENT EVALUATION MODULE

The system constructs a multi-dimensional intelligent evaluation system for training teaching quality, covering student learning effect, teacher teaching quality and curriculum adaptation effect. The large model automatically analyzes teaching big data, quantitatively evaluates the improvement of students' practical skills, the rationality of teacher teaching arrangement and the matching degree between curriculum content and post demands, generates regular teaching quality evaluation reports, and provides data basis for school teaching management and curriculum reform.

V. SYSTEM IMPLEMENTATION AND APPLICATION EXPERIMENT

A. EXPERIMENTAL ENVIRONMENT AND OBJECT

This experiment selects two parallel classes of mechanical manufacturing and automation major in a higher vocational college as the research objects, with 45 students in each class. The experimental class adopts the AI large model-based intelligent adaptation system for training teaching, and the control class adopts the traditional unified training teaching mode. The experimental period is one semester (18 weeks), and the training content is mechanical parts processing and equipment maintenance professional training. The system deployment environment adopts cloud server + local terminal architecture, and the large model is deployed in a private cloud to ensure data security and operation stability.

B. EXPERIMENTAL EVALUATION INDICATORS

In order to verify the application effect of the system, four core evaluation indicators are set: training task completion rate, operation qualification rate, student learning satisfaction and post skill matching degree. Through the collection of teaching platform data, student questionnaire survey and enterprise post evaluation data, the teaching effects of the two teaching modes are compared and analyzed.

C. EXPERIMENTAL RESULT AND ANALYSIS

After one semester of teaching experiment, the comparative data of teaching effect between the experimental class and the control class is shown in Table 2. It can be seen from the experimental data that compared with the traditional teaching mode, the intelligent adaptation system has significantly improved all evaluation indicators.

TABLE 2.

Evaluation Indicators	Control Class (Traditional Teaching)	Experimental Class (Intelligent Adaptive Teaching)	Improvement Rate
Training Task Completion Rate	82.3%	96.8%	14.5%
Operation Qualification Rate	78.6%	94.2%	15.6%
Student Learning Satisfaction	80.5%	95.3%	14.8%
Post Skill Matching Degree	76.2%	93.5%	17.3%

In terms of learning effect, the task completion rate and operation qualification rate of students in the experimental class are significantly higher than those in the control class, which indicates that the personalized adaptive teaching mode can effectively adapt to students' individual learning differences, solve the problems of difficult learning for poor foundation students and insufficient learning challenge for excellent students, and improve the overall training teaching quality. In terms of talent training quality, the post skill matching degree of the experimental class is increased by 17.3%, which verifies that the system can effectively realize the docking of training courses and industrial post demands and improve the pertinence of talent training.

In terms of learning experience, students' learning satisfaction is significantly improved. Questionnaire results show that most students think the intelligent adaptive system can accurately locate their own learning weaknesses, provide targeted learning guidance and resources, change the passive learning state of traditional training, and effectively improve independent learning ability and practical operation level. The histogram and line comparison curve of core evaluation indicators is shown in Figure 3, which intuitively reflects the significant improvement of teaching effect after adopting the intelligent adaptation system.

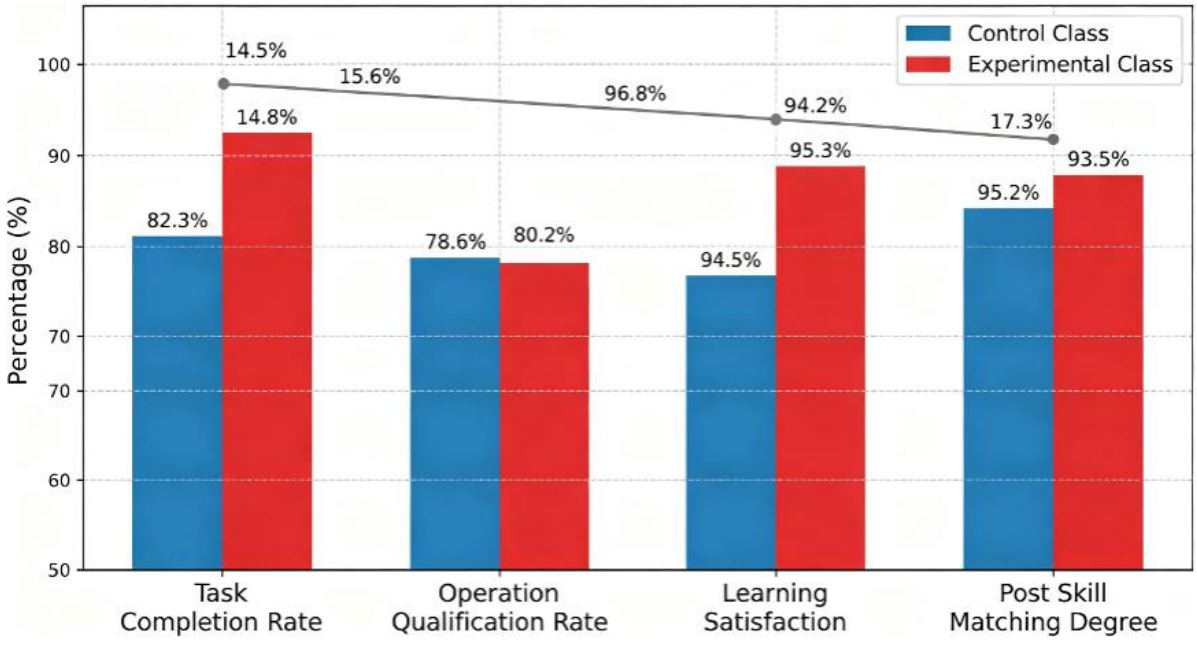

FIGURE 3. Quantitative comparison of teaching effect indicators between experimental class and control class

To intuitively verify the practical application effect of the proposed intelligent adaptation system, this paper conducts a quantitative comparative analysis of four core evaluation indicators between the experimental class (intelligent adap-

tive teaching) and the control class (traditional teaching). As shown in the indicator comparison data, all indexes of the experimental class are significantly better than those of the control class. Specifically, the training task completion rate increased from 82.3% to 96.8%, the practical operation qualification rate increased from 78.6% to 94.2%, student learning satisfaction increased from 80.5% to 95.3%, and industrial post skill matching degree increased from 76.2% to 93.5%, with all indicators achieving a growth rate of more than 14%. The data results fully prove that the AI large model-driven intelligent adaptation system can effectively make up for the defects of homogenized traditional teaching, significantly improve students' practical skill level and autonomous learning ability, and realize the precise docking between vocational training and industrial post competency requirements, with excellent teaching application value and popularization significance.

D. SYSTEM APPLICATION ADVANTAGES

Compared with the traditional vocational training teaching system, the AI large model-based intelligent adaptation system has three obvious application advantages: First, it realizes the transformation from "uniform teaching" to "personalized teaching", breaks through the limitation of fixed teaching mode, and realizes teaching students in accordance with their aptitude; second, it realizes the dynamic iteration of courses driven by industrial data, solves the problem of curriculum content lagging behind industrial development, and improves the industrial adaptability of talent training; third, it realizes the whole-process data-based intelligent management of training teaching, reduces the repetitive teaching work of teachers, and improves teaching efficiency and quality.

VI. RESEARCH CONCLUSION AND PROSPECT

A. RESEARCH CONCLUSION

Aiming at the existing problems of higher vocational training teaching, this paper constructs an intelligent adaptation system for higher vocational training courses based on AI large model, designs the overall system architecture and core functional modules, and realizes the organic integration of AI large model technology and vocational practical training teaching. The system builds a multi-dimensional student portrait evaluation system and a dual-driven curriculum intelligent adaptation mechanism of student difference and post demand, realizes personalized learning path planning, intelligent resource matching, whole-process teaching diagnosis and dynamic curriculum iteration.

The teaching experiment results verify that the system can significantly improve the completion quality of vocational training tasks, students' practical operation ability and post skill matching degree, effectively solve the pain points of traditional training teaching, and provide a new intelligent teaching solution for the digital transformation of higher vocational education.

B. RESEARCH PROSPECT

At present, the system has achieved good application results in mechanical manufacturing majors. In the follow-up research, we will further expand the application scope of the system, carry out adaptive optimization for different vocational majors such as electronic information, automobile maintenance and e-commerce, and build a universal intelligent adaptation system for vocational training courses.

At the same time, we will further optimize the large model fine-tuning algorithm, improve the accuracy of student portrait modeling and curriculum adaptation decision-making, integrate virtual simulation training technology, build a virtual-real integrated intelligent training teaching scene, and further improve the intelligent level and application value of vocational training teaching.

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