Innovation and Practice of Database Teaching in Higher Vocational Education under the Teacher-AI-Student Tripartite Synergistic Framework

Fang Li

College of Computer Science, Wuhan Vocational College of Software and Engineering, Wuhan Open University, Wuhan, China

1558731947@qq.com

Abstract. In view of some difficulties existing in database teaching in higher vocational colleges, such as difficulty in understanding abstract concepts, lack of practical ability, students' low enthusiasm in class, and difficulty in teaching students in accordance with their aptitude, this paper proposes and practices a "teacher AI student" ternary collaborative teaching framework based on generative artificial intelligence (AI) model. The framework takes the large language model based on transformer architecture (such as deepseek) as the core technical support, combines fine tuning, AST analysis, knowledge map and parametric exercise generation algorithm, and designs intelligent teaching modules such as dialogue question answering, real-time error correction, dynamic case generation, etc. A 16 week teaching control experiment (37 in the experimental group and 34 in the control group) was carried out. The experimental research shows that the framework can significantly improve the students' SQL operation accuracy (19.7%), concept understanding level (11.5%) and practical efficiency (the completion time is shortened by 38.7%). This study constructs a new teaching mode of "teacher led, student-centered, AI supported", which reflects the systematic integration of AI technology and education scene, and provides an operable practice path for Vocational Education in the intelligent era.

Keywords: AI large model, Higher vocational education, Database teaching, Ternary synergy, Teaching innovation.

1 Introduction

1.1 Research Background

The vocational education informatization 2.0 action plan clearly puts forward the need to promote the deep integration of intelligent technology and education [1]. At the same time, the generative artificial intelligence technology has made a breakthrough, and the large language model with transformer architecture as the core has shown strong ability in natural language understanding and generation [2], providing a new technical tool for educational innovation [3]. In the database course of higher vocational education,

C. F. Peng et al. (eds.), *Proceedings of the 2026 5th International Conference on Humanities, Wisdom Education and Service Management (HWESM 2026)*, Advances in Social Science, Education and Humanities Research 1024,
https://doi.org/10.2991/978-2-38476-593-5_26

the traditional teaching mode is faced with challenges such as abstract concept (such as paradigm theory), insufficient practice guidance, and large differences in students' foundation, which urgently needs the teaching reform of technology empowerment.

1.2 Research Significance

This study has theoretical value and practical significance. At the theoretical level, the research focuses on the application scenarios of intelligent technology in vocational education, and explores the theoretical basis and practical path of the new teaching paradigm of "human-computer cooperation", which further enriches the research content of vocational education informatization and teaching theory, and provides a new perspective for the improvement of the relevant theoretical system.

From a practical point of view, the value of research is mainly reflected in the following aspects:

Promoting education equity: AI can provide non discriminatory, all-weather learning support and alleviate the problem of uneven resources.

Support scale personalized teaching: realize differentiated teaching through dynamic path planning and content generation.

Empowering teachers' Professional Development: Liberate teachers from repetitive work and have more time and energy to focus on teaching design, thinking inspiration and emotional care.

Cultivate students' high-level ability: enable students to focus more on problem solving, system design and innovative practice.

2 Theoretical Basis of Teaching Application of AI Big Model

2.1 AI Assisted Instruction Design Based on Constructivist Learning Theory

Constructivist learning theory emphasizes the active constructive role of learners in the learning process. The theory holds that knowledge is not acquired through passive reception, but is gradually formed by learners in a specific situation, with the help of teachers, learning partners and other people, with the support of teachers, peers, and learning materials [4].

This theory is highly consistent with the application of AI model in MySQL database teaching. Taking students' learning of E-R model as an example, when students ask questions about this knowledge point, the AI model can not only provide clear and detailed answers, but also help students sort out ideas and deepen understanding through step-by-step guidance. This interactive mode is very similar to the process in which students actively explore knowledge under the guidance of teachers or peer collaboration in the constructivist learning environment. Some scholars have confirmed through relevant research that this kind of interactive learning method can enable students to continuously find knowledge loopholes, supplement cognitive blind spots, and gradually improve their own knowledge system in the dialogue and communication with the large model[5].

2.2 Teaching Optimization Based on Cognitive Load Theory

Cognitive load theory suggests that human cognitive resources are limited. In the process of learning, if the difficulty of the information to be processed exceeds the scope of cognitive load, it is easy to cause the problem of cognitive overload, which will have a negative impact on the learning effect [6].

This theory has been well applied in teaching multi table join queries in AI assisted databases. In practical teaching scenarios, AI models will use a layered and progressive teaching strategy to carry out teaching activities based on the core logic of cognitive load theory. At the beginning of teaching, students will be presented with simple and easy to understand query cases to help them quickly understand the basic operation steps of multi table connection queries; As the learning progresses, gradually increase the complexity of the query task, and clearly explain the specific impact of each operation on the result set during the explanation of each step. This teaching arrangement, which progresses from shallow to deep and layers by layers, allows students to gradually understand the execution logic of complex query statements within their own cognitive ability, effectively reducing cognitive pressure during learning and ultimately significantly improving learning efficiency.

3 Design of teaching practice scheme

3.1 Construction of "Teacher AI Student" Ternary Collaborative Framework

Around the needs of teaching practice, this study built a collaborative teaching framework of "teacher led, student-centered, AI supported" (as shown in Fig. 1). The core goal of this framework design is to achieve human-machine complementarity, process optimization, and learning experience upgrading by integrating teachers' educational experience, students' learning initiative, and AI technology advantages.

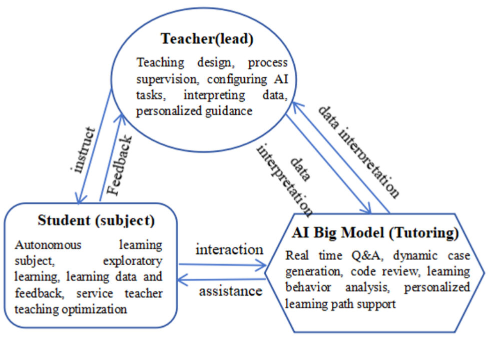

Fig. 1. "Teacher AI student" ternary collaborative framework

1) As the chief designer of teaching, teachers coordinate goal setting, situational creation, task arrangement, learning supervision, and value guidance, and use intelligent tools to undertake basic teaching affairs, focusing on core educational processes such as thinking inspiration, discussion organization, personalized intervention, and emotional support.

2) The AI big model provides four major supports: real-time Q&A, personalized content adaptation, process effect tracking, and learning data analysis, in a "one-on-one" exclusive assistant mode. It is available 24/7 online to provide adaptive learning support for students.

3) Under the guidance of the teacher's task framework and personalized path of intelligent tools, students use exploratory, project-based learning and continuous interactive practice to sort out the knowledge framework, strengthen skill application, and construct a database knowledge and skill system that fits their own cognition.

3.2 Technical Realization

In order to support the effective operation of the "teacher AI student" ternary collaborative teaching framework, this study uses the deepseek large language model based on transformer architecture as the core engine, and systematically customizes and optimizes the functions around the database teaching scenario. The technical implementation mainly includes the following four modules:

Dialog Engine. The fine tuning method is used to fit the pre training model. The training corpus is derived from the previously accumulated database teaching materials, including common question and answer, typical error cases, SQL programming examples, etc. (more than 30000 question and answer pairs), which improves the accuracy of the model's response to SQL syntax and database concepts, supports multiple rounds of interaction, and combines the dialogue history for coherent semantic understanding and reasoning guidance.

Real Time Error Correction Module. The module adopts the strategy of combining rule matching with abstract syntax tree (AST) analysis. Real time parsing and error location of SQL statements input by students. The system will mark the location of the error in real time and give suggestions for modification. At the same time, it will provide relevant grammar instructions and correct examples to help students understand the root cause of the error.

Dynamic Case Generation. Based on the teaching knowledge map and ability model, a set of parameterized exercise generation algorithm is designed. The system dynamically adjusts the difficulty parameters of the questions (such as the number of tables involved in the query, where condition complexity, etc.) according to the students' recent learning performance (such as the correct answer rate, response time, error type distribution, etc.), automatically generates hierarchical practice questions, and supports adaptive learning paths[7].

Learning Situation Tracking and Visualization. the system completely records students' learning interaction data, automatically generates multi-dimensional learning report through the analysis engine, and visually presents the learning progress, knowledge weaknesses and ability distribution to teachers with the help of visual dashboard. The system supports early warning mechanism, which can automatically mark students with learning difficulties or repeated errors, and help teachers achieve precise intervention[8].

3.3 Framework Based Hybrid Teaching Process Reconstruction

Based on the "teacher AI student" ternary collaborative framework constructed above, this study further reconstructs the teaching process of database course into a hybrid teaching mode of "double line integration and three-stage progression" (the specific model is shown in Figure .2). This model takes "teacher led AI support student-centered" as the logical main line, runs through the whole process before, during and after class, and realizes the organic unity of structured knowledge and personalized learning.

"Double line integration" means that the two teaching paths complement each other. Line a (traditional teaching module) ensures the systematicness and standardization of the knowledge system. Line B (AI enhancement module) provides personalized and adaptive learning support based on the large model to solve the "one size fits all" problem.

The "three-stage progression" is embodied in the phased design of teaching process and the ability gradient promotion:

Pre Class - Intelligent Preview and Diagnosis. AI generates guided questions and micro assessment content according to the topics published by teachers, and students complete preview in interaction. AI synchronously records the learning situation data and feeds it back to teachers in visual form to help teachers "determine teaching by learning".

In Class - Precise Teaching and Immersion Practice. Teachers give intensive lectures on common problems in preview and release project tasks. AI acts as a "classroom assistant" (B1) to answer questions in real time, and as a "coding coach" (B2) to provide real-time error correction and optimization suggestions for SQL practice. Teachers' patrol guidance focuses on guiding thinking expansion and collaborative reflection, forming a closed loop of "explanation practice feedback optimization".

After Class - Personalized Development and Continuous Evaluation. AI, as a "case generator" (B3), provides hierarchical homework resources, and as an "automatic reviewer", conducts multidimensional evaluation and feedback on the submitted code, supporting students' iterative practice.

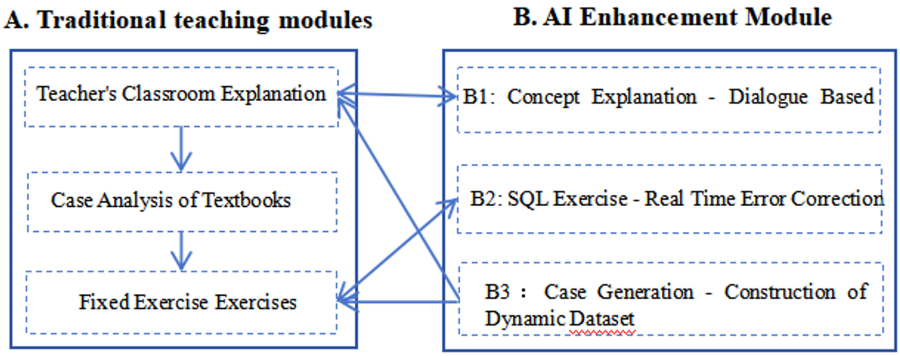

Fig. 2. Curriculum Refactoring Model Diagram

3.4 Typical Application Scenarios and Teaching Value

This study designed the following four AI enhanced teaching scenarios to reflect its practical application value in the database course:

Intelligent Tutoring. For SQL syntax problems raised by students (such as "where clause cannot filter null values"), AI can immediately feed back the standard writing methods and principles to help students quickly master grammar rules and efficiently solve learning puzzles.

Virtual Experiment Assistant. According to the students' learning progress, it automatically generates practical questions from basic to advanced (such as single table query and complex transaction processing) to help students gradually improve their database operation ability.

Automatic Code Review. Carry out normal form analysis and optimization suggestions on SQL statements such as creating tables written by students, guide students to understand database design specifications, and cultivate rigorous programming thinking.

Digital Processing of Paper Form. After students upload the form image, AI automatically analyzes the structure and generates standard SQL statements, helping students quickly master the table structure design and data import skills, and intuitively understand the transformation logic from unstructured data to structured data.

4 Empirical Research

4.1 Experimental Design

The experimental subjects were selected from two parallel classes of the same grade level, with the selection criteria being the same major, consistent course progress, and similar students' basic knowledge and ability levels. The teaching cycle is 16 weeks, and the control group (34 people) is taught using traditional teaching and practice methods. The experimental group (37 people) fully integrated the above-mentioned three element collaborative framework and AI enhancement module on the basis of traditional teaching. Teachers should receive training before using AI models to ensure that they can proficiently guide students to use them correctly.

4.2 Comparison of Key Indicators

Independent sample t-test was conducted on the post experimental data, and the results showed significant differences in key indicators (as shown in Table I below). Data analysis shows that the tripartite collaborative framework has significant positive effects in improving students' skill accuracy, conceptual understanding depth, and learning efficiency.

Table 1. Key Indicators of Experimental Data

Indicator	Experimental Group	Control Group	Improvement Rate
SQL accuracy	84.4%	70.5%	+19.7%
Average score of concept test	86.2	77.3	+11.5%
Project completion time	1.9h	3.1h	-38.7%

4.3 Data Analysis and Visualization Support

To further verify the effect, this study conducted a multi-dimensional analysis of the learning process data of the experimental group and the control group, and drew the following chart:

1) Comparison of Learning Effectiveness Trends: Figure 3 shows the trajectory of changes in comprehensive ability scores between the experimental group and the control group over a period of 16 weeks. From this, it can be seen that from the 6th week onwards, the comprehensive ability score curve of the experimental group was significantly higher than that of the control group, and the gap between the two groups showed a gradually widening trend with the progress of teaching. This indicates that the tripartite collaborative framework can effectively maintain and promote students' long-term learning gains.

2) Evolution analysis of SQL error types: Figures 4 and 5 present the distribution changes of SQL error types in the experimental group and the control group during the first 8 weeks and the last 8 weeks, respectively. Comparing the two figures, it can be found that the experimental group (Figure 4), with the assistance of AI real-time error correction module, showed a significant decrease in the proportion of "grammar errors" and "logic errors" in the last 8 weeks compared to the first 8 weeks. On the other hand, in the control group (Figure 5), there was no significant structural change in the distribution of various errors between the first 8 weeks and the last 8 weeks, with the proportion of "logical errors" and "paradigm violations" even slightly increasing. This highlights the limitations of traditional teaching methods in helping students correct deep cognitive biases.

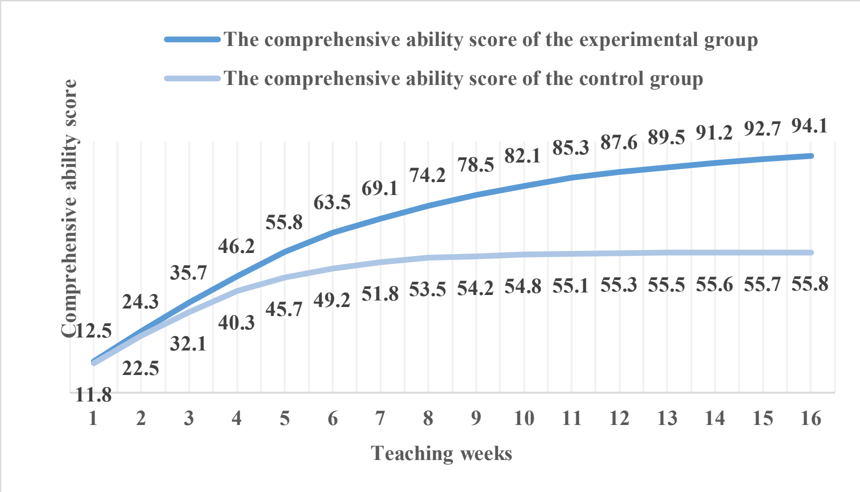

Fig. 3. Comparison of weekly trends in comprehensive ability scores between the experimental group and the control group

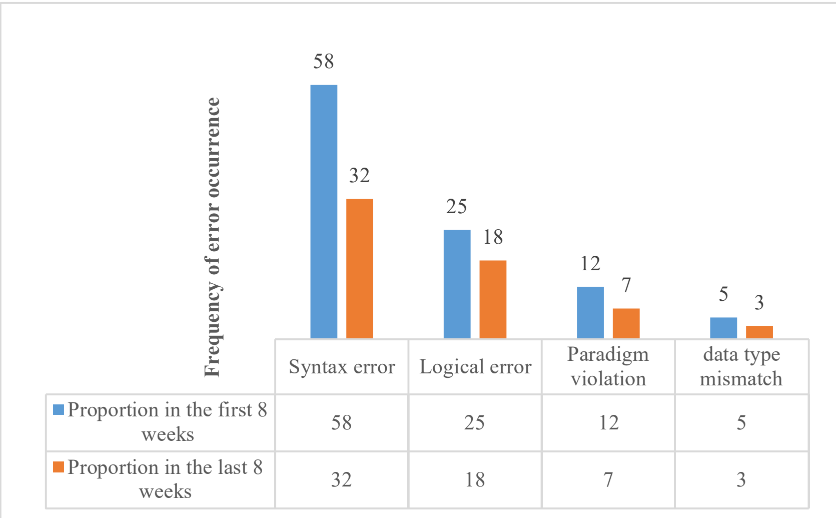

Fig. 4. Changes in the Distribution of SQL Error Types in the Experimental Group (the First 8 Weeks Vs the Last 8 Weeks)

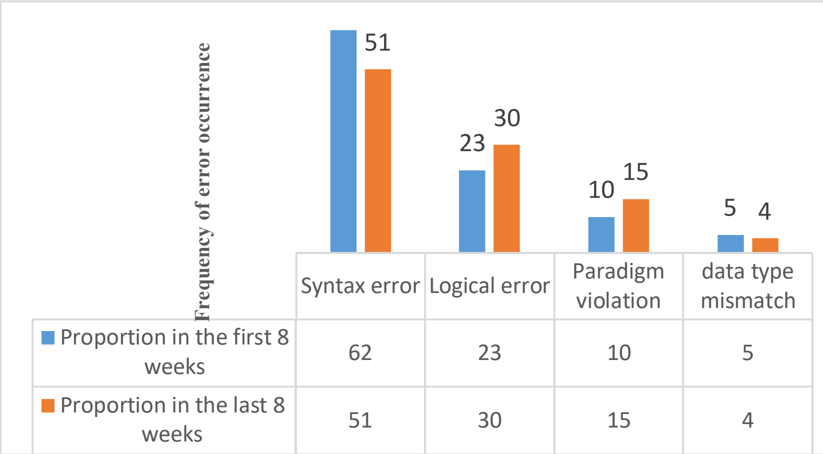

Fig. 5. Changes in the Distribution of SQL Error Types in the Control Group (the First 8 Weeks Vs the Last 8 Weeks)

5 Risks and Countermeasures

5.1 Potential Problems

Students' Over Dependence Affects their Autonomy. Students' excessive reliance on intelligent auxiliary tools may lead to the weakening of active thinking and problem solving ability, and the limited development of metacognition, which is not conducive to the cultivation of long-term learning ability.

Hidden Dangers of Data Security and Privacy Disclosure. In the process of using the AI model, students' learning data, code and other information may face the risk of disclosure, threatening students' personal privacy and school teaching safety.

Tool Algorithm Deviation Affects Teaching Justice. Some large models may have algorithm bias, which may have an unfair impact on different students and affect the fairness of teaching when providing learning resources and guidance.

5.2 Coping Strategies

Guide Students' Autonomous Learning. Build a guiding mechanism for students' autonomous learning, gradually reduce students' dependence on intelligent auxiliary tools, encourage independent thinking and problem solving, and strengthen the cultivation of metacognitive ability.

Establish Data Security Protection Mechanism. Encryption technology is used to protect student data, and regular security assessment and vulnerability detection are carried out to ensure the security of student data [9].

Diversified Evaluation and Manual Intervention. Combined with AI evaluation and teacher evaluation, the key decisions are manually reviewed to ensure that the evaluation is fair and comprehensive.

6 Conclusion and Prospect

6.1 Research Conclusion

The "teacher AI student" ternary collaborative framework proposed in this study has effectively solved some problems in database teaching in Higher Vocational Colleges by systematically integrating teachers' educational wisdom, students' learning subjectivity and the computational advantages of AI model. Empirical research shows that the framework can significantly improve the teaching effect. This research reflects the technology trend of deep integration of generative AI and education scene, shows a feasible path of large language model, adaptive learning system and data-driven teaching in vocational education, and also reflects the development direction of intelligent education of "humanistic orientation and technology empowerment".

6.2 Research Limitations

Although this study has preliminarily verified the effectiveness of the ternary collaborative framework, there are still some limitations that need to be improved in the follow-up study:

1) The sample size is limited, involving only 71 students in two classes. The universality of the conclusion needs to be verified in a wider range of teaching practice.

2) The experimental period is 16 weeks. The continuous impact of this model on students' long-term learning effect and ability development still needs to be tracked for a longer time.

3) The technical tools supported by the research are still developing, and their applicability and stability in different teaching situations may have a certain impact on the effect.

4) The existing evaluation mainly focuses on knowledge mastery and operational efficiency, which can be further included in the comprehensive investigation of high-level capabilities such as cooperation, design and innovation in the future.

6.3 Future Direction

Looking forward to the follow-up research and practice, we can further expand the application boundary of AI model in Higher Vocational database teaching. On the one hand, we can explore the combination of AI large model, virtual reality (VR), augmented reality (AR) and other technologies to create an immersive database learning scene, so that the abstract database principle and operation process can be visualized and visualized, so as to enhance students' sense of learning and experience [10]; On the other hand, intelligent textbooks can be developed based on the adaptive characteristics of AI large model, so that they can dynamically adjust the content presentation order and difficulty gradient according to students' real-time learning progress and knowledge mastery, and further optimize the teaching adaptability. Through these explorations, we will continue to promote the innovative development of database basic teaching in higher vocational colleges, and provide more practical reference for the reform of vocational education informatization.

References

1. Ministry of education (2018) Vocational education informatization 2.0 action plan [eb/ol]. retrieved from https://www.moe.gov.cn/srcsite/A16/s3342/201804/t20180425_334188.html
2. Brown, T. B., et al. (2020). Language models are few-shot learners. Advances in Neural Information Processing Systems, 33, 1877–1901. https://doi.org/10.48550/arXiv.2005.14165
3. Chen Ming, Zhang Hua, Li Jing (2024) A review of the application of large language model in education Computer education, 22 (5), 12 – 19 https://doi.org/10.16512/j.cnki.jsjjy.2024.05.002
4. Wangzhuli, Lu Yao (2022) Review, reflection and Prospect of the construction of learning theory in the network era Research on audio visual education, 43 (12), 61 – 69 https://doi.org/10.13811/j.cnki.eer.2022.12.009
5. Liuming, wuzhongming, liaojian, et al (2023). The educational application of large language model: principles, current situation and challenges Modern educational technology, 33 (8), 19 – 28 https://doi.org/10.3969/j.issn.1009-8097.2023.08.003
6. Sweller, J. (1988). Cognitive load during problem solving: Effects on learning. Cognitive Science, 12(2), 257–285. https://doi.org/10.1207/s15516709cog1202_4
7. Wang Zhiqiang, Liu Yang, Zhou Tao (2023) Design and implementation of deep learning driven adaptive learning system Modern educational technology, 33 (10), 88 – 95 https://doi.org/10.3969/j.issn.1009-8097.2023.10.011
8. Nieruihua, wangxinming, lizhuoyue (2017) From concept to practice: Research on the framework and implementation of basic education big data Audio visual education in China, (3), 70 – 75 https://doi.org/10.3969/j.issn.1006-9860.2017.03.011
9. Wang Zilin Build a solid foundation for network security and pave the way for the development of large models [n]. Shanghai Securities News, 2025-03-04 (004) https://doi.org/10.28719/n.cnki.nshzj.2025.001037
10. Jinhui, penglihua, Wang Ping, et al (2023). Generating the future: AI and higher education reform in the new vision of education Journal of distance education, 41 (03), 3 – 11 https://doi.org/10.15881/j.cnki.cn33-1304/g4.2023.03.001