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Research on Optimization of Digital Transformation Path of E-commerce Major Classroom Empowered by Virtual Digital Humans Driven by Generative Artificial Intelligence

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Abstract: The rapid development of generative artificial intelligence technology has provided a brand-new technological foundation for the in-depth reform of vocational education teaching modes. As a concrete carrier of generative artificial intelligence in educational scenarios, virtual digital humans are reshaping the basic paradigms of teacher-student interaction, knowledge transmission and ability cultivation in classroom teaching. Focusing on the classroom of E-commerce major in higher vocational colleges, this study systematically discusses the role positioning, interaction mechanism and effectiveness generation logic of generative AI-driven virtual digital humans in teaching scenarios, constructs a four-dimensional interaction model of "AI agent — learner — teaching content — industrial scenario", and puts forward a systematic path optimization scheme from the dimensions of curriculum reconstruction, teaching mode innovation, in-depth integration of industry and education, iteration of teachers' ability, and reshaping of evaluation system. The study aims to provide theoretical support and practical guidance for the digital transformation of E-commerce major classrooms in higher vocational colleges, and promote the paradigm leap of vocational education from "simulated training" to "real participation".

1. Introduction of the Problem

The e-commerce industry is undergoing an unprecedented profound transformation. The vigorous development of new business formats such as live-streaming e-commerce, social e-commerce, cross-border e-commerce and content e-commerce has put forward brand-new requirements for the knowledge structure, skill level and comprehensive literacy of e-commerce practitioners[1]. The traditional e-commerce talent cultivation mode, which focuses on theoretical teaching supplemented by limited simulated training, has been difficult to adapt to the urgent demand of the industry for talents' practical ability, innovation ability and cross-domain collaboration ability. As the main position of talent cultivation, the digital transformation of classroom has become a key breakthrough to improve the teaching quality of E-commerce major.

The breakthrough progress of generative artificial intelligence technology has provided strong technical support for this transformation[2]. Generative AI with large language models as the core has

the capabilities of natural language understanding and generation, multimodal content creation, scenario simulation and reasoning, which makes it possible to build highly realistic, interactive and evolvable virtual digital humans. Virtual digital humans are no longer simple animated images or players with preset scripts, but intelligent teaching agents that can understand students' intentions, generate personalized feedback and simulate complex business situations. This technical feature is highly consistent with the inherent requirements of situational, interactive and practical nature in E-commerce major teaching.

From an international perspective, Nanyang Technological University in Singapore has introduced virtual account managers in business teaching, where students exercise business practical ability through activities such as negotiating and promoting products with AI digital humans. Foreign research has shifted from single technology application to systematic teaching mode reconstruction, emphasizing the "personification", "situationalization" and "interactivity" of AI agents. However, existing studies mostly focus on general higher education or basic education fields, and application research targeting vocational education, especially higher vocational E-commerce majors, is still relatively scarce, and lacks in-depth adaptation of localized teaching scenarios.

From the perspective of domestic practice, although some colleges and universities have begun to explore the application of virtual digital humans in teaching, most of them stay at the level of technology display, and have not yet formed systematic teaching design schemes and promotable implementation paths. Problems such as vague role positioning of virtual digital humans in the classroom, insufficient integration depth with teaching content, and lack of docking mechanism with industrial scenarios are widespread. How to truly transform these cutting-edge technologies into effective tools to improve teaching quality, rather than just technical gimmicks, is a practical problem that needs to be solved urgently.

Against this background, this study is carried out to systematically answer the core proposition of how generative AI-driven virtual digital humans can effectively empower the digital transformation of E-commerce major classrooms in higher vocational colleges from the two levels of theoretical construction and practical path.

2. Theoretical Basis and Analytical Framework

2.1 Extended Application of Embodied Cognition Theory

Embodied cognition theory emphasizes that cognitive processes are not isolated in the brain, but deeply embedded in the interaction between the body and the environment[3]. In traditional classrooms, students' cognition mainly relies on auditory and visual channels, with limited physical participation, which restricts the depth of cognition. The introduction of virtual digital humans opens up new space for the application of embodied cognition theory in educational scenarios. When students conduct dialogue, negotiation and game with virtual digital humans, their cognitive process is no longer passive information reception, but an active, situational and multi-sensory participatory construction process. Through multimodal interaction methods such as voice, expression and body language, virtual digital humans create a cognitive environment close to real business scenarios, enabling students to achieve in-depth knowledge construction and ability development in the process of "learning by doing".

In E-commerce major teaching, the value of embodied cognition is particularly prominent. The cultivation of core abilities such as live-streaming operation, customer communication and business negotiation is essentially a kind of embodied practical wisdom, which needs to be gradually formed in specific situational interactions. By simulating roles such as real business opponents, customers and partners, virtual digital humans provide students with a safe and realistic embodied cognitive environment, enabling them to accumulate business intuition and adaptability through repeated

interactive practices.

2.2 Intelligent Expansion of Situated Learning Theory

Situated learning theory holds that knowledge is generated and applied in specific situations, and learning should occur in situations consistent with knowledge application. Traditional situated learning relies on the construction of physical environment or the presentation of cases, and its richness, dynamics and personalization of situations are greatly limited. Generative AI-driven virtual digital humans have greatly expanded the boundary of possibilities for situated learning.

Virtual digital humans can dynamically generate diverse business scenarios according to teaching objectives and learner characteristics. In the course of Live-streaming Operation, virtual digital humans can play different types of audiences — critical consumers, hesitant potential buyers, malicious screen-swiping disturbers — to create highly realistic live-streaming interaction scenarios for students. In the course of New Media Marketing, virtual digital humans can simulate algorithm recommendation logic and user behavior patterns of different platforms, helping students understand the differentiated effects of marketing strategies in different situations. This dynamically generated situated learning breaks through the static limitations of traditional case teaching, making the learning process closer to the complexity and uncertainty of the real business world.

2.3 AI Environment Reconstruction of Social Constructivism

Social constructivism emphasizes that knowledge is negotiated and constructed in social interaction, and learning is essentially a social activity. In traditional classrooms, social interaction mainly occurs between teachers and students and among students, and the frequency, depth and diversity of interaction are restricted by objective conditions such as class size and teachers' energy. The addition of virtual digital humans provides new possibilities for the reconstruction of social constructivism in the AI environment.

Virtual digital humans can participate in the learning process as "cognitive partners", conduct Socratic dialogue guidance with students, and stimulate students' in-depth thinking; they can act as "holders of opposing views" to debate with students and promote the development of critical thinking; they can serve as "collaborative partners" to complete project tasks with students and cultivate team collaboration ability. This human-machine collaborative social construction model not only enriches the subjects and forms of interaction, but also enables each student to obtain an interactive experience suitable for their cognitive level through the personalized response ability of AI.

2.4 Four-Dimensional Interaction Model of "AI Agent — Learner — Teaching Content — Industrial Scenario"

Based on the above theoretical analysis, this study constructs a four-dimensional interaction model of "AI agent — learner — teaching content — industrial scenario" as the overall analytical framework to guide virtual digital humans to empower the digital transformation of E-commerce major classrooms.

In this model, AI agents (virtual digital humans) are the core hub connecting the other three dimensions. AI agents carry the knowledge logic of teaching content, interact with learners in an anthropomorphic way, and introduce real elements of industrial scenarios into the classroom. Through multiple rounds of interaction with AI agents, learners complete in-depth understanding of teaching content and ability construction in the immersion of industrial scenarios. Through the intelligent presentation and dynamic adjustment of AI agents, teaching content realizes the transformation from static knowledge to dynamic ability. Through the simulation and reproduction of AI agents, industrial

scenarios realize the seamless connection from the external world to the classroom space.

Multi-directional interactive relationships are formed among the four dimensions: learners' behavior data is fed back to AI agents, driving them to adjust interaction strategies and content presentation methods; changes in industrial scenarios update teaching content, which in turn affects the behavior patterns of AI agents; the deepening of teaching content in turn enriches the simulation dimensions of industrial scenarios. This dynamic cyclic interaction mechanism constitutes the internal power system of classroom digital transformation.

3. Practical Dilemmas of Digital Transformation of E-commerce Major Classrooms in Higher Vocational Colleges

3.1 Insufficient Teaching Interaction: Inertia Continuation of One-Way Transmission Mode

At present, the classroom of E-commerce major in higher vocational colleges still takes teacher lecturing as the main teaching form, and teacher-student interaction is mostly limited to the simple mode of question-answer. The ability cultivation objectives of core courses of E-commerce major such as Live-streaming Operation, New Media Marketing and Cross-border E-commerce Practice highly rely on situational interactive practice, but traditional classrooms can hardly provide sufficient interaction opportunities. For a class of dozens of students, teachers cannot carry out live-streaming speech training, customer communication simulation or marketing scheme discussion one by one, resulting in a large number of students being in a passive acceptance state and serious insufficient cultivation of practical ability.

The introduction of virtual digital humans could have solved this dilemma, but in practical application, many colleges and universities only use virtual digital humans as "electronic courseware players" or "automatic question answering robots", failing to give full play to their potential of deep interaction and scenario simulation. The interaction design stays at the shallow level of information retrieval and simple question and answer, lacking in-depth simulation of complex business scenarios and effective stimulation of students' higher-order thinking ability.

3.2 Lack of Training Resources: Difficulty in Obtaining Real Business Scenarios

The practical teaching of E-commerce major highly relies on real business environment and business data. However, the acquisition of real business scenarios faces many obstacles: for the sake of business secrets and operational efficiency, enterprises are difficult to provide sufficient practical operation opportunities for students; the rules of e-commerce platforms change frequently, and the simulation systems built by schools often lag behind the actual platforms; the training of new business formats such as live-streaming e-commerce requires a large amount of equipment investment and continuous operation and maintenance, which many colleges and universities can hardly afford.

This lack of training resources directly restricts the cultivation of students' practical ability. The theoretical knowledge learned by students in the classroom cannot be verified and strengthened in an environment close to reality, and they often need a long adaptation period after graduation to enter enterprises. Virtual digital human technology provides new ideas for solving this problem, but how to effectively embed the real logic of the industry into the behavior model of virtual digital humans, so that the simulated business scenarios have sufficient authenticity and complexity, is still a technical and teaching design problem to be overcome.

3.3 Weak Personalized Support: Technical Bottleneck of Teaching Students in Accordance with Their Aptitude

There are significant differences in knowledge base, learning style and ability level among students majoring in E-commerce. Some students are good at creative planning but weak in data analysis ability, some are proficient in technical operation but lack business thinking, and some have outstanding expression ability but insufficient systematic planning ability. The "one-size-fits-all" teaching mode of traditional classrooms is difficult to meet such differentiated needs.

Generative artificial intelligence has strong personalized response ability, and theoretically can provide each student with tailor-made learning paths and feedback guidance[4]. However, in practical teaching application, the realization of personalized support faces multiple challenges: the collection and analysis mechanism of student portrait data is not yet perfect; the design of personalized strategies for AI agents lacks effective guidance from pedagogical theories; it is difficult to balance personalized learning and unified teaching objectives. These problems lead to the insufficient release of the personalized potential of virtual digital humans.

3.4 Lagging Digital Literacy of Teachers: Subject Bottleneck of Technology Empowerment

The effectiveness of classroom digital transformation largely depends on teachers' digital literacy and AI application ability. At present, among the teachers of E-commerce major in higher vocational colleges, the proportion of those with generative AI application ability and virtual digital human teaching design ability is still low. Many teachers hold a wait-and-see attitude towards new technologies and worry that technologies will replace their own roles; some teachers are willing to try, but lack systematic training support and practical guidance; some teachers simply equate technology application with tool use, failing to achieve a real transformation from the level of teaching philosophy.

The lagging of teachers' AI literacy not only affects the implementation effect of virtual digital human teaching application, but also restricts the in-depth innovation of teaching mode. How to build a systematic teacher AI literacy improvement system and help teachers move from "technology fear" to "technology control" and from "tool use" to "mode innovation" is a key problem that must be solved in classroom digital transformation.

3.5 Mismatched Evaluation System: Inadaptability of Traditional Assessment Methods

Classrooms empowered by virtual digital humans emphasize process-based learning, situational practice and comprehensive ability development, but the current teaching evaluation system still focuses on summative evaluations such as final exams and homework submission, which is difficult to effectively measure students' core literacy such as communication ability, adaptability and innovative thinking displayed in virtual interaction. The lagging of evaluation methods not only affects the driving force of teaching reform, but also leads to the lack of internal motivation for students to deeply participate in virtual interactive learning.

4. Path Optimization of Virtual Digital Humans Empowering Digital Transformation of E-commerce Major Classrooms in Higher Vocational Colleges

4.1 Curriculum Reconstruction Path: Constructing an "AI-Native" Curriculum Content System

Classroom digital transformation is not simply superimposing technical tools on existing courses,

but requires building an "AI-native" curriculum content system starting from the underlying logic of curriculum design. The so-called "AI-native" means that the course takes virtual digital humans as the core teaching element for overall design from the very beginning, rather than embedding technology into the existing framework afterwards.

In the course of Live-streaming Operation, a "virtual live-streaming room" teaching module can be designed, where virtual digital humans play different types of audiences and platform operators. Students conduct real-time live-streaming practice in the virtual live-streaming room, and virtual audiences will make differentiated responses according to students' speech, rhythm and interaction methods — some actively place orders, some raise questions, and some leave directly. Virtual platform operators will give operation suggestions based on live-streaming data to help students understand traffic logic and conversion mechanism. This design upgrades the traditional mode of "teacher explanation + student simulation" to the mode of "student practice + AI feedback", greatly improving the density and realism of training.

In the course of New Media Marketing, a "virtual marketing sandbox" can be constructed, where multiple virtual digital humans play roles such as target consumers, competitive product marketers and platform auditors respectively. After formulating marketing strategies, students conduct delivery tests in the sandbox. Virtual consumers will respond realistically to advertising content according to their portrait characteristics, virtual competitors will adopt targeted competitive strategies, and virtual platform auditors will intercept illegal content. This multi-role and multi-strategy interactive design enables students to experience the complete chain and complex consequences of marketing decisions in a safe environment.

In the course of Cross-border E-commerce Practice, virtual digital humans can simulate overseas customers from different cultural backgrounds, with different communication habits, consumption preferences and negotiation styles. Students need to adjust communication strategies and product recommendation schemes for different types of virtual customers to cultivate cross-cultural business communication ability.

4.2 Teaching Mode Innovation Path: Building a New Classroom Ecology of "Human-Machine Collaboration"

The introduction of virtual digital humans should not replace teachers, but form a complementary and collaborative new teaching relationship with teachers. In this mode, the core role of teachers changes from "knowledge transmitter" to "learning designer", "scenario architect" and "growth guide", while virtual digital humans undertake the functions of "knowledge presenter", "scenario simulator", "instant feedback provider" and "personalized tutor".

The specific teaching mode can be designed as a "three-stage progressive" structure. In the "cognitive construction" stage, virtual digital humans conduct knowledge explanation and concept interpretation as virtual teachers, guide students to understand core knowledge points through dialogic teaching, and teachers are responsible for monitoring learning progress and answering in-depth questions at this stage. In the "situational drill" stage, virtual digital humans switch to roles such as virtual customers, virtual anchors and virtual partners, and conduct in-depth interaction with students in simulated business scenarios. Teachers are responsible for observing students' performance and recording key problems at this stage. In the "reflection and improvement" stage, teachers guide students to review the interaction process and analyze successful experiences and failure lessons, while virtual digital humans provide data-based personalized learning suggestions and improvement directions.

The advantage of this "human-machine collaboration" mode is that virtual digital humans undertake teaching tasks with high repeatability and strong standardization, releasing teachers' time

and energy so that they can focus on higher-order teaching activities such as in-depth tutoring, innovation guidance and emotional care[5]. At the same time, the tirelessness and infinite patience of virtual digital humans ensure that each student can obtain sufficient practice opportunities and timely feedback guidance.

4.3 In-Depth Integration Path of Industry and Education: Realizing "Teaching as Production, Classroom as Workplace"

The deep value of virtual digital humans empowering classroom digital transformation lies in breaking down the barriers between teaching and industry, and realizing the in-depth integration of "teaching as production, classroom as workplace". The realization of this goal requires the joint efforts of e-commerce platforms, MCN institutions, AI technology enterprises and other parties to jointly develop teaching applications.

At the technical level, we should conduct in-depth cooperation with AI technology enterprises to ensure that the behavior patterns of virtual digital humans are highly consistent with the actual needs of the industry. By introducing real business data and scenario logic, the response mode, decision-making logic and communication style of virtual digital humans can reflect the real business environment. For example, the school cooperates with leading MCN institutions to collect live-streaming speeches, interaction strategies, and adaptability skills of excellent anchors, and transforms them into behavior models of virtual audiences, so that students can experience live-streaming scenarios close to reality when interacting with virtual audiences.

At the content level, a dynamic update mechanism for industrial scenarios should be established. The rules, gameplay and trends of the e-commerce industry change extremely fast, and the behavior models and scenario settings of virtual digital humans need to be iterated accordingly. An "industrial scenario material library" can be established to regularly collect the latest business cases, platform rule changes and market trend data from cooperative enterprises, and transform them into behavior parameters and scenario settings of virtual digital humans to ensure the timeliness and cutting-edge nature of teaching content.

At the evaluation level, real business indicators of enterprises can be introduced as reference standards for teaching evaluation. For example, data such as conversion rate, customer unit price and audience retention rate of students in the virtual live-streaming room can be compared with the industry average level to help students establish an intuitive understanding of business performance. This practice of embedding industry standards into the teaching process effectively bridges the gap between school evaluation and enterprise employment standards.

4.4 Teacher AI Literacy Improvement Path: Constructing a Hierarchical Progressive Ability Development System

Teachers are the key executors and ultimate decision-makers of classroom digital transformation. Without the synchronous improvement of teachers' AI literacy, no matter how advanced the technology is, it is difficult to transform into actual teaching effects. A hierarchical progressive training system for teachers' AI literacy improvement should be constructed, covering the complete ability spectrum from basic cognition to in-depth application and then to innovation leadership.

At the basic cognition level, help teachers understand the basic principles, capability boundaries and educational application prospects of generative artificial intelligence, and eliminate technical fears and cognitive misunderstandings. Through experiential training, let teachers personally experience the interactive ability of virtual digital humans, and establish an intuitive cognition and positive attitude towards technology-empowered teaching.

At the application skill level, train teachers to master the basic operation of the virtual digital

human teaching system, including scenario configuration, role setting, interaction process design, learning data analysis, etc. The school focuses on cultivating teachers' design ability to transform teaching objectives into virtual digital human interaction tasks, so that they can flexibly call and combine various functions of virtual digital humans according to curriculum needs.

At the innovation design level, guide teachers to think about the in-depth value of virtual digital humans empowering classrooms from the perspective of teaching philosophy, and encourage them to explore new teaching modes and evaluation methods. The school sets up teaching innovation experimental projects to support teachers in carrying out teaching reform practices based on virtual digital humans, and forms replicable exemplary cases and best practices.

At the sustainable development level, establish a normalized update mechanism for teachers' AI literacy. With the rapid iteration of technology, teachers need to continuously learn new tools and methods. A teacher learning community can be established to promote experience sharing and collaborative innovation; regularly invite technical enterprises and industry experts to share cutting-edge knowledge, so as to maintain teachers' sensitivity to technological development and industrial changes.

4.5 Evaluation System Reshaping Path: Constructing a Three-Dimensional Evaluation Framework of "Process — Ability — Literacy"

Classrooms empowered by virtual digital humans require a matching new evaluation system. Traditional summative examinations are difficult to measure students' comprehensive abilities displayed in virtual interaction, so it is necessary to construct a three-dimensional evaluation framework of "process — ability — literacy".

In the process dimension, the virtual digital human system is used to automatically record students' learning behavior data, including interaction frequency, dialogue depth, task completion degree, error correction trajectory, etc. These data can objectively reflect students' learning input degree and cognitive development process, and provide quantitative basis for process evaluation.

In the ability dimension, design ability assessment schemes based on situational tasks. By setting up virtual business scenarios with different difficulties and complexities, observe students' performance in them, and evaluate their core literacy such as communication ability, adaptability, decision-making ability and innovation ability. The evaluation standards should refer to the actual ability requirements of the industry to ensure that the evaluation results have industrial validity.

In the literacy dimension, pay attention to soft literacy such as professional attitude, ethical awareness and team cooperation spirit displayed by students in virtual interaction. Ethical dilemma scenarios can be set through virtual digital humans to observe students' value judgments and behavior choices, and evaluate the development level of their professional literacy.

The evaluation results of the three dimensions should form a comprehensive student ability portrait, which is not only used for academic assessment, but also as the basis for adjusting personalized learning paths. Virtual digital humans can automatically adjust the difficulty, content and strategy of subsequent interactions according to the evaluation results, realizing a virtuous cycle of "evaluation as learning".

4.6 Technical Platform Construction Path: Building an Open and Shared Smart Teaching Infrastructure

The effective operation of virtual digital human teaching application requires strong technical platform support. A smart teaching platform integrating virtual digital human engine, teaching management system, learning analysis system and industrial data interface should be built to provide infrastructure guarantee for classroom digital transformation.

In terms of virtual digital human engine, it should support multi-role, multi-scenario and multimodal interaction capabilities. Virtual digital humans should not only have natural language dialogue ability, but also have non-verbal interaction abilities such as expression and body language to enhance the authenticity and immersion of interaction. The engine should support teachers to customize role attributes and behavior rules, so that virtual digital humans in different courses can present differentiated characteristics.

In terms of teaching management system, it should support basic functions such as curriculum configuration, task release, progress tracking and grade management, and provide visual orchestration tools for virtual digital human interaction scenarios to reduce the technical threshold for teachers[6]. The system should support flexible switching of multiple teaching modes to adapt to the needs of different courses and teaching links.

In terms of learning analysis system, it should be able to collect and analyze students' learning behavior data in real time, and generate visual learning reports and ability portraits. The analysis results not only serve teachers' teaching decisions, but also should be fed back to students in an appropriate way to promote the development of their metacognitive ability.

In terms of industrial data interface, a data docking mechanism with cooperative enterprises should be established. On the premise of ensuring data security and privacy protection, real business data should be introduced into teaching scenarios to enhance the authenticity and timeliness of virtual digital human simulation.

5. Implementation Guarantees and Promotion Strategies

5.1 Organizational Guarantee: Establishing a Cross-Departmental Collaborative Promotion Mechanism

Classroom digital transformation involves multiple fields such as teaching, technology and industry-education cooperation, so it is necessary to establish a cross-departmental collaborative promotion mechanism. At the school level, a leading group for digital transformation work composed of the academic affairs office, information technology department, secondary colleges and school-enterprise cooperation office should be established to coordinate the promotion of various reform measures. At the level of the college where the E-commerce major is located, a special working group should be set up to be responsible for specific scheme design, resource construction and teaching implementation.

5.2 Institutional Guarantee: Improving Supporting Management Systems

The Implementation Plan for Virtual Digital Human Teaching Reform of E-commerce Major in Higher Vocational Colleges should be formulated to clarify the reform objectives, implementation steps, responsibility division, resource allocation and assessment standards. The plan should cover operation guidelines such as curriculum design specifications, teaching process standards, technology application specifications and evaluation standards, so as to provide a clear action framework for teachers. At the same time, the talent cultivation plan should be updated to integrate AI teaching ability requirements into cultivation objectives and curriculum modules, so as to ensure that the reform achievements are consolidated at the institutional level.

5.3 Resource Guarantee: Constructing a Multi-Input Mechanism

The development, deployment and operation and maintenance of the virtual digital human teaching system require continuous capital investment. A multi-input mechanism of "school main

investment + enterprise technical support + government project funding" should be established. The school actively applies for educational and teaching reform projects and special digital transformation projects at all levels to obtain external financial support; establishes strategic cooperative relations with AI technology enterprises to reduce technical costs through joint research and development and achievement sharing; and establishes special funds within the school to ensure daily operation, maintenance, and content updates of the system.

5.4 Quality Guarantee: Establishing a Continuous Improvement Mechanism

A quality monitoring and continuous improvement mechanism for the teaching application of virtual digital humans should be established. The school regularly collects usage feedback from teachers and students to evaluate teaching effects and user experience; tracks graduates' employment performance and employer evaluation to test the actual effectiveness of talent cultivation; pays attention to technological development trends and changes in industrial demand, and promptly adjusts the functional design and content settings of virtual digital humans. Through the cyclic iteration of "practice — evaluation — improvement", the school ensures that the digital transformation always advances in the correct direction.

5.5 Risk Prevention and Control: Focusing on Ethical and Security Issues

The application of virtual digital humans in teaching involves sensitive issues such as data security, privacy protection and AI ethics, so it is necessary to establish a sound risk prevention and control mechanism. In terms of student data protection, relevant laws and regulations should be strictly followed to clarify the boundaries and specifications of data collection, storage and use. In terms of AI ethics, it should be ensured that the behavior settings of virtual digital humans meet educational ethical requirements and avoid improper guidance or prejudice reinforcement. In terms of technical security, a system security monitoring and emergency response mechanism should be established to prevent data leakage and system failure risks.

6. Conclusion

Generative AI-driven virtual digital humans are bringing profound paradigm changes to the classrooms of E-commerce major in higher vocational colleges. This change is not a simple technical superposition, but a systematic reconstruction of teaching philosophy, teaching mode and teaching evaluation. With its strong scenario simulation ability, personalized interaction ability and dynamic evolution ability, virtual digital humans provide brand-new solutions to long-standing problems in E-commerce major teaching such as insufficient interaction, lack of training resources and weak personalized support.

However, technology itself does not automatically improve teaching quality. The effectiveness of virtual digital humans empowering classroom digital transformation ultimately depends on whether educators can start from the essence of educating people, organically integrate technology into the whole process of teaching design, and realize the in-depth integration of technology and education. This requires teachers to complete the role transformation from "knowledge transmitter" to "learning designer", requires schools to complete the governance upgrade from "experience management" to "data-driven", and requires industry-education cooperation to complete the mode leap from "formal docking" to "in-depth symbiosis".

Looking forward to the future, with the continuous evolution of generative artificial intelligence technology and the continuous expansion of educational application scenarios, the role of virtual digital humans in E-commerce major classrooms will be more diverse, the interaction will be more

natural, and the empowerment will be more in-depth. The four-dimensional interaction model of "AI agent — learner — teaching content — industrial scenario" will be continuously enriched and improved in practice, contributing more theoretical wisdom and practical experience to the digital transformation of vocational education. Although the exploration of this study focuses on higher vocational E-commerce majors, its core concepts and methodologies are also of reference value for the classroom digital transformation of other vocational education majors. It is expected that more educational practitioners will join this exploration and jointly promote vocational education to a new stage of intelligence, personalization and situationalization.

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