Trends in Social Sciences and Humanities Research
Print ISSN: 2959-992X
Online ISSN: 2959-9938
DOI: https://doi.org/10.61784/tsshr3174

EXPLORATION ON THE COLLABORATIVE CONSTRUCTION OF ANTI-FRAGILITY IN HIGHER VOCATIONAL COMPUTER EDUCATION UNDER THE BACKGROUND OF DIGITAL TRANSFORMATION

LiPing He
Department of Information Management, Guangdong Justice Police Vocational College, Guangzhou 510520, Guangdong, China.
Corresponding Email: gzlphe@126.com

Abstract: Under the global wave of digital transformation, higher vocational computer education is facing dual challenges from technological iterations and industry demands. New technologies such as cloud computing and artificial intelligence are reshaping the professional landscape and subverting traditional talent cultivation models, creating a complex situation of opportunities and challenges. This study takes the dynamic feedback mechanism of system dynamics as the analytical framework, combines the symbiotic evolution theory of educational ecology, and innovatively introduces Taleb's anti-fragility theory as the core methodology. From four dimensions: innovation of teaching models, optimization of teaching staff, deep integration of industry and education, and coordination of school-enterprise resources, a collaborative development strategy model with adaptive adjustment capabilities is constructed. The aim is to enhance the resilience and evolutionary potential of higher vocational computer education in an uncertain environment. Experimental results show that students in the experimental group significantly outperform those in the control group in terms of theoretical application and practical innovation abilities, verifying the effectiveness of the model in improving educational adaptability and evolutionary capabilities. This research aims to assist higher vocational computer education in adapting to the development of the digital economy and provide theoretical and practical references for cultivating high-quality applied talents.
Keywords: Digital transformation; Higher vocational computer education; Anti-fragility; Collaborative construction; Educational reform

1 INTRODUCTION

Against the backdrop of digital technology reshaping the global economic and social landscape, higher vocational computer education, as a core link in cultivating applied digital talents, faces dual challenges of rapid technological iterations and volatile industrial demands. McKinsey predicts that by 2025, the global digital skills talent gap will reach 290 million, posing higher requirements for employment-oriented higher vocational computer education [1]. Traditional education models struggle to cope with technological changes and demand fluctuations, urgently needing to build a new educational ecosystem. Taleb's anti-fragility theory suggests that systems can not only withstand risks in the face of uncertainties but also upgrade through fluctuations. By introducing this theory into higher vocational computer education and constructing a collaborative mechanism between education and industry, promoting the dynamic adaptation of teaching resources, courses, and practical platforms, the continuous evolution of the education system can be achieved [2]. Based on the anti-fragility theory, this paper analyzes the vulnerabilities of higher vocational computer education, explores the collaborative paths among educational, industrial, and policy entities, and provides references for the development of vocational education.

2 THEORETICAL BASIS

2.1 Taleb's Theory

Taleb's tripartite system theory model of vulnerability, resilience, and anti-fragility, proposed in Antifragile: Things That Gain from Disorder, explains the laws of how systems respond to uncertainties. Vulnerable systems are sensitive to external shocks; for example, traditional closed teaching is difficult to adapt to educational changes brought about by rapid technological iterations. Resilient systems have self-healing capabilities, such as systems integrated with practical teaching, which can maintain system stability. Anti-fragile systems break through traditional adaptation theories and can achieve evolution under pressure [3]. The core of this theory is that systems gain energy from shocks, advocating the promotion of system evolution through controlled disturbances and dynamic feedback. This provides theoretical support for constructing the anti-fragility system of higher vocational computer education. In practice, vulnerability points can be identified through fault simulation experiments and multi-dimensional reflection mechanisms to promote the matching of teaching with industry demands. Meanwhile, elements such as teaching staff capabilities and industry-education integration can be refined to build an adaptive educational ecosystem.

2.2 Theory of Vocational Competence Development

Rooted in the theories of dynamic capabilities and resilience, and deeply integrating the cutting-edge concept of embedding anti-fragile vocational competencies into professional qualities, a dual-core driving model of technical and non-explicit capabilities is systematically constructed. In the dimension of technical capabilities, the focus is on core areas of computer science such as programming development, algorithm design, and system architecture. Through the dynamic design and continuous optimization of a modular curriculum system, the dynamic evolution and organic integration of knowledge and skills are achieved, ensuring that students can keep up with industry technology trends. In terms of non-explicit capabilities, adaptability and resilience are regarded as core elements. Adaptability corresponds to the high-order cognitive ability to actively solve complex problems, emphasizing students' rapid learning and innovative thinking in the face of technological iterations and industry changes. Resilience focuses on the psychological adjustment ability to break through adversity, focusing on cultivating students' stress resistance and psychological resilience in the face of career development difficulties [4]. During the research process, the Delphi method and the analytic hierarchy process are comprehensively used. Through multiple rounds of expert consultations and scientific quantitative analysis, 12 key elements such as data sensitivity, technological foresight, and innovative thinking are accurately identified. A scientific and comprehensive evaluation index system is constructed from four dimensions: knowledge reconstruction, skill transfer, psychological adjustment, and environmental adaptation [5]. This system not only provides solid theoretical support for the reform of higher vocational computer education but also aims to cultivate compound talents with both technical expertise and excellent risk resistance capabilities to meet the urgent needs of the industry for high-quality computer talents in the context of digital transformation.

3 IDENTIFICATION OF CORE ELEMENTS OF ANTI-FRAGILITY IN HIGHER VOCATIONAL COMPUTER EDUCATION UNDER DIGITAL TRANSFORMATION

3.1 Basis and Logic of Element Identification

Taking curriculum design, teaching organization, and student evaluation as the core research dimensions, combined with the characteristics of rapid technological iteration and uncertain job requirements in digital transformation, key elements are refined based on the principles of theoretical adaptation and practical relevance. In curriculum design, in response to the rapid development of cutting-edge technologies such as artificial intelligence and cloud computing, a modular and dynamically updatable curriculum system is constructed to ensure that teaching content keeps pace with industry technology evolution [6]. In teaching organization, project-based learning and blended teaching models are introduced to create a teaching paradigm that integrates theory, practice, and innovation, enhancing students' ability to solve complex problems [7-8]. Student evaluation breaks through traditional quantitative assessment, and a multi-dimensional evaluation system covering process, project results, and professional qualities is constructed [9]. Through the practice of these three dimensions, the impact of digital transformation on higher vocational computer education is analyzed, and the key nodes of educational adaptability are positioned based on the theory of anti-fragility to solve problems such as curriculum lag and weak practice, providing support for the construction of an anti-fragility collaborative mechanism [10].

3.2 Construction of the Core Element System

3.2.1 Core elements of the collaborative construction of anti-fragility in higher vocational computer education under digital transformation

The core element system of the anti-fragility collaboration in higher vocational computer education presents the characteristics of multi-dimensional collaborative evolution. Based on the theoretical framework of the Complex Adaptive System (CAS), curriculum structure design achieves self-adaptive coupling between educational supply and industrial demand through the dynamic cycle mechanism of modular knowledge unit reorganization, interdisciplinary task group construction, and industry-education integration [11]. In the innovation of teaching organization paradigms, with the core logic of trial and error and collaborative repair, through project-based learning, in-depth analysis of failure cases, and reverse instructional design, a two-way cultivation path for students' knowledge reconstruction and ability iteration is constructed. The construction of the evaluation system introduces a non-linear dynamic feedback model to build a process evaluation matrix covering dimensions such as cognitive development, practical innovation, and collaborative effectiveness. Through the collaborative participation of multiple evaluation subjects, a continuous improvement loop is formed [12]. The support guarantee system focuses on the cultivation of digital literacy of the teaching staff and the ecological construction of the school-enterprise collaborative innovation network. Relying on the two-way empowerment mechanism of the education chain and the industry chain, a dynamic adaptive collaborative system of anti-fragility in higher vocational computer education is finally formed.

3.2.2 Analysis of element correlation mechanisms

Under the background of digital transformation, deepening the construction of the internal and external collaborative correlation system is the key to implementing the collaborative construction mechanism of anti-fragility in higher vocational computer education. Internally, a highly tolerant teaching mechanism needs to be constructed to support the dynamic self-adaptive curriculum system. Specifically, professional courses can be modularly decomposed, elastic learning nodes can be integrated, and a three-stage progressive project-based learning model of foundation building through basic tasks, improvement through advanced challenges, and expansion through innovative practice can be adopted to achieve the integration of learning and application [13]. At the same time, a growth-oriented evaluation system is established, incorporating cognitive reconstruction, strategy optimization, and error transformation abilities into process evaluation to form a closed-loop feedback system for curriculum design, practical teaching, and effectiveness evaluation. Externally, the construction of a three-dimensional teacher professional development system is taken as the core to inject sustainable impetus into the dynamic iteration of courses [14]. Specifically, guided by scientific teacher professional ability standards, teachers' professional qualities are improved through multiple channels such as on-campus training, corporate internships, and academic seminars. With the coordination of the professional construction committee, a dynamic curriculum update mechanism is established. In practical teaching, school-enterprise cooperation is deepened to create a teaching model that integrates project chains and curriculum groups, implement the dual-tutor system, and build an intelligent industry-education integration platform to optimize the allocation of practical teaching resources.

4 THEORETICAL MODEL OF THE COLLABORATIVE CONSTRUCTION OF ANTI-FRAGILITY IN HIGHER VOCATIONAL COMPUTER EDUCATION UNDER DIGITAL TRANSFORMATION

4.1 Model Framework Design

Based on the coupling relationship between digital transformation and higher vocational computer education, this paper innovatively constructs a theoretical model with one goal layer, four core dimensions, and two-way collaboration, as shown in Figure 1.

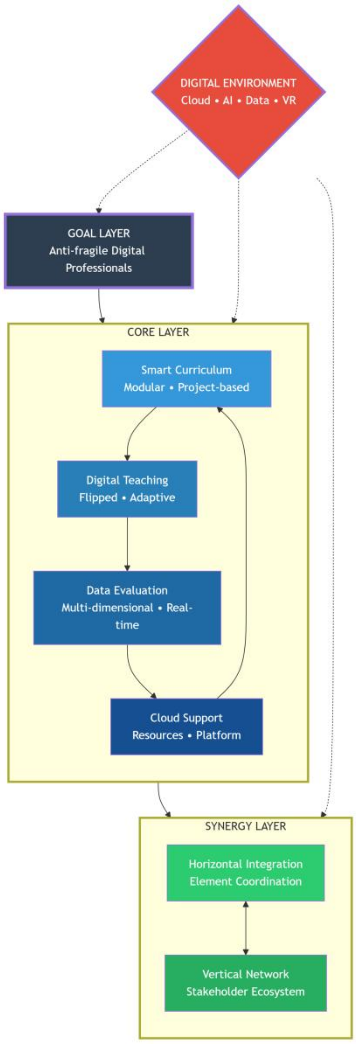

Figure 1 Framework Design of the Theoretical Model for the Collaborative Construction of Anti-fragility in Higher Vocational Computer Education under Digital Transformation

Goal Layer: In the context of rapid digital technology iteration and dynamic changes in industry talent demand, cultivating higher vocational computer professionals with anti-fragile attributes is the key to optimizing the adaptability of the educational ecosystem to digital transformation. By reconstructing the educational paradigm, it helps students maintain stable professional capabilities in complex technical and industry environments and builds an ability system that actively adapts to technological changes and promotes the improvement of professional qualities to cope with the challenges and opportunities brought by digital transformation.

Core Layer: Based on the theory of complex adaptive systems and combined with the requirements of digital transformation, the anti-fragility of higher vocational computer education is systematically improved through the multi-dimensional collaboration of curriculum structure optimization, teaching organization innovation, and evaluation system reconstruction. Curriculum structure optimization closely follows the trends of technologies such as cloud computing and artificial intelligence. With modular curriculum groups and project-based units as the framework, content is dynamically updated, enterprise cases are embedded, and immersive workshops are created to ensure that the curriculum is synchronized with the industry. Teaching organization innovation constructs a problem-oriented elastic paradigm, integrates collaborative learning and flipped classrooms, uses digital tools to establish an instant feedback mechanism, and optimizes the process through dynamic grouping and blended teaching. The reconstruction of the evaluation system establishes a three-dimensional evaluation model including process, value-added, and multiple subjects, introduces enterprise experts, and uses big data to achieve dynamic and precise evaluation oriented by students' digital ability growth [15]. The construction of the support system relies on the theory of government-school-enterprise-industry collaborative innovation, integrates digital resources, and builds an educational resource sharing platform and industry-education integration training bases. Cloud computing is used to build an online learning resource library, virtual reality is used to create virtual training scenarios, and a long-term mechanism for cultivating teachers' digital teaching capabilities is established. The four elements collaborate and dynamically adjust to form a collaborative construction mechanism for the anti-fragility of higher vocational computer education.

Collaboration Layer: Relying on the two-dimensional architecture of horizontal and vertical collaboration, closely following the characteristics of digital transformation, deep collaboration among educational elements and participating subjects is achieved. Horizontal collaboration focuses on curriculum structure, teaching organization, evaluation system, and support system. Through industry-education collaboration, curriculum design is optimized, and digital disassembly of industry projects drives the integration of theory and practice teaching. Intelligent algorithms and big data technologies are used to construct a closed loop for evaluation and resource allocation, and the training and teaching staff systems are improved. Vertical collaboration builds a collaborative network among colleges, enterprises, teachers and students, and industry experts. Schools and enterprises jointly build industrial colleges, unify standards, and develop training systems. Teachers and students interact through online platforms, and industry experts empower through online lectures, promoting the deep integration of the education chain, talent chain, and industry chain to adapt to the needs of digital transformation.

4.2 Model Operation Logic

With the digital transformation driving profound changes in the social and economic system, the structural contradictions in the higher vocational computer education system have become increasingly prominent. The update speed of the textbook system is far behind the development of cutting-edge technologies such as artificial intelligence, cloud computing, and big data, resulting in a disconnection between teaching content and the forefront of industry technology. There is a structural mismatch between the talent cultivation standards and the needs of industrial digitization, and graduates' engineering practice and innovation capabilities hardly meet the requirements of enterprises, exacerbating the imbalance between talent supply and demand [16].

Therefore, this paper proposes the construction of a three-in-one collaborative support system, focusing on the professional development of teaching staff and the integration of school-enterprise resources. In terms of teaching staff construction, a regular industry technology training and corporate internship system is established to improve teachers' practical teaching abilities and technical sensitivity. In terms of school-enterprise cooperation, deep integration of the education chain and the industry chain is promoted through ways such as jointly building training bases and developing courses [17]. At the same time, a fault-tolerant repair training model based on constructivism is introduced to encourage students to expose cognitive biases in practice and achieve cognitive reconstruction through system feedback. A multi-dimensional evaluation system covering knowledge, skills, and qualities is constructed to establish a three-dimensional evaluation framework from aspects such as theoretical mastery, project practice, and professional qualities.

This collaborative system operates based on the logic of shock perception, dynamic response, structural remodeling, and ability leap, aiming to create an anti-fragile development mechanism for higher vocational computer education. When the external technical environment or industry demand changes, the system can quickly perceive the shock through multi-source information collection, use dynamic response to optimize resource allocation and reconstruct the educational structure, promoting the educational system to transform from passive adaptation to active evolution and achieving the sustainable development of the educational ecosystem.

5 COLLABORATIVE CONSTRUCTION PATHS FOR THE ANTI-FRAGILITY OF HIGHER VOCATIONAL COMPUTER EDUCATION IN THE DIGITAL TRANSFORMATIONL

5.1 Collaborative Adaptation Path between Curriculum Structure and Digital Technologies

5.1.1 Building a modular and dynamically updatable curriculum system

Against the backdrop of the accelerated digital transformation, core technologies such as artificial intelligence, cloud computing, and big data are continuously evolving. These advancements not only expand and deepen the technical fields but also drive profound changes in industrial forms and talent demands. In this context, building a modular and dynamic curriculum system through in-depth school-enterprise collaboration has become a crucial path to precisely align education with industrial needs [18].

The construction of the curriculum system is driven by school-enterprise collaboration. Based on industrial links such as technology research and development, application practice, and operation and maintenance management, a progressive modular structure is established to achieve an organic unity of knowledge imparting and ability cultivation. Through collaborative mechanisms such as joint research and enterprise technology demand collection, schools and enterprises jointly establish a dynamic optimization mechanism for industry technology monitoring and curriculum content iteration. A joint teaching and research team composed of enterprise technical experts and university teachers uses methods such as the Delphi method and technology roadmap analysis to jointly assess the evolution trend of industrial technologies and talent requirement standards, ensuring that the curriculum system always keeps pace with the forefront of industry development. On this basis, 20%-30% of the curriculum content is dynamically updated each semester, integrating new technologies, tools, and standards into teaching in a timely manner, thus achieving synchronous resonance between educational supply and industrial demand.

5.1.2 Design of real project-based teaching tasks with interdisciplinary elements

The digital transformation has given rise to the trend of multi-technology integration, with scenarios such as the combination of artificial intelligence and big data, and cloud computing enabling software development emerging continuously. To cultivate composite talents adaptable to complex technical environments, it is necessary to design real project-based teaching tasks integrating multi-technology through the school-enterprise collaborative education mechanism.

During the project design process, schools and enterprises jointly construct a fuzzy goal-oriented design model and a resource-constrained practical strategy. By categorizing and defining failure types and opening up solution design, students are guided to break through the boundaries of technical cognition. By setting a 30-day development cycle, quantifying computing resources, and providing technical support, the time and resource constraints of real enterprise projects are simulated. During project implementation, students need to continuously optimize technical solutions and reconstruct team collaboration processes under the guidance of school-enterprise mentors amidst dynamically changing technical requirements, enhancing their dynamic adaptability and technological innovation capabilities in solving complex engineering problems within real business scenarios, thus achieving deep integration of school-enterprise collaborative education [19].

5.2 Collaborative Integration Path between Teaching Organization and Anti-Fragility Concepts

5.2.1 Implementing the integrated project-based review teaching model

In the wave of digital transformation, to enhance the anti-fragility of higher vocational computer education, this paper constructs a spiral teaching model centered around students' trial-and-error and team collaborative repair. This model covers courses such as programming design and database management and consists of four stages: project initiation, trial-and-error practice, collective review, and strategy optimization. At the project initiation stage, previous failure cases are introduced through a digital platform, and students are guided to predict risks and analyze scenarios using risk assessment theory. During the trial-and-error practice stage, digital simulation technology is used to create error scenarios, and students complete code review and debugging through group collaboration, exercising their problem-solving abilities. In the collective review stage, mind maps are utilized to visualize knowledge, and general solutions are extracted through cross-group comparison. In the strategy optimization stage, solutions are optimized based on review results, and a question bank for error prevention is established using knowledge management theory to form a preventive knowledge system. Digital tools are deeply integrated into each link. Through the deconstruction and reconstruction of failure cases, the integration of teaching and practice is achieved [20], cultivating students' abilities in problem diagnosis, team collaboration, and knowledge transfer, and promoting the high-quality development of higher vocational computer education.

5.2.2 Integration of reverse instructional design and digital tools

Relying on a virtual simulation teaching platform, a full-link digital transformation typical technical failure scenario library is constructed. The scenarios cover basic failures such as system crashes and data loss, as well as complex situations such as cyber security attacks, microservice cascading failures, and abnormal cloud computing resource scheduling. In teaching, the OBE (Outcome-Based Education) reverse instructional design is adopted, transforming enterprise operation and maintenance work orders into cases. Through five stages - failure observation, impact assessment, technical tracing, solution design, and verification - students are guided to learn knowledge such as operating system principles and data recovery algorithms, as well as skills such as log analysis and emergency response in reverse from the perspective of failure requirements [21].

This model drives knowledge construction through problems. With a gradient-increasing task system, combined with the real-time feedback and dynamic evaluation of the virtual simulation platform, it cultivates students' anti-fragility thinking. For example, in the system crash scenario, students need to comprehensively consider data protection, service recovery, and resource scheduling, forming a closed-loop thinking of risk identification, adaptability to changes, and utilization of fluctuations during the problem-solving process [22]. At the same time, school-enterprise cooperation is deepened, and enterprise experts are invited to participate in scenario design and teaching evaluation. With the practical experience of enterprises, it is ensured that teaching content keeps up with the development of industry technologies, achieving digital collaboration between education and enterprise needs.

5.3 Collaborative Matching Path between Evaluation System and Ability Growth

5.3.1 Constructing a three-dimensional process evaluation index system

Based on a three-dimensional evaluation framework of adaptability, resilience, and growth feedback, the index system is deconstructed from three dimensions: dynamic adaptation, crisis handling, and sustainable development. In the technical adaptability dimension, a six-item secondary index quantification system is constructed, focusing on the cognitive cycle of new technologies and the application efficiency of open-source frameworks, dynamically evaluating the adaptability of the teaching system to cutting-edge technologies. In the failure resilience dimension, a four-core index evaluation model is established, paying attention to the speed of failure diagnosis and response and the reconstruction cycle of solutions. In software development training, the failure event log system records the repair duration, analyzes team collaboration and solution paths, and forms a case library. In the comprehensive growth dimension, a cross-project ability matrix evaluation model is adopted. Based on five indicators such as Git code contribution and the quality of project review reports, the development trajectory of students' abilities is tracked. Evaluation data is collected in real-time through the growth archive system, and ability maps are generated by visualization tools to achieve intelligent analysis of learning process data.

5.3.2 Establishing a multi-subject collaborative and dynamic feedback evaluation mechanism

Against the backdrop of the digital transformation reshaping the industrial and educational landscapes, the innovation of the evaluation system for higher vocational computer education is the key to industry-education integration. A three-dimensional evaluation system centered around teachers' professional development, students' metacognitive self-assessment, and enterprise job competence is constructed. Using quantitative tools such as project reviews and ability matrices, dynamic evaluations are carried out 2-3 times per semester. The Delphi method and analytic hierarchy process are used for teachers' professional development evaluation, constructing indicators from teaching design, methods, and effects [23]. Students' metacognitive self-assessment uses the Likert scale to construct a monitoring scale [24]. The evaluation of enterprise job competence is based on professional standards, and a model is constructed using the behavioral event interview method. At the same time, a closed-loop of evaluation, feedback, and improvement is formed, and the results are integrated into curriculum reconstruction and teaching innovation.

5.4 Collaborative Guarantee Path between Support Systems and Core Elements

5.4.1 Building a teaching staff that integrates digital and anti-fragility concepts

Teachers' digital teaching abilities are enhanced through a multi-dimensional mechanism. An enterprise attachment practice system is established to normalize teachers' participation in enterprise digital transformation projects, enabling them to accumulate experience in scenarios such as industrial Internet development and intelligent system integration and transform it into teaching resources. The thematic teaching and research mode conducts workshop training guided by anti-fragility theory, helping teachers master skills such as teaching objective adjustment and fault-tolerant task design [25]. The knowledge inheritance and innovation mechanism realizes knowledge transfer and innovation through a gradient mentoring system, seminars, etc., and an incentive mechanism is established to promote the professional growth of the team and adapt to the needs of digital transformation.

5.4.2 Building a school-enterprise collaborative resource sharing platform

School-enterprise cooperation is deepened, and a digital platform for educational resources is constructed to create a technical dynamics database and a practical case database. The technical dynamics database tracks the update of cutting-edge technologies, industry achievements, and standards through enterprise data interfaces and artificial intelligence collection technologies. The practical case database establishes a full-process collection system, collecting multi-modal data such as enterprise technical failures and project documents. Schools and enterprises jointly formulate resource specifications and standards to ensure that resources meet teaching needs and enhance the anti-fragility of higher vocational computer education [26].

6 EXPERIMENTAL VERIFICATION AND ANALYSIS

To verify the effectiveness of the collaborative construction model for the antifragility of computer education in higher vocational colleges under the background of digital transformation, a comparative experiment was designed. Two higher vocational colleges with similar teaching resources were selected. College A, adopting the traditional computer education model, served as the control group, while College B, implementing the education reform plan based on the collaborative construction of antifragility, served as the experimental group. The experiment lasted for one semester, and the teaching effects were evaluated through multi-dimensional indicators. The specific data are shown in Figure 2 and Figure 3.

Academic Performance: Compare the average scores and excellent rates of students from the two colleges in courses such as computer fundamentals, programming languages, and project practice.

Skill Competitions: Count the number and grades of awards won by students in computer-related competitions at the provincial level and above.

Enterprise Feedback: Collect satisfaction scores from partner enterprises regarding the digital tool application and problem-solving abilities of graduates.
Innovation Ability: Evaluate the number and innovation level of digital projects independently developed by students.

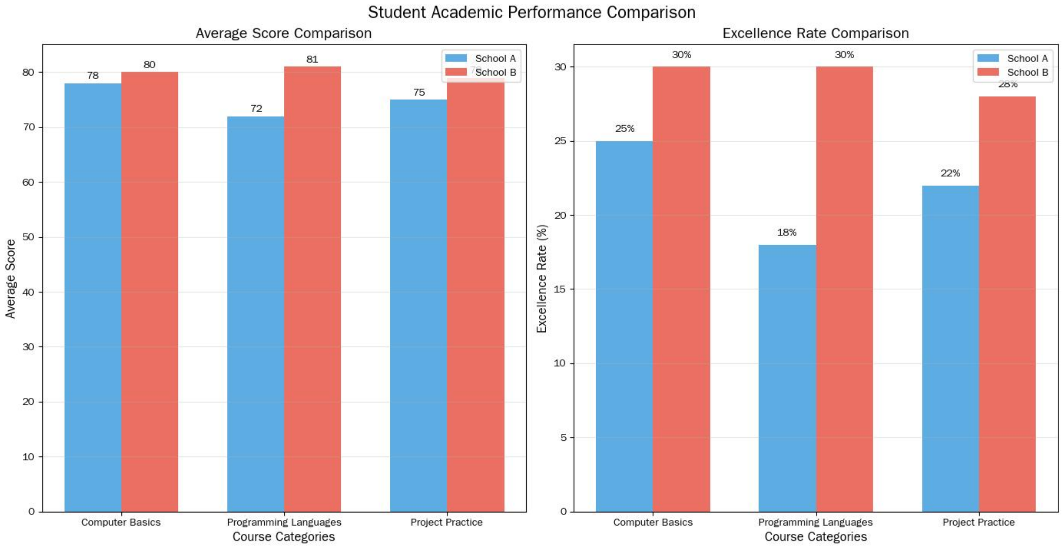

Figure 2 Comparison of Students' Academic Performance

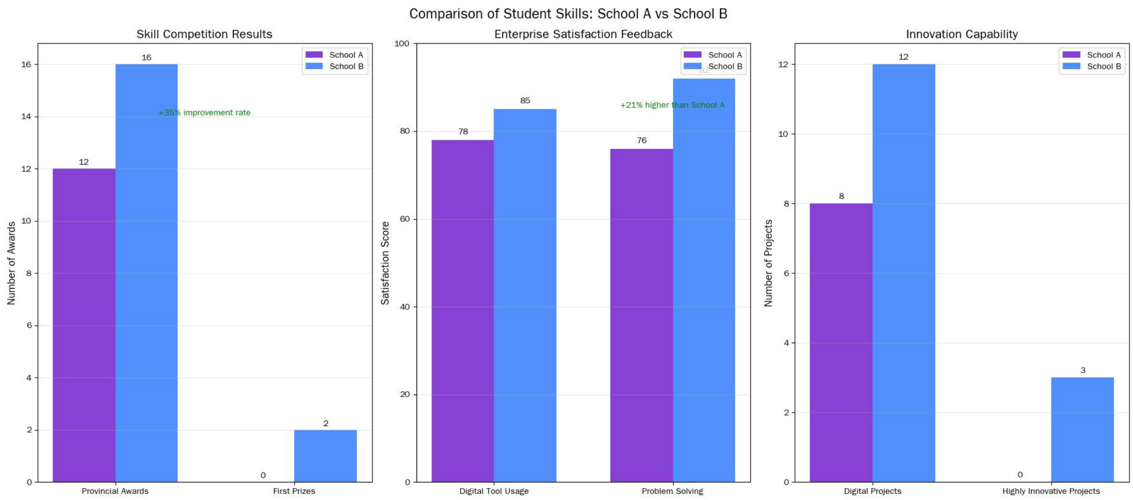

Figure 3 Comparison of Students' Performance in Skills Competitions, Enterprise Feedback, and Innovation Ability

The experimental results show that the average score of students from School B in programming language courses increased by 12%, the provincial competition award - winning rate increased by 35%, and the enterprise satisfaction score for their ability to solve complex problems was 21% higher than that of the control group. A significance test using SPSS ($p<0.05$) verified that the anti - fragile collaborative construction model has a significant effect on improving students' digital capabilities and professional adaptability, providing data support for the practical application of the model.

7 CONCLUSION AND OUTLOOK

This study has achieved breakthroughs both theoretically and practically. Theoretically, it has systematically sorted out the laws of higher vocational computer education, constructed a one-layer goal, four-dimensional core, and two-way collaboration model, and improved the educational system of anti-fragility theory. In practice, it has addressed industry pain points through curriculum updates, teaching innovations, and evaluation reconstruction. However, there are limitations, such as insufficient consideration of external variables like policy response mechanisms and lack of attention to the specific needs of different majors. In the future, it is necessary to supplement influencing factors and iterate the model.
Future research will be advanced from theoretical, practical, and international perspectives. Theoretically, it will explore the coupling mechanism between digital transformation and anti-fragility, and introduce cutting-edge methods to quantify the relationships among various elements. In practice, the model will be extended to majors such as higher vocational electronic information and artificial intelligence, optimized through pilot projects, and promoted for cross-

domain applications. Internationally, in light of global vocational education reforms, research results will be shared through conferences, papers, and cooperative projects, offering a Chinese perspective.

COMPETING INTERESTS

The authors have no relevant financial or non-financial interests to disclose.

FUNDING

This research was funded by the Special Research Project on Digital Transformation of Higher Education Institutions, 2025 (Grant No. GJX25Z2162), the "14th Five-Year Plan" Research Project of Guangdong Association of Higher Education, 2024 (Grant No. 24GWB159), and 2025-2026 Teaching Research Project of the National Research Association for Computer Basic Education in Higher Institutions(Grant No.2025-AFCEC-345).

REFERENCES

[1] Ping W. Research on the Demand and Current Situation of Digital Talent Training in China's Higher Vocational Colleges in the Digital Economy Era. International Educational Research, 2025, 8(4): 121. https://doi.org/10.30560/ier.v8n4p121.

[2] Wei Y, Ren C. Research on the industry-education integration in higher vocational education from the perspective of social partnership theory. Edelweiss Applied Science and Technology, 2025, 9(6): 1740–1747. https://doi.org/10.55214/25768484.v9i6.8237.

[3] Corvello V, Felicetti A M, Troise C, et al. Betting on the future: how to build antifragility in innovative start-up companies. Review of Managerial Science, 2023, 18(4): 1101–1127. https://doi.org/10.1007/s11846-023-00636-x.

[4] Baker W E, Mukherjee D, Gattermann Perin M. Learning orientation and competitive advantage: A critical synthesis and future directions. Journal of Business Research, 2022, 144: 863–873. https://doi.org/10.1016/j.jbusres.2022.02.003.

[5] Borah D, Ellwood P. The micro-foundations of conflicts in joint university-industry laboratories. Technological Forecasting and Social Change, 2022, 175: 121377. https://doi.org/10.1016/j.techfore.2021.121377.

[6] Zhao Y. Research on the Optimization of Digital Technology-Based Higher Education Teaching Models. Journal of Contemporary Educational Research, 2025, 9(6): 100–105. https://doi.org/10.26689/jcer.v9i6.10898.

[7] Exploration and practice of hybrid teaching model for computer fundamental courses under the background of new engineering. Curriculum and Teaching Methodology, 2025: 8(3). https://doi.org/10.23977/curtm.2025.080322.

[8] Skliarova I. Project-Based Learning and Evaluation in an Online Digital Design Course. Electronics, 2021, 10(6): 646. https://doi.org/10.3390/electronics10060646.

[9] Zhang F, Li S, Zhao Q, et al. Assessing and prioritizing interactive teaching modes based on student satisfaction in higher education: A case study of a freshmen class. Education and Information Technologies, 2024, 30(5): 6511–6545. https://doi.org/10.1007/s10639-024-13073-4.

[10] Collins H. Future work skills response: A teaching transformation using agility and evidence. Studies in Technology Enhanced Learning, 2023, 3(2). https://doi.org/10.21428/8c225f6e.9b1a2982.

[11] Kang L. Revolutionizing Vocational Education: Information-Based Instruction and the Knowledge Economy. Journal of the Knowledge Economy, 2024, 16(2): 6248–6280. https://doi.org/10.1007/s13132-024-01797-0.

[12] Lu Y, Wang T. Quality Evaluation Model of Vocational Education in China: A Qualitative Study Based on Grounded Theory. Education Sciences, 2023, 13(8): 819. https://doi.org/10.3390/educsci13080819.

[13] Chen X, Yu S. Synergizing Culture and Tourism Talents: Empowering Tourism Enterprises for Success. Journal of the Knowledge Economy, 2023, 15(3): 12439–12471. https://doi.org/10.1007/s13132-023-01598-x.

[14] Skrbinjek V, Vičič Krabonja M, Aberšek B, et al. Enhancing Teachers' Creativity with an Innovative Training Model and Knowledge Management. Education Sciences, 2024, 14(12): 1381. https://doi.org/10.3390/educsci14121381.

[15] Zhang K, Zhou J, Zhang S. Research on Building Vocational Education Teaching Quality Evaluation System Based on Big Data Technology. Proceedings of the 2nd International Conference on Information, Control and Automation, ICICA 2022, December 2-4, 2022, Chongqing, China. 2024. https://doi.org/10.4108/eai.2-12-2022.2327919.

[16] Zhang W, Palaoag T, Han G. Problems and Countermeasures of Computer Applied Talents Training Under the Background of "Production-Education Integration and Collaborative Education". Journal of Higher Education Teaching, 2024, 1(6): 1–7. https://doi.org/10.62517/jhet.202415601.

[17] Wang H, Zhang L. Research on Collaborative Education Innovation Model in Vocational and Technical Colleges. Occupation and Professional Education, 2025, 2(1): 57–61. https://doi.org/10.62381/o252110.

[18] R A, V S. Bridging the Gap Between Industry Needs and Student Skills for Quality Education Through Sdgs: An Industry-Academia Collaboration in Curriculum Development. Journal of Lifestyle and SDGs Review, 2024, 4(4): e03616. https://doi.org/10.47172/2965-730x.sdgsreview.v4.n04.pe03616.

[19] Kiriliuk O M, Zakharova V D. Innovative strategies for the development of the university's ecosystem in the age of digital transformation. Krasnoyarsk Science, 2024, 13(2): 16–32. https://doi.org/10.12731/2070-7568-2024-13-2-239.

[20] Pang D, Wang S, Ge D, et al. Enhancing E-commerce Management with Machine Learning and Internet of Things: Design and Development. Journal of the Knowledge Economy, 2024, 16(1): 290–316. https://doi.org/10.1007/s13132-024-01969-y.

[21] Fan H, Deng Q, Zhou W, et al. Exploration of Data Acquisition and Processing Technology Course Education Based on OBE Concept. IGARSS 2022 - 2022 IEEE International Geoscience and Remote Sensing Symposium, 2022: 4114–4117. https://doi.org/10.1109/igarss46834.2022.9884626.

[22] Cui L, Xiao Y, Liu D, Han H. Digital twin-driven graph domain adaptation neural network for remaining useful life prediction of rolling bearing. Reliability Engineering & System Safety, 2024, 245: 109991. https://doi.org/10.1016/j.ress.2024.109991.

[23] Jinmei W, Chaozhu H, Wenshu T, et al. Construction of a core competitiveness evaluation index system for undergraduate training in nursing. In Chinese Journal of Nursing Education, 2023.

[24] Wallström J, Lindblom J. Design and Development of the USUS Goals Evaluation Framework. In Springer Series on Bio- and Neurosystems. Springer International Publishing, 2020: 177-201. https://doi.org/10.1007/978-3-030-42307-0_7.

[25] Hörmann C, Kuka L, Schmidthaler E, et al. Digital education training for teachers—Learnings from Austria. Frontiers in Education, 2024, 9. https://doi.org/10.3389/feduc.2024.1490123.

[26] Li Z. Design of Teaching Resource Sharing Platform Towards Intelligent Informatization. 2023 IEEE 3rd International Conference on Social Sciences and Intelligence Management (SSIM), 2023: 119–122. https://doi.org/10.1109/ssim59263.2023.10469321.